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R E P O R T

FROM THE

SELECT COMMITTEE

ON

SCIENTIFIC INSTRUCTION;

TOGETHER WITH THE

PROCEEDINGS OF THE COMMITTEE,

MINUTES OF EVIDENCE,

AND APPENDIX.

Ordered, by The House of Commons, to be Printed,
15 July 1868.

Tuesday, 24th March 1868

Ordered, THAT a Select Committee be appointed to inquire into the provisions for giving instruction in theoretical and applied Science to the Industrial Classes.

Friday, 27th March 1868.

Ordered, THAT the Select Committee on Scientific Instruction do consist of Eighteen Members.

Committee nominated.—

Mr. Acland.	Mr. Gregory.
Mr. Akroyd.	Mr. Thomas Hughes.
Mr. Bagnall	Sr Charles Lanyon.
Mr. Bazley.	Mr. M'Lagan.
Mr. Beecroft	Lord Robert Montagu.
Mr. Henry Austin Bruce.	Mr. Edmund Potter.
Lord Frederic Cavendish.	Mr. Powell.
Mr. Dixon.	Mr. Read.
Mr. Graves.	Mr. Samuelson.

Ordered, THAT the Committee have power to send for Persons, Papers, and Records.

Ordered, THAT Five be the Quorum of the Committee.

Monday, 30th March 1868.

Ordered, THAT the Committee do consist of Nineteen Members.

Ordered, THAT Mr. William Lowther be added to the Committee.

Wednesday, 16th July 1868.

Ordered, THAT the Committee have power to report their Observations, together with the Minutes of Evidence taken before them, to the House.

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R E P O R T.

THE SELECT COMMITTEE appointed to inquire into the Provisions for giving INSTRUCTION in Theoretical and Applied SCIENCE to the INDUSTRIAL CLASSES;—HAVE considered the matters to them referred, and have agreed to the following REPORT.—

In order to ascertain the state of scientific instruction amongst the industrial classes, your Committee has called before it witnesses representing the following bodies.—

1st. The Department of Science and Art of South Kensington, the Committee of Council for Education, and the Government Colleges of Science and Naval Architecture.

2nd The Universities of Oxford, Cambridge, London, and Edinburgh; The Royal College of Science, Dublin, Queen's College, Belfast, King's College and University College, London; and Owens' College, Manchester.

3rd. The few secondary schools in which science has been for some time systematically taught

4th. The managers and teachers of science classes and mechanics' institutes receiving aid from the State, or supported exclusively by voluntary efforts.

5th. The population engaged in the great staple industries carried on in the principal manufacturing towns and districts

Their evidence may be included under two heads.—

1st The state of scientific instruction of,

(1.) The foremen and workmen engaged in manufactures.

(2) The smaller manufacturers and managers.

(3) The proprietors and managers-in-chief of large industrial undertakings, and—

2nd. The relation of industrial education to industrial progress.

I.—THE STATE OF SCIENTIFIC INSTRUCTION OF FOREMEN and WORKMEN.

It is stated that the foremen are almost, without exception, persons who have been selected from the class of workmen by reason of their superior natural aptitude, steadiness, and industry. Their education, and that of the workmen, during the school age, has been received in elementary schools; and owing both to the defective character of the instruction in some of those schools, and to the early age at which the children go to work, it is rarely sufficient to enable them to take advantage of scientific instruction at a later period.

In this statement the children educated as half-timers under the Factory Acts must as a rule be included. The evidence of Mr. Mundella and other witnesses tends to show that the primary education received in the factory schools

is insufficient, except where the employment and education are both uninterrupted between the ages of 8 and 13, and where the instruction is given in good schools established or supported by manufacturers who take an active and intelligent interest in the welfare of the children whom they employ.

The little rudimentary knowledge acquired at school is rarely retained after the young people have been at work two or three years, and elementary scientific instruction is thus entirely beyond the reach of a large portion of our industrial population. The series of schools at Halifax, at Oldham, &c. are exceptional instances of fair elementary education to children, followed by elementary instruction in theoretical and applied science to young persons and adults.

It is stated by many witnesses (and on this subject your Committee would direct particular attention to the evidence of the Rev. Thos. Cromwell, Principal of the Training School at Chelsea) that the tendency of the Revised Code has been to diminish the efficiency of elementary education. It is hoped that the recent introduction of a seventh standard of examination may have a contrary and beneficial effect, and it is contended that drawing and elementary knowledge of physical geography, of the properties of matter, and of the laws of health, may be taught to young children in every elementary school.

The existing elementary classes in experimental science are generally held in connection with mechanics' or literary institutions; although their number has increased of late, they are confined chiefly to the Metropolis and its neighbourhood, and to Lancashire, the West Riding of Yorkshire and Cornwall, and to Edinburgh and Glasgow, and Birmingham.

The pupils may present themselves for the examinations of the Society of Arts, and of the Department of Science and Art at South Kensington. When such pupils are of the artizan class, and are successful, payment according to results is made to the teachers by the Department, and Queen's prizes or medals are given to the pupils themselves.

Besides artizans, draughtsmen, clerks, teachers, and other persons of various grades, attend these classes, and the evidence of Professor Tyndall, Professor Huxley, and the other examiners, as well as of many other competent witnesses, concurs to show that the instruction, though elementary, is sound.

Elsewhere these classes scarcely exist. There are no such classes permanently established in the north-eastern, eastern, west midland, or southern counties, and in many parts of England the fact that Government aid is granted to them was unknown until public attention was drawn to it by the recent discussion of the subject of technical education, and by the appointment of this Committee. It is true that the Science and Art Directory shows numerous classes scattered over the country, but they are mostly confined to rudimentary instruction in chemistry, physiology, and botany, in various schools. Though not without value of their own, they have very little, if any, direct influence on the industrial occupations of any class.

In Scotland, where the superior primary instruction of the artizans removes one of the obstacles to their acquiring scientific instruction, the Watt Institution of Edinburgh and the Andersonian University of Glasgow have rendered good service, the former during nearly half a century, the latter for more than 20 years; they can boast amongst their scholars such names as those of Nasmyth, James Young, and many others. Technical objections have hitherto prevented these schools from receiving the grants of the Science and Art Department, but within the last 12 months these have been overcome.

The Mining School of Cornwall, as described by Mr. Robert Hunt, Keeper of Mining Records, is the only one of its kind: the mining population being scattered over a wide area, it is necessary to send a teacher to the villages in order to conduct the classes.

The miners are taught the elements of chemical and physical science with special reference to their occupations; and the school is producing results which are excellent, though limited as to their area by want of funds. The wages of the miners are inadequate to enable them to pay fees sufficiently high to support the school, even with the aid of payment on results from the Department of Science and Art, and the local subscriptions do not enable the promoters to provide instruction for all the villages which require or desire it.

The witnesses from the North of England, representing the coal trade,
Messrs.

Messrs. Daglish and Cochrane, are anxious for the establishment of a similar peripatetic school in the pit villages of Durham and Northumberland. Until their attention was drawn to the Cornish Mining School, they were quite unaware of its existence. They state that the proprietors of collieries would be willing to provide the necessary buildings, and they consider it essential that the Department of Science and Art should give its advice, and the services of its organising master, to the local committees which may be formed to carry out science instruction amongst the mining population of those counties.

At the Working Men's College, Halifax, evening classes for scientific instruction in chemistry, as applied to the manufactures of the locality, and in machine drawing and practical geometry, were opened in August 1867. At Huddersfield special classes are now in course of formation for teaching chemistry, as applied to dyeing, to foremen and apprentices. These classes are supported by the principal manufacturers and merchants of the neighbourhood. At Bradford a subscription list has been opened for the erection of a School of Science and Art, at a cost of 50,000 £., to which one of its citizens has offered a contribution of 5,000 £. The munificent gift of 100,000 £. by Mr. Whitworth, for the endowment of scholarships in mechanical engineering is offered on conditions that give to the artizans, concurrently with men of other grades, and who have received a more liberal education, an opportunity of acquiring a scientific knowledge of their craft and profession.

The Hulme branch of the Amalgamated Society of Carpenters has been the first trade society to establish an adult school in which carpenters and joiners, whether members of the society or not, may be taught drawing, the principles of building, construction, and other branches of science having special reference to their trade.

The Bristol Trade School, and the Navigation School of Hull, both aided by grants on results from the Science and Art Department, are conspicuous examples of the successful introduction of science teaching into elementary schools of a superior kind for artizans. The Bristol School is fully described in the evidence of Mr. Thomas Comber. The building, formerly used as a national school, is rent free, and receives some 150 boys of the ages of 12 to 15, who are taught elementary mathematics, chemistry, physics, and mechanical drawing. They pay a fee of 3 £. per annum, which, together with the grant on results, covers the cost of conducting the school. The principal engineering and chemical establishments of the city accept for their vacant apprenticeships, with marked preference and partiality, the pupils of the Trade School.

A hindrance second only to that of the defective elementary instruction of the pupils is the scarcity of science teachers, and the want of schools for training them. The remuneration of the teachers, arising from pupils' fees and payment on results by the Department of Science and Art, is with few exceptions so scanty that science teaching is scarcely ever followed as a profession, but only as an addition to some more profitable employment. Hence classes are frequently suspended whenever the more important occupations of the teacher demand increased attention, or cause him to remove to other localities.

Nearly all the witnesses claim, as a means of augmenting their emoluments, some relaxation of the rule which prevents teachers being paid on the results of instruction given to persons who are not artizans.

As the demand for instruction increases, the incomes of the teachers will doubtless increase likewise, but the want of competent men will still remain. The offer, under a recent Minute of the Department, of sums of 25 £. per annum in aid of scholarships to be founded by localities contributing like sums, together with the remission of the fees of the Government Colleges of Science to the holders of such scholarships, will probably induce some young men to prepare themselves for the career of elementary science teachers.

II.—THE SCIENTIFIC INSTRUCTION OF THE SMALLER MANUFACTURERS AND MANAGERS.

Unfortunately, this division may be disposed of in a very few words. Its members have either risen from the rank of foremen and workmen, in which case all that has been stated of the first division will also apply to them; or

else they are an offshoot from the class of smaller tradesmen, clerks, &c, and have been educated in the ordinary secondary endowed, and so-called commercial schools. With some admirable exceptions, the instruction which they afford is certainly not superior to that of the best conducted elementary schools, and even in the better schools of this grade the principles of science are scarcely ever taught. The pupils have, however, generally remained at school till the age of 14 or 15, and they never lose the use of the elementary instruction which they had acquired at school. Hence, where the opportunity for instruction in adult science classes exists, they have not, like the artizans, to contend with the mere clerical obstacles to the acquisition of scientific knowledge.

III.—THE PROPRIETORS AND MANAGERS OF GREAT INDUSTRIAL UNDERTAKINGS.

In those not unfrequent cases where these persons also have risen from the rank of artizans, the same exceptional gifts, including more especially those of unconquerable perseverance and energy which had caused their elevation, have also enabled them generally to correct the deficiencies of their early literary training. Any knowledge of scientific principles which they may have acquired is generally the result of solitary reading, and of observation of the facts with which their pursuits have made them familiar.

More generally, however, the training of the capitalists, and of the managers of their class, has been that of the higher secondary schools, followed in rare, though in more recent years less unfrequent, instances, by a course of more or less systematic scientific instruction in colleges like the Royal School of Mines, the Royal College of Chemistry, University and King's Colleges, London, Owens' College, Manchester, and the Laboratories of the Universities of Edinburgh and Glasgow. The scientific courses of Oxford have been too recently instituted, and have hitherto been devoted too entirely to pure science, to have had any appreciable influence on the scientific instruction of this class, besides which, a feeling exists, to which expression was given by Mr Chance, the eminent manufacturer of Smethwick, himself a man of great scientific attainments, and a distinguished member of the University of Cambridge, that however suitable the Universities may be or become for the training of professors of science of the higher class, the habits at present, acquired there by the sons of wealthy men are not conducive to the successful prosecution of an industrial career.

The Military and Scientific Department of the Proprietary College of Cheltenham, and the City of London Endowed School, are exceptional instances of secondary schools in which instruction in science holds the first place. In the great public schools of Harrow and Rugby, instruction in one scientific subject, in addition to classics and mathematics, has only recently been made compulsory.

Any attempt to analyse briefly the evidence as to the degree of instruction given at King's College and University College, London, and Owens' College, Manchester, would probably fail to convey a correct impression, your Committee would therefore direct attention to the evidence. The same observation applies to the University of Edinburgh, where a Chair of Civil Engineering has recently been founded by Sir David Baxter, to the endowment of which the Government has agreed to contribute.

The engineers of Manchester and the neighbourhood have raised a fund for endowing a similar Chair at Owens' college in that city. To that fund, a single firm of mechanical engineers contributes 3,000 *l.*, besides a subscription of 250 *l.* per annum from one of its partners. The college is full to overflowing, and a proposed building fund of 150,000 *l.* has already received subscriptions amounting to 40,000 *l.*

The Royal School of Mines in Jermyn-street, in addition to its lectures to artizans, delivered by some of the most eminent men of science, has systematic courses of lectures in nearly every subject usually comprised in a higher technical course, with the important exception of mathematics.

The number of its matriculated students is under 20, its metallurgical laboratory, which has room for only 10 students, is always full. The Royal College of Chemistry in Oxford-street, which is connected with it, has about 40 students in its laboratory. It cannot accommodate more.

It has been possible, in consequence of the good preparatory teaching of elementary mathematics in the Dockyard Schools from which the pupils are drafted, to make mathematical instruction, which is wanting in Jermyn-street, one of the principal features of the Royal School of Naval Architecture at South Kensington, the only school of naval construction in the kingdom. According to the evidence of Mr. Reed, Chief Constructor to the Navy, this school is rendering most essential service to that department. The pupils are engaged during six months in constructive works in the various dockyards, and undergo a complete course of technical training at South Kensington in all that relates to their art, during the rest of the year.

Your Committee does not consider it desirable to refer in this report to the Royal College of Science in Dublin, or to the Queen's Colleges and science classes in Ireland, as the subject of the institutions for promoting science and art in Ireland is now undergoing separate investigation.

2. *The Relation of Industrial Education to Industrial Progress.*

The industrial system of the present age is based on the substitution of mechanical for animal power; its development is due in this country to its stores of coal and of metallic ores, to our geographical position, and temperate climate, and to the unrivalled energy of our population.

The acquisition of scientific knowledge has been shown by the witnesses to be only one of the elements of an industrial education and of industrial progress. Indeed, there is a preponderance of evidence to show that so far as the workmen, as distinguished from the managers, are concerned, it can be considered an essential element only in certain trades, or, generally, as enlarging the area from which the foremen and managers may be drawn.

In all cases another and an indispensable element of industrial success is the acquisition of practical experience and manipulative skill.

The evidence given before your Committee places beyond all doubt the fact, that these latter acquirements are possessed in a pre-eminent degree by our manufacturing population of every grade, according to their several necessities. They are obtained in our factories, our forges, our workshops, our shipyards, and our mines, which, in their organization and appliances, are the models which, with a few special exceptions, other nations have hitherto imitated and followed, but not surpassed.

Although the pressure of foreign competition, where it exists, is considered by some witnesses to be partly owing to the superior scientific attainments of foreign manufacturers, yet the general result of the evidence proves that it is to be attributed mainly to their artistic taste, to fashion, to lower wages, and to the absence of trade disputes abroad, and to the greater readiness with which handicraftsmen abroad, in some trades, adapt themselves to new requirements.

It is owing to one or more of these favourable conditions, rather than to superior education or technical skill, that the lacemakers of Calais, and the locomotive manufacturers of Creuzot and of Esslingen, are competing with this country in neutral markets, and even at home; and Mr. Cochrane states that the low rate of wages alone enabled the factory at Anzin to furnish him with pumping and winding engines, constructed according to his own design, but of excellent workmanship, for his collieries in Northumberland and Durham.

Only two witnesses from Birmingham, the one an eminent merchant, the other a manufacturing jeweller, and Mr. Gill, a woollen manufacturer, of Innerleithen, in Scotland, attribute the loss of certain trades to the superior skill, appliances, and education of the German, Belgian, and American manufacturers; and the great steel works of Krupp, in Westphalia, have been named as the only instance of a factory which is said to possess an organisation superior to that of any establishment in the same branch of industry in this country.

At the same time, nearly every witness speaks of the extraordinarily rapid progress of Continental nations in manufactures, and attributes that rapidity, not to the model workshops which are met with in some foreign countries, and are but an indifferent substitute for our own great factories, and for those which are rising up in every part of the Continent; but, besides other causes, to the scientific training of the proprietors and managers in France,

Switzerland, Belgium, and Germany, and to the elementary instruction which is universal amongst the working population of Germany and Switzerland. There can be no doubt, from the evidence of Mr. Mundella, of Professor Fleeming Jenkin, Mr Kitson, and others, and from the numerous reports of competent observers, that the facilities for acquiring a knowledge of theoretical and applied science are incomparably greater on the Continent than in this country, and that such knowledge is based on an advanced state of secondary education.

All the witnesses concur in desiring similar advantages of education for this country, and are satisfied that nothing more is required, and that nothing less will suffice, in order that we may retain the position which we now hold in the van of all industrial nations. All are of opinion that it is of incalculable importance economically that our manufacturers and managers should be thoroughly instructed in the principles of their arts.

They are convinced that a knowledge of the principles of science on the part of those who occupy the higher industrial ranks, and the possession of elementary instruction by those who hold subordinate positions, would tend to promote industrial progress by stimulating improvement, preventing costly and unphilosophical attempts at impossible inventions, diminishing waste, and obviating in a great measure ignorant opposition to salutary changes.

Whilst all the witnesses concurred in believing that the economical necessity for general and scientific education is not yet fully realised by the country, some of them consider it essential that the Government should interfere much more actively than it has done hitherto, to promote the establishment of scientific schools and colleges in our great industrial centres.

In reference to the sufficiency, or the reverse, of voluntary efforts, it is stated, on the one hand, that premiums of several hundred pounds are paid for the admission into the offices of civil, and the workshops of mechanical engineers, of pupils, many of whom fail to avail themselves fully of the valuable instruction which they would obtain there, owing to the absence on their part of all preliminary instruction in mathematics and physical science. It is reasonably inferred that persons who are willing to pay those large sums, and who do not hesitate to send their sons to expensive schools, will be prepared to pay for instruction in science as soon as they are convinced of its utility. It is argued, on the other hand, that in all countries, and at all times, the offer of education of every kind has preceded the demand, and that any temporary sacrifice on the part of the State, in order to place scientific instruction within the reach of those who would be likely to appreciate it, will be amply and speedily repaid by the increase of the general intelligence and prosperity which it will produce.

A more general opinion on the part of the witnesses than either of these opposite views is, that wherever any locality in which, from its geographical position and industrial importance, it may be presumed that a scientific college or a higher secondary school of science is likely to be successful, is prepared to contribute largely to the creation and maintenance of such an institution, the State may fairly give assistance to such locality by liberal grants for building and apparatus, in addition to the existing payments on results and scholarships.

CONCLUSIONS.

The evidence which has been given before your Committee, and in part summarised in the preceding pages, together with the information which is accessible to them in common with other members of the community, has convinced them :

(1) That with the view to enable the working class to benefit by scientific instruction it is of the utmost importance that efficient elementary instruction should be within the reach of every child.

(2) That unless regular attendance of the children for a sufficient period can be obtained, little can be done in the way of their scientific instruction.

(3) That elementary instruction in drawing, in physical geography, and in the phenomena of nature, should be given in elementary schools.

(4.) That

(4.) That adult science classes, though of great use to artizans, to foremen, and to the smaller manufacturers, cannot provide all the scientific instruction which those should possess who are responsible for the conduct of important industrial undertakings. That all whose necessities do not oblige them to leave school before the age of 14, should receive instruction in the elements of science as part of their general education.

(5.) That the reorganisation of secondary instruction and the introduction of a larger amount of scientific teaching into secondary schools are urgently required, and ought to receive the immediate consideration of Parliament and of the country.

(6.) That it is desirable that certain endowed schools should be selected in favourable situations for the purpose of being reconstituted as science schools, having in view the special requirements of the district, such schools to be rendered available to the surrounding districts, by the establishment of exhibitions open to public competition, so that the children of every grade may be able to rise from the lowest to the highest school.

(7.) That superior colleges of science, and schools for special scientific instruction requiring costly buildings and laboratories, cannot be supported by fees alone, without aid from one or more of the following sources, namely, the State, the localities, and endowments or other benefactions.

(8.) That such colleges and special schools are most likely to be successful if established in centres of industry, because the choice of such centres tends to promote the combination of science with practice on the part both of the professors and of the pupils, and to enable many to attend them to whom the expense of living at a distance from home would otherwise be an insuperable barrier.

(9.) That the provinces of England, especially the agricultural districts, have not received a sufficient proportion of the State grants for scientific education.

(10.) That those provinces of England are entitled to such a modification of the public grants as will afford them increased aid, supplementary to the funds which they may raise in their own localities for the purpose of promoting scientific instruction. That grants of money from the national exchequer for local scientific instruction should be chiefly designed to promote local activity, and a better use of resources otherwise available, and should be regarded as occasional or temporary.

(11.) That some slight addition to the emoluments of science teachers would probably tend materially to promote the establishment and permanence of elementary science classes.

(12.) That the provisions of the Public Libraries and Museums Act should be altered so as to enable public bodies to levy a slightly increased rate for scientific purposes.

(13.) That the managers of training colleges for the teachers of elementary schools should give special attention to the instruction of those teachers in theoretical and applied science, where such instruction does not exist already.

(14.) That teachers in elementary day schools should be paid on results, for teaching science to the older scholars, in the same way as payment is now made for drawing in such schools. That the education of higher science teachers should be encouraged, by the granting of degrees in science at Oxford and Cambridge as at other Universities, and by the opening of a greater number of fellowships to distinction in natural science as well as in literature, and mathematical and moral science.

(15.) That a more intimate connection between the various Government institutions for scientific instruction in London would increase the efficiency of each of those institutions, and that the constitution and management of those institutions and their future relations to each other requires further investigation.

PROCEEDINGS OF THE COMMITTEE.

Thursday, 2nd April 1868.

MEMBERS PRESENT:

Mr. Samuelson.	Mr. Read.
Mr. Akroyd.	Mr. Acland.
Mr. E. Potter.	Mr. Dixon.
Mr. Powell.	Mr. Gregory.
Mr. M'Lagan.	Lord Frederic Cavendish.
Mr. William Lowther.	Mr. Graves.
Mr. Bagnall.	

Mr. *Samuelson* was called to the Chair.

The Committee deliberated.

[Adjourned to Thursday, 23rd April, at Twelve o'clock.

Thursday, 23rd April 1868.

MEMBERS PRESENT:

Mr. SAMUELSON in the Chair.

Mr. Gregory.	Lord Frederic Cavendish.
Mr. Dixon.	Lord Robert Montagu.
Mr. Potter.	Sir Charles Lanyon.
Mr. Bazley.	Mr. Austin Bruce.
Mr. M'Lagan.	Mr. Bagnall.
Mr. Lowther.	Mr. Graves.

Mr. *Henry Cole*, C.B., and Captain *Donnelly*, R.E., were severally examined.

[Adjourned to Monday next, at Twelve o'clock.

Monday, 27th April 1868

MEMBERS PRESENT:

Mr. SAMUELSON in the Chair.

Mr. Akroyd.	Mr. Austin Bruce.
Mr. Bagnall.	Mr. Gregory.
Lord Robert Montagu.	Lord Frederic Cavendish.
Mr. Read.	Sir Charles Lanyon.
Mr. M'Lagan.	Mr. William Lowther.
Mr. Bazley.	Mr. Dixon.
Mr. Potter.	Mr. Acland.

Captain *Donnelly*, R.E., further examined.

Mr. *R. R. W. Lingen* examined.

[Adjourned to Thursday next, at Twelve o'clock.

Thursday, 30th April 1868.

MEMBERS PRESENT.

Mr. SAMUELSON in the Chair.

Mr. Akroyd.	Mr. Austin Bruce.
Mr. Read	Mr. Gregory
Mr. Potter.	Mr. M'Lagan,
Lord Robert Montagu.	Mr. Bazley.
Lord Frederic Cavendish	Mr. Dixon.
Sr Charles Lanyon.	Mr. Bagnall.
Mr Acland.	Mr. Lowther

Mr. Henry Cole and Captain Donnelly, R E, further examined

Dr. Lyon Playfair examined

[Adjourned to Monday next, at Twelve o'clock.

Monday, 4th May 1868.

MEMBERS PRESENT:

Mr SAMUELSON in the Chair

Mr. Bazley	Lord Frederic Cavendi
Mr. Potter	Lord Robert Montagu.
Mr Akroyd	Mr Dixon.
Mr. Lowther.	Mr. Read
Mr Bagnall.	Mr Austin Bruce
Mr. Graves	

Mr. Trenham Reeks, Mr. J. F. Lelan, and Dr. J. Percy, were severally examined.

[Adjourned till Thursday next, at Twelve o'clock.

Thursday, 7th May 1868.

MEMBERS PRESENT.

Mr. SAMUELSON in the Chair.

Mr. Bazley.	Lord Frederic Cavendish.
Mr. Potter.	Mr. Austin Bruce
Mr. Akroyd.	Mr Graves.
Mr. Dixon.	Mr M'Lagan.
Mr. Acland.	Mr Read.
Mr. Lowther.	

Mr. Joseph Whitworth and Mr. Robert Hunt, F R S., were severally examined.

[Adjourned till Monday next, at Twelve o'clock.

Monday, 11th May 1868.

MEMBERS PRESENT:

Mr. SAMUELSON in the Chair

Mr. Lowther.
Mr. Acland.
Mr. Austin Bruce.
Mr. Akroyd.
Mr. Potter.

Mr. Bazley.
Sir Charles Lanyon.
Mr. M'Lagan
Lord Frederic Cavendish.
Mr. Read.

Dr. *W. B. Carpenter* and Professor *John Tyndall* were severally examined

[Adjourned to Thursday next, at Twelve o'clock.

Thursday, 14th May 1868.

MEMBERS PRESENT:

Mr. SAMUELSON in the Chair.

Mr. Graves.
Mr. Bazley.
Mr. Potter.
Mr. Dixon.
Mr. Lowther.
Mr. Acland.
Mr. Akroyd.

Lord Frederic Cavendish.
Mr. Read
Mr. M'Lagan
Lord Robert Montagu.
Mr. Austin Bruce.
Sir Charles Lanyon.

Room cleared—The Committee deliberated.

Professor *Fleming Jenkin* examined.

[Adjourned to Monday next, at Twelve o'clock.

Monday, 18th May 1868.

MEMBERS PRESENT:

Mr. SAMUELSON in the Chair

Mr. Gregory.
Mr. Lowther.
Mr. Acland.
Lord Robert Montagu.
Mr. Akroyd.
Mr. Potter.

Mr. Bazley.
Mr. M'Lagan
Sir Charles Lanyon.
Mr. Read.
Mr. Powell.
Mr. Dixon

Professor *R. B. Clifton* and Sir *R. Kane* were severally examined.

[Adjourned till Thursday next, at Twelve o'clock.

Thursday, 21st May 1868.

MEMBERS PRESENT:

Mr. SAMUELSON in the Chair.

Mr. Graves
Mr. Dixon.
Mr. Acland.
Mr. Bagnall.
Mr. Bazley.

Mr. William Lowther.
Mr. Potter.
Mr. Read.
Mr. M'Lagan.

Rev. Dr. *Joseph Woolley* and Mr. *E. J. Reed* were severally examined.

[Adjourned till Monday next, at Twelve o'clock.

Monday, 25th May 1868.

MEMBERS PRESENT:

Mr SAMUELSON in the Chair

Mr. Graves.	Mr. Bazley
Mr. Gregory.	Mr. Bagnall.
Mr. Potter.	Mr. Acland.
Mr. Dixon.	Mr. M'Lagan.
Mr. Akroyd.	Mr. Read.
Lord Frederic Cavendish.	Sir Charles Lanyon.

Mr *J. W. Cunningham*, Dr. *W. A. Miller*, and Rev. *E. A. Abbott*, M.A., were severally examined.

[Adjourned till Thursday next, at Twelve o'clock.

Thursday, 28th May 1868.

MEMBERS PRESENT.

Mr SAMUELSON in the Chair.

Mr. Gregory.	Mr. Dixon.
Mr. Bazley.	Mr. Acland.
Mr. Potter.	Mr. William Lowther
Mr. Akroyd.	Mr. Bagnall

Rev. Canon *Moseley*, Mr. *Thomas Coomber*, and Rev. *John G. Cromwell*, M.A., were severally examined.

[Adjourned till Monday, 8th June, at Twelve o'clock.

Monday, 8th June 1868.

MEMBERS PRESENT

Mr. SAMUELSON in the Chair

Mr. Lowther.	Mr. Read.
Lord Frederic Cavendish.	Mr. M'Lagan.
Mr. Akroyd.	Mr. Dixon.
Mr. Potter	

Mr. *Henry William Ripley*, Mr. *George Gibb*, Mr. *William Henry Stopford*, and Mr. *George Jarman*, were severally examined.

[Adjourned till Thursday next, at Twelve o'clock

Thursday, 11th June 1868.

MEMBERS PRESENT.

Mr. SAMUELSON in the Chair.

Mr. Potter.	Lord Frederic Cavendish.
Mr. Dixon.	Mr. Akroyd.
Mr. Bazley.	Mr. Powell.
Mr. Graves.	Mr. Austin Bruce.
Mr. Lowther.	Sir Charles Lanyon.
Mr. Bagnall.	Mr. Beecroft.

Mr. *Anthony John Mundella*, Mr. *Henry Ashwell*, Mr. *Thomas Isaac Birkin*, Mr. *James Kitson*, jun., and Mr. *Henry H. Sales*, were severally examined.

[Adjourned till Monday next, at Twelve o'clock.

Monday, 15th June 1868.

MEMBERS PRESENT :

Mr. SAMUELSON in the Chair.

Mr. Acland.	Mr. Bagnall.
Mr. Akroyd.	Mr. M'Lagan.
Mr. Lowther.	Mr. Read.
Mr. Potter	Mr. Dixon.
Mr. Bazley.	Mr. Powell.

Dr. J. Watts, Mr. Thomas Lawton, and Mr John Angell, were severally examined.
Mr. J. F. Ischn further examined.

[Adjourned till Thursday next, at Twelve o'clock.

Thursday, 18th June 1868

MEMBERS PRESENT :

Mr. SAMUELSON in the Chair.

Mr. Potter	Mr. Lowther
Mr. Bazley.	Mr. Powell.
Mr. Akroyd.	Sir Charles Lanyon.
Mr. Acland	Mr. Dixon.
Mr. Bagnall.	Mr. M'Lagan.

Professor Henry E. Roscoe, F.R.S., and Mr John Platt (a Member of the House) were severally examined.

[Adjourned till To-morrow, at Twelve o'clock.

Friday, 19th June 1868

MEMBERS PRESENT :

Mr. SAMUELSON in the Chair.

Mr. Read.	Mr. Dixon.
Mr. Potter.	Mr. Powell
Mr. Acland.	Mr. Bagnall.
Mr. Lowther.	Lord Frederic Cavendish.

Mr. Robert Rumney examined.

[Adjourned till Monday next, at Twelve o'clock.

Monday, 22nd June 1868.

MEMBERS PRESENT :

Mr. SAMUELSON in the Chair.

Mr. Dixon.	Mr. Bagnall.
Mr. Potter	Mr. Acland.
Mr. Lowther.	Lord Frederic Cavendish.
Mr. Akroyd.	Mr. Powell.

Mr. John Henry Chamberlann, Mr. W. C. Aitken, Mr. John Bragg, and Mr. C Hibbs were severally examined.

[Adjourned till Thursday next, at Twelve o'clock

Thursday, 25th June 1868

MEMBERS PRESENT.

Mr. SAMUELSON in the Chair.

Lord Robert Montagu.	Mr Graves.
Mr Dixon.	Mr Acland.
Mr. Potter.	Mr Lowther.
Mr. Powell.	Mr M'Lagan
Mr. Akroyd.	Mr. Read.

Captain *Donnelly*, R. E., further examined.

Mr. *James Chance*, Mr. *Alfred Field*, Dr. *George Lloyd*, and Mr. *John Sharrow Wright*, were severally examined

[Adjourned till Monday next, at Twelve o'clock.

Monday, 29th June 1868.

MEMBERS PRESENT.

Mr. SAMUELSON in the Chair

Mr Akroyd.	Mr. Powell
Mr. M'Lagan.	Lord Frederic Cavendish.
Mr. Bazley.	Mr. Dixon
Mr. Potter	Mr. Read.
Sir Charles Lanyon.	

Sir *C Lanyon* (a Member of the Committee), Mr *R Calvert Clapham*, Mr. *William Cochrane*, Mr. *John Daglish*, and Mr. *Henry Watson*, were severally examined.

[Adjourned till Thursday next, at Twelve o'clock

Thursday, 2nd July 1868

MEMBERS PRESENT :

Mr. SAMUELSON in the Chair.

Mr. Gregory	Mr. M' Lagan.
Mr M'Lagan.	Mr. Austin.
Mr. Lowther.	Lord Frederic Cavendish.
Mr. Akroyd.	Mr. Dixon.
Mr. Bazley.	Mr. Graves.
Mr. Powell.	

Dr. *Stevenson Macadam*, Mr. *John Mayer*, F C S., Mr. *Robert Gill*, and Mr. *William Bann*, were severally examined.

[Adjourned till To-morrow, at Twelve o'clock.

Friday, 3rd July 1868.

MEMBERS PRESENT:

Mr SAMUELSON in the Chair.

Lord Robert Montagu	Mr. M'Lagan.
Mr. Dixon	Mr. Akroyd.
Mr. Potter	Mr. Acland.
Mr. Bazley	Mr. Lowther.
Mr. Powell.	Lord Frederic Cavendish.

Captain *Donnelly*, R E, further examined.

Lord *Robert Montagu* (a Member of the Committee), Professor *T H. Huxley*, F.R.S., Dr *E Frankland*, F R S, and Mr *J. C Buchmaster*, were severally examined.

[Adjourned to Tuesday, 14th, at Twelve o'clock (to consider Report).

Tuesday, 14th July 1868.

MEMBERS PRESENT

Mr SAMUELSON in the Chair.

Mr Powell.	Sir Charles Lanyon
Mr Potter	Lord Robert Montagu.
Mr Akroyd	Mr. Acland.
Mr. Bazley	Mr. Read.
Mr. Dixon.	

DRAFT REPORT proposed by the Chairman, read a first time as follows—

“ 1. In order to ascertain the state of scientific instruction amongst the industrial classes, your Committee has called before it witnesses representing the following bodies.—

“ 1st. The Department of Science and Art of South Kensington, the Committee of Council for Education, and the Government Colleges of Science and Naval Architecture

“ 2nd. The University of Oxford, the University of London, and certain institutions unconnected with the State, in which science is taught exclusively, or holds a prominent position

“ 3rd. The few secondary schools in which science has been for some time systematically taught.

“ 4th. The managers and teachers of science classes and mechanics' institutes receiving aid from the State, or supported exclusively by voluntary efforts.

“ 5th. The population engaged in the great staple industries carried on in the principal manufacturing towns and districts

“ 2. Their evidence may be included under two heads —

“ 1st. The state of scientific instruction of,

“ (1) The foremen and workmen engaged in manufactures

“ (2) The smaller manufacturers and managers.

“ (3) The proprietors and managers-in-chief of large industrial undertakings, and—

“ 2nd. The relation of industrial education to industrial progress.

“ I.—THE STATE OF SCIENTIFIC INSTRUCTION OF FOREMEN AND WORKMEN.

“ 3. It is stated that the foremen are almost, without exception, persons who have been selected from the class of workmen by reason of their superior natural aptitude, *steadiness*, and industry. Their education, and that of the workmen, during the school age, has been received in elementary schools; and owing both to the defective character of the instruction

instruction in those schools, and to the early age at which the children go to work, it is rarely sufficient to enable them to take advantage of scientific instruction at a later period.

" 4. In this statement the children educated as half-timers under the Factory Acts must, as a rule, be included. The evidence of Mr Mundella and other witnesses tends to show, that the primary education received in the factory schools is insufficient, except where the employment and education are both uninterrupted between the ages of eight and 13, and where the instruction is given in good schools established or supported by manufacturers who take an active and intelligent interest in the welfare of the children whom they employ.

" 5 As a rule, the little rudimentary knowledge acquired at school is rarely retained after the young people have been at work two or three years, and elementary scientific instruction is thus entirely beyond the reach of a large portion of our industrial population. The series of schools at Halifax, at Oldham, &c., are exceptional instances of fair elementary education to children, followed by elementary instruction in theoretical and applied science to young persons and adults.

" 6. It is stated by nearly every witness (and on this subject your Committee would direct particular attention to the evidence of the Rev Thos. Cromwell, principal of the training school at Chelsea) that the tendency of the Revised Code has been to diminish the efficiency of elementary education. It is hoped that the recent introduction of a seventh standard of examination may have a contrary and beneficial effect, and it is contended that physical geography, the elements of drawing, of the properties of matter, and of the laws of health, may be taught to young children in every elementary school.

" 7. The existing elementary classes in experimental science are generally held in connection with mechanics or literary institutions, although their number has increased of late, they are confined chiefly to the Metropolis and its neighbourhood, and to Lancashire, the West Riding of Yorkshire and Cornwall, and to Edinburgh and Glasgow.

" The pupils may present themselves for the examinations of the Society of Arts, and of the Department of Science and Art at South Kensington. When such pupils are of the artizan class, and are successful, payment according to results is made to the teachers by the Department, and Queen's prizes or medals are given to the pupils themselves.

" Besides artizans, draughtsmen, clerks, teachers, and other persons of various grades, attend these classes, and the evidence of Professor Tyndall, Professor Huxley, and the other examiners, as well as of many other competent witnesses, concurs to show that the instruction, though elementary, is sound.

" 8 Elsewhere than in the districts named, these classes scarcely exist. In the midland counties, the Midland Institution of Birmingham is the only one in which experimental science is systematically taught. There are no such classes permanently established in the north-eastern, eastern, west midland, or southern counties, and in many parts of England, the fact that Government aid is granted to them was unknown, until public attention was drawn to it by the recent discussion on the subject of technical education, and by the appointment of this Committee. It is true that the Science and Art Directory shows numerous classes scattered over the country, but they are mostly confined to rudimentary instruction in chemistry, physiology, and botany, in various schools. Though not without value of their own, they have very little, if any, direct influence on the industrial occupations of any class.

" 9 In Scotland, where the superior primary instruction of the artizans removes one of the obstacles to their acquiring scientific instruction, the Watt Institution of Edinburgh, and the Andersonian University of Glasgow have rendered good service, the former during nearly half a century, the latter for more than 20 years, they can boast amongst their scholars such names as those of Nasmyth, James Young, and many others. Technical objections have hitherto prevented these schools from receiving the grants of the Science and Art Department, but within the last 12 months these have been overcome.

" 10. The Mining School of Cornwall, as described by Mr Robert Hunt, Keeper of Mining Records, is the only one of its kind; the mining population being scattered over a wide area, it is necessary to send a teacher to the villages in order to conduct the classes.

" The miners are taught the elements of chemical and physical science with special reference to their occupations; and the school is producing results which are excellent, though limited as to their area by want of funds. The wages of the miners are inadequate to enable them to pay fees sufficiently high to support the school, even with the aid of payment on results from the Department of Science and Art, and the local subscriptions do not enable the promoters to provide instruction for all the villages which require or desire it.

" 11. The witnesses from the north of England, representing the coal trade, Messrs. Dalglish & Cochrane, are anxious for the establishment of a similar peripatetic school in the

pit villages of Durham and Northumberland. Until their attention was drawn to the *Corman Mising School*, they were quite unaware of its existence. They state that the proprietors of collieries would be willing to provide the necessary buildings, and they consider it essential that the Department of Science and Art should give its advice, and the services of its organising master, to the local matter which may be formed to carry out science instruction amongst the mining population of those counties.

"12 At Huddersfield special classes are now in course of formation for teaching chemistry, as applied to dyeing, to foremen and apprentices. These classes are supported by the principal manufacturers and merchants of the neighbourhood. At Bradford a subscription list has been opened for the erection of a school of Science and Art, at a cost of 50,000 £, to which one of its citizens has offered a contribution of 5,000 £; and the munificent gift of 10,000 £ by Mr. Whitworth, for the endowment of scholarships in mechanical engineering, is offered on conditions that give to the artisans, concurrently with men of other grades, and who have received a more liberal education, an opportunity of acquiring a scientific knowledge of their craft and profession.

"13. The Hulme branch of the Amalgamated Society of Carpenters has been the first trade society to establish an adult school in which carpenters and joiners, whether members of the society or not, may be taught drawing, the principles of building, construction, and other branches of science having special reference to their trade.

"14. The Bristol Trade School, and the Navigation School of Hull, both aided by grants on results from the Science and Art Department, are conspicuous examples of the successful introduction of science teaching into elementary schools of a superior kind for artisans. The Bristol school is fully described in the evidence of Mr Thomas Comber. The building, formerly used as a national school, is rent free, and receives some 150 boys of the ages of 12 to 15, who are taught elementary mathematics, chemistry, physics, and mechanical drawing. They pay a fee of 3 £. per annum, which, together with the grant on results, covers the cost of conducting the school.

"15. A hindrance second only to that of the defective elementary instruction of the pupils is the scarcity of science teachers, and the want of schools for training them. The remuneration of the teachers, arising from pupils' fees and payment on results by the Department of Science and Art, is, with few exceptions, so scanty that science teaching is scarcely ever followed as a profession, but only as an addition to some more profitable employment. Hence, classes are frequently suspended whenever the more important occupations of the teacher demand increased attention, or cause him to remove to other localities.

"Nearly all the witnesses claim, as a means of augmenting their emoluments, some relaxation of the rule which prevents teachers being paid on the results of instruction given to persons who are not artisans.

"16 As the demand for instruction increases, the incomes of the teachers will doubtless increase likewise, but the want of competent men will still remain. The offer, under a recent Minute of the Department, of sums of 25 £ per annum in aid of scholarships to be founded by localities contributing like sums, together with the remission of the fees of the Government Colleges of Science, to the holders of such scholarships, will probably induce some young men to prepare themselves for the career of elementary science teachers.

" II. THE SCIENTIFIC INSTRUCTION OF THE SMALLER MANUFACTURERS AND MANAGERS.

"17 Unfortunately, this division may be disposed of in a very few words. Its members have either risen from the rank of foremen and workmen, in which case all that has been stated of the first division will also apply to them; or else they are an offshoot from the class of smaller tradesmen, clerks, &c, and have been educated in the secondary endowed, and so-called commercial schools. With some advantage the instruction which they afford is certainly not superior to that of elementary schools; and even in the better schools of this grade the principles of science are scarcely ever taught. The pupils have, however, generally remained at school till the age of 14 or 15, and they never lose the use of the elementary instruction which they had acquired at school. Hence, where the opportunity for instruction in adult science classes exist, they have not, like the artisans, to contend with the mere clerical obstacles to the acquisition of scientific knowledge.

" III.—THE PROPRIETORS AND MANAGERS OF GREAT INDUSTRIAL UNDERTAKINGS.

"18. In those not unfrequent cases where these persons also have risen from the rank of artisans, the same exceptional gifts, including more especially those of unconquerable perseverance and energy which had caused their elevation, have also enabled them generally to correct the deficiencies of their early literary training. Any knowledge of scientific

scientific principles which they may have acquired is generally the result of solitary reading, and of synthetical observation of the facts, with which their pursuits have made them familiar.

" 19 More generally, however, the training of the capitalists, and of the managers of their class, has been that of the higher, secondary, or public schools, followed in rare, though in more recent years less unfrequent, instances, by a course of more or less systematic scientific instruction in colleges like the Royal School of Mines, the Royal College of Chemistry, University and King's Colleges, London, Owens' College, Manchester, and the laboratories of the Universities of Edinburgh and Glasgow. The scientific courses of Oxford have been too recently instituted, and have hitherto been devoted too entirely to pure science, to have had any appreciable influence on the scientific instruction of this class, besides which, a feeling exists, to which expression was given by Mr Chance, the eminent manufacturer of Smethwick, himself a man of great scientific attainments, and a distinguished member of the University of Cambridge, that however suitable the universities may be or become for the training of professors of science of the higher class, the habits at present acquired there by the sons of wealthy men are not conducive to the successful prosecution of an industrial career.

" 20 The Military and Scientific Department of the Proprietary College of Cheltenham, and the City of London Endowed School, are exceptional instances of secondary schools in which instruction in science holds the first place. In the great public schools of Harrow and Rugby, instruction in one scientific subject, in addition to classics and mathematics, has only recently been made compulsory.

" 21. Any attempt to analyse briefly the evidence as to the degree of instruction given at King's College and University College, London, and Owens' College, Manchester, would probably fail to convey a correct impression your Committee would therefore direct attention to the evidence *in extenso*. The same observation applies to the University of Edinburgh, where a Chair of Civil Engineering has recently been founded by Sir David Baxter, to the endowment of which the Government has agreed to contribute.

" 22 The inhabitants of Manchester have raised a fund for endowing a similar Chair at Owens' College in that city. To that fund, a single firm of mechanical engineers contributes 3,000 *l.*, besides a subscription of 250 *l.* per annum from one of its partners. The college is full to overflowing, and a proposed building fund of 150,000 *l.* has already received subscriptions amounting to 40,000 *l.*

" 23. The Royal School of Mines, in addition to its lectures to artizans delivered by some of the most eminent men of science, has systematic courses of lectures in nearly every subject usually comprised in a higher technical course, with the important exception of mathematics.

" The number of its matriculated students is under 20; its metallurgical laboratory, which has room for only 10 students, is always full. The Royal College of Chemistry in Oxford-street, which is connected with it, has about 40 students in its laboratory. It cannot accommodate more.

" 24 It has been possible, thanks to the good preparatory teaching of elementary mathematics in the Dockyard schools from which the pupils are drafted, to make mathematical instruction, which is wanting in Jermyn-street, one of the principal features of the Royal School of Naval Architecture at South Kensington, the only school of naval construction in the kingdom. According to the evidence of Mr Reed, Chief Constructor to the Navy, this school is rendering most essential service to that department. The pupils are engaged during six months in constructive works in the various dockyards, and undergo a complete course of technical training at South Kensington in all that relates to their art, during the rest of the year.

" 25 Your Committee does not consider it desirable to refer in this Report to the Royal College of Science in Dublin, or to the Queen's Colleges and science classes in Ireland, as the subject of the institutions for promoting science and art in Ireland is now undergoing separate investigation.

" 26 The following abstracted statement of the cost of instruction in some of the preceding schools or institutions, though only approximate, may be of service—

" Royal School of Mines, 30 *l.* for three years, exclusive of laboratory fees, which are from to per annum.

" Royal College of Chemistry, 6 *l.* per annum, exclusive of laboratory fees, which are

" King's College Scientific Department,

" University College,

" Owens' College, Manchester; evening classes to working men, at per course

" Cheltenham College Military Department, 28 *l.* per annum, books, laboratory, &c., 8 *l.* per annua.

" City of London School, 9 £ per annum.

" Bristol Diocesan Trade School, 3 £ per annum.

" *Note.*—King's College is self-supporting; the ground having been contributed by the State, and the building, for all departments, having cost £

" Owens' College is endowed by very large benefactions of the late Mr. Owens and others.

" The City of London School, according to the evidence of the head master, the Rev. E. Abbott, would be compelled to raise the fees from 9 £ to 13 £, if it had to pay rent for its buildings, and received no aid from endowments; and the masters are said to be inadequately remunerated.

" The Bristol Trade School has no endowment, except the free use of the buildings

" The fees in the adult science classes usually vary from 5 s to 10 s. per course, the State contributes to the maintenance of the teachers by payments on the results of the May examination of artizan pupils, in addition to which there is in nearly all cases considerable aid from local subscriptions, and from the general funds of mechanics' and other similar institutions.

" 2 *The Relation of Industrial Education to Industrial Progress*

" 27. The industrial system of the present age is based on the substitution of mechanical for animal power; its development is due in this country to its stores of coal and of metallic ores, to our geographical position and temperate climate, and to the unrivalled energy of our population.

" 28. The acquisition of scientific knowledge has been shown by the witnesses to be only one of the elements of an industrial education and of industrial progress. Indeed there is a preponderance of evidence to show that, so far as the workmen, as distinguished from the managers, are concerned, it can be considered an essential element only in certain exceptional trades, or, generally, as enlarging the area from which the foremen and managers may be drawn

" 29. In all cases another and an indispensable element of industrial success is the acquisition of practical experience and manipulative skill.

" 30. The evidence given before your Committee places beyond all doubt the fact, that these latter acquirements are possessed in a pre-eminent degree by our manufacturing population of every grade, according to their several necessities. They are obtained in our factories, our forges, our workshops, our shipyards, and our mines, which, in their organization and appliances, are the models which, with a few special exceptions, other nations have hitherto imitated and followed, but not surpassed.

" 31. The pressure of foreign competition, where it exists, is attributed mainly to the artistic taste of foreign nations, to fashion, to lower wages, and to the absence of trade disputes abroad.

" 32. It is owing to one or more of these favourable conditions, rather than to superior education or technical skill, that the lacemakers of Calais, and the locomotive manufacturers of Creuzot and of Esslingen, are competing with this country in neutral markets, and even at home; and Mr. Cochrane states that the low rate of wages alone enabled the factory at Anzin to furnish him with pumping and winding engines, constructed according to his own design, but of excellent workmanship, which he has erected at his collieries in Northumberland and Durham.

" 33. Only two witnesses from Birmingham, the one an eminent merchant, the other a manufacturing jeweller, and Mr. Gill, a woollen manufacturer, of Innerleithen, in Scotland, attribute the loss of certain trades to the superior skill, appliances, and education of the German, Belgian, and American manufacturers, and the great steel works of Krupp, in Westphalia, have been named as the only instance of a factory which is said to possess an organization superior to that of any establishment in the same branch of industry in this country

" 34. At the same time, nearly every witness speaks of the extraordinarily rapid progress of Continental nations in manufactures, and attributes that rapidity, not to the model workshops which are met with in some foreign countries, and are but an indifferent substitute for our own great factories, and those which are rising up in every part of the Continent; but, besides other causes, to the scientific training of the proprietors and managers in France, Switzerland, Belgium, and Germany, and to the elementary instruction which is universal amongst the working population of Germany and Switzerland. There can be no doubt, from the evidence of Mr. Mundella, of Professor Fleeming Jenkin, Mr. Kitson, and others, and from the numerous reports of competent observers, that the facilities for acquiring a knowledge of theoretical and applied science are incomparably greater on the Continent than in this country, and that such knowledge is based on an advanced state of secondary education.

" 35. All

"35. All the witnesses concur in deaving similar advantages of education for this country, and are satisfied that nothing more is required, and that nothing less will suffice, in order that we may retain the position which we now hold in the van of all industrial nations. All are of opinion that it is of incalculably greater importance economically that our manufacturers and managers should be thoroughly instructed in the principles of their arts than that the artizans themselves should possess the elements of such knowledge; and all are agreed that good primary instruction is what is to be chiefly desired for the working class.

"36 They are convinced that a knowledge of the principles of science on the part of those who occupy the higher industrial ranks, and the possession of elementary instruction by those who hold subordinate positions, would tend to promote industrial progress by stimulating improvement, preventing costly and unphilosophical attempts at impossible inventions, diminishing waste, and obviating in a great measure ignorant opposition to salutary changes.

"37. At the same time, the witnesses are far from believing that the economical necessity for general and scientific education is as yet fully realised by the country, and some of them consider it essential that the Government should interfere much more actively than it has done hitherto, to promote the establishment of scientific schools and colleges in our great industrial centres.

"38. In reference to the sufficiency, or the reverse, of voluntary efforts, it is stated, on the one hand, that premiums of several hundred pounds are paid for the admission into the offices of civil, and the workshops of mechanical engineers, of pupils, many of whom fail to avail themselves fully of the valuable instruction which they would obtain there, owing to the absence on their part of all preliminary instruction in mathematics and physical science, and it is reasonably inferred that persons who are willing to pay those large sums, and who do not hesitate to send their sons to expensive schools, will be prepared to pay for instruction in science as soon as they are convinced of its utility; whilst it is argued, on the other hand, that in all countries, and at all times, the offer of education of every kind has preceded the demand, and that any temporary sacrifice on the part of the State, in order to place scientific instruction within the reach of those who would be likely to appreciate it, will be amply and speedily repaid by the increase of the general intelligence and prosperity which it will produce

"39 A more general opinion on the part of the witnesses than either of these extreme views is, that wherever any locality in which, from its geographical position and industrial importance, it may be presumed that a scientific college or a higher secondary school of science is likely to be successful, is prepared to contribute largely to the creation and maintenance of such an institution, the State may fairly give assistance to such locality by moderate grants, and by testing the results of the school

CONCLUSIONS.

"40. The evidence which has been given before your Committee, and in part summarised in the preceding pages, together with the information which is accessible to them in common with other members of the community, has convinced them—

"(1.) That it is of the most vital importance that increased efforts should be made to place efficient elementary instruction within the reach of every child.

"(2) That whilst every assistance should be afforded by parochial aid, or otherwise, to enable poor parents to send their children to school, the cupidity or indifference of those who are placed above want should not be permitted to interfere with the claims of every child to receive such instruction.

"(3) That elementary instruction in drawing, in physical geography, and in the phenomena of nature, should be given in all the larger elementary schools

"(4.) That adult science classes, though of great use to artizans, to foremen, and to the smaller manufacturers, cannot be deemed a substitute for the scientific instruction which those should possess who are responsible for the conduct of important industrial undertakings. That these, in common with all whose necessities do not oblige them to leave school before the age of 16, should receive instruction in the elements of science as part of their general education

"(5) That the reorganization of secondary instruction is urgently required, and that the elaborate reports of the Schools Inquiry Commission, which prove the instruction in those schools to be lamentably defective, whilst abundant funds for efficient education are shown to exist, together with the recommendations of that Commission, ought to receive the immediate consideration of Parliament and of the country.

"(6) That superior primary schools, and secondary schools of various grades, in which science would more or less take the place of classics as an instrument of culture as well as of direct instruction, can be established, and would be self-supporting, if the fees are equal to those paid for literary instruction in good proprietary or adventure schools of similar grade.

"(7.) That superior colleges of science, and special schools for technical instruction requiring costly buildings and laboratories, cannot be supported by fees alone, but must receive aid from one or more of the following sources—from the State, from the localities, and from benefactions.

"(8.) That such colleges and special schools are, for various reasons, most likely to be successful if established in large centres of industry, and more especially for the reason that the choice of such centres tends to promote the combination of science with practice on the part both of the professors and of the pupils

"(9.) That the taxpayers of the provinces of England have not received a full share of the benefit of their contributions to the common fund, out of which the large grants to South Kensington, to Jermyn-street, to the Scottish and Irish Universities, and to the Irish Colleges, have been made.

"(10.) That, therefore, if the principal of sustaining Government Colleges of Science and Museums, and of giving aid to Scottish Universities and Irish Colleges be maintained, the large manufacturing and mining centres of England may fairly ask for such a redistribution of the public grants as will afford them increased aid supplementary to the funds which they may raise in their own localities for the purpose of promoting scientific instruction.

"(11.) That some slight addition to the emoluments of science teachers would probably tend materially to promote the establishment and permanence of elementary science classes. It will be for the department to consider whether such addition, if made, should be by increased payment on results in all or some of the subjects taught, or in other ways which may not appear to be open to abuse

"(12.) That the provisions of the Public Libraries' and Museums' Act should be altered so as to enable public bodies to levy a slightly increased rate for scientific purposes.

"(13.) That the managers of training colleges for the teachers of elementary schools be invited to give special attention to the instruction of those teachers in theoretical and applied science, where such instruction does not exist already

"(14.) That teachers in elementary day schools should be paid on results, for teaching science to the older scholars, in the same way as payment is now made for drawing in such schools.

"(15.) That a more intimate connection between the various Government institutions for scientific instruction in London would increase the efficiency of each of those institutions; but that, having considered the plan of a central college of science at South Kensington, proposed by the Science and Art Department, your Committee would not recommend its adoption until Parliament shall have referred it to the consideration of competent persons "

DRAFT REPORT, proposed by Mr *Acland*, read as follows

" I.—IMPORTANCE OF SCIENTIFIC INSTRUCTION TO THE INDUSTRIAL COMMUNITY.

"(1) *To Firms and Managers*—Scientific instruction is important to the heads and principal managers of manufacturing firms, generally, as one among other branches of a liberal education, and, in particular cases, as supplying information necessary for the economical conduct of business.

"(2) *To the Artizans*—As regards artizans, scientific instruction is desirable, firstly, as a means of cultivating intelligent habits of observation, secondly, as tending to set trades free from obstinate adherence to traditional rules of practice inapplicable to modern requirements; thirdly, scientific instruction is important to the artizan, who has the practical and moral qualities which might fit him to rise to the post of foreman or manager, because the absence of such knowledge might operate as an obstacle to the progress of a man otherwise well qualified for promotion.

" II.—SCIENTIFIC INSTRUCTION, HOW CONNECTED WITH GENERAL EDUCATION, AND TECHNICAL PRACTICE.

" The practical course to be taken in making systematic provision for scientific instruction cannot be decided without taking into account the existing arrangements for general education, and for the acquirement of the technical information commonly required for the practice of particular professions and branches of business.

" These arrangements are in part dependent on certain legal restrictions affecting public endowed institutions (such as the grammar schools), and partly on social, profes-

sional,

sional, and commercial usages, which have created a demand for instruction in private establishments.

"Very large sums are expended in England on *general education*; these sums are derived in part from ancient endowments, in part from modern contributions to proprietary and other schools, and to a very large extent from the payments of parents in the upper and middle classes.

"*Technical instruction* in England exists chiefly in the form of apprenticeship and pupilage, and for the advantage supposed to be derived from seeing practice in those forms, very large sums are paid, in the form of premiums, by persons who desire their sons to enter upon professional, manufacturing, commercial, or agricultural pursuits.

"For *scientific instruction*, either as a part of *general education* or as introduction to *technical training*, the expenditure at present is very small. It is obvious that the success of any course to be pursued with a view to make provision for scientific instruction must depend in great measure on the co-operation of parents; and that such co-operation must be founded on a general conviction of the practical advantage of the means offered. It is probable that, when such conviction shall have been established, private resources may be relied upon for supplying a considerable portion of the necessary expenses.

"It has, however, been frequently asserted that the higher branches of learning, which may not seem to the public at large to produce immediate results, require the sustentation of public funds in order to place the highest talent at the service of the nation. The same statement is probably not less true of many branches of science, the ultimate results of which to the nation, though most beneficial, may not be obvious or generally recognised.

III — PRACTICAL FORMS IN WHICH SCIENTIFIC INSTRUCTION IS NEEDED

"1 The universal establishment of primary schools, in which some of the elements of natural history may form a part of the instruction, accompanied by measures tending to prevent the rising generation from suffering from the neglect or ignorance of their parents or guardians.

"2 The establishment in all towns of secondary schools for artisans and tradesmen willing to keep their children at school to the age of 14 or 15. Drawing, and the elements of mathematics and natural science to be taught in such schools, and the school fees not to exceed 1 l. per quarter.

"3 The further extension and encouragement of evening classes, and the appointment of circulating or organising teachers.

"4 The introduction of the elements of natural science into all endowed secondary schools in which scholars continue their education up to the age of 16 or 18.

"5 The selection of certain endowed schools, in favourable situations in the manufacturing districts, as special science schools, having in view the special requirements of the district; such schools to be rendered available as boarding schools to the surrounding towns, by the establishment of Exhibitions open to public competition; so that the children of the artisan may be promoted from the lowest to the highest school.

"6 The establishment of a small number of colleges for adults more or less corresponding to Owen's College, Manchester, in which advanced science teaching may be given on a scale parallel to that of the Universities, but in more direct relation to the industry of the particular district in which each college is situated. The annual cost of such instruction is estimated at about 30 l. per head, it being presumed that there are 200 pupils, and that good buildings are provided.

"7 The encouragement and certification of trained science teachers by the recognition of natural science as one element in the curriculum of the training colleges or normal schools aided and inspected by Government. It deserves also to be considered whether teachers of secondary schools should be admitted into the training schools on payment of the expense of their instruction.

"8 The encouragement by examination and certificate of self-taught science teachers in the industrial classes.

"9 The establishment of courses of higher science teachers by the granting of degrees in science at Oxford, Cambridge, and opening fellowships to distinction in natural science as well as in mathematics and moral science.

"10 The organisation, by the State, of the secondary education of the country, as a whole, as regards the government and inspection of all publicly-endowed institutions, and the establishment of a recognised standard of attainment for teachers, whether public or private.

“ IV.—SOURCES FROM WHICH THE FUNDS MAY BE DERIVED FOR THE EXPENSES OF SCIENTIFIC INSTRUCTION.

“ The expenses are of three kinds.—

“ *a* *Current Expenses*—Salaries, text-books, materials, chemicals, &c.; repair of apparatus.

“ *b* *Permanent Objects*.—Buildings, new apparatus, museums, libraries of reference.

“ *c* *Official Expenses*.—Inspection; organizing staff for stimulating local action and diffusing information.

“ These expenses may be met by funds derived from the following sources:—

“ The sources of income are as follows:—

“ 1. Fees paid by pupils.

“ 2. Endowments devoted to education.

“ 3. Other public funds, such as obsolete charities, and others of doubtful or mischievous tendency.

“ 4. Voluntary contributions.

“ 5. Local rates.

“ 6. Grants from the public exchequer, or loans advanced on local or personal security.

“ V.—GENERAL PRINCIPLES

“ It is submitted that it is premature to lay down, as applicable to all places, the proportions in which the expenses of scientific instruction may be provided from the above-named sources, but the following general principles are suggested for discussion.—

“ (1) That while moral and economical considerations may justify the expenditure from the national exchequer of considerable sums on general, and especially on primary education, with a view to the diminution of crime, pauperism, and disease, the payment, in whole or in part, of the expense of instruction in science for particular classes is open to *prima facie* objection, and requires some special justification.

“ (2) That such justification for temporary grants from the national funds may to a certain limited extent be sought in present circumstances, which suggest the expediency of measures tending to awaken local activity, and to promote a better use of existing resources.

“ (3) That on this ground some extension of the action of the Department of Science and Art may be deserving of consideration as a temporary measure.

“ (4) That in any extended action of the Government the following principles should be borne in mind —

“ *a*. That expenditure on scientific instruction on the part of the Government is useless without local co-operation, and therefore that the initiative should be taken on the spot, the Government aiding in providing the means, and testing the results.

“ *b*. That endowments for the annual expense of instruction are more effectual when used to stimulate and reward exertion than when they are expended on fixed salaries with a view to make instruction cheap. Therefore, that any portion of existing endowments which may be rightly applicable to scientific instruction should be applied to that object, in the form of exhibitions tenable at good schools or colleges giving scientific instruction.

“ *c*. That the administration of local funds for scientific instruction should be vested in responsible bodies, representing a sufficiently wide area, with a view to guard against undue local influence, and to secure the free action of enlightened public opinion.

“ *d*. That while the evidence before the Committee shows that there is in some quarters great indifference to the importance of scientific instruction, it proves, at the same time, that enlightened individuals and communities, when they are convinced of its necessity, have shown a disposition and ability to make contributions as great as, if not greater than, any which a Government could venture to propose to Parliament to sanction, and therefore that it is more expedient to awaken and direct local exertion than to supersede the necessity for its exercise.

“ *e*. That

"e. That all classes of pupils seeking scientific instruction should be called upon to contribute, according to their means, to the expense of such instruction.

"f. That as regards the special interests of manufacturers, the nation has no more interest in providing for the technical instruction of artizans, and foremen, and managers, than it has in providing agricultural instruction for farm labourers, and hinds, and land agents, with a view to the increase of the production of food

CONCLUSION.

"The general conclusion to be drawn from the inquiries of the Committee is, that Parliament should be urged to proceed without delay—

"1. To organise secondary education.

"2. To recognise instruction in natural science as an indispensable element in such education.

"3. To provide for the central, provincial, and local administration of existing funds, with due regard to the wants and capabilities of each branch of industry.

"4. To press forward further measures for primary education."

Draft Report, proposed by the Chairman, read a second time, paragraph by paragraph

Motion made, and Question put, That paragraphs 1 to 39 inclusive, be postponed—The Committee divided

Ayes, 5.		Noes, 2.
Mr. Acland.		Mr. Akroyd
Mr. Bazley.		Lord R. Montagu
Mr. Dixon.		
Sir C. Lanyon.		
Mr. Powell		

Paragraph 40—Section 1; Amendments made Another Amendment proposed, at the end of the section, to add the words, "And that greater regularity of attendance at school, and a lengthened duration of school life should be secured"—(Mr. Dixon)—Question, That those words be there added—put, and *negatived*.

Section 1, as amended, *agreed to*.

Section 2—Amendments made

Another Amendment proposed, by leaving out the words, "by parochial aid"—(Mr. Acland).—Question put, That those words stand part of the section—The Committee divided

Ayes, 5.		Noes, 2.
Mr. Akroyd.		Mr. Acland.
Mr. Dixon.		Mr. Bazley.
Sir C. Lanyon.		
Lord R. Montagu.		
Mr. Powell.		

Another Amendment proposed, by leaving out the word "poor," in order to insert the word "pauper"—(Lord R. Montagu) instead thereof—Question put, That the word "poor" stand part of the section.—The Committee divided

Ayes, 3.		Noes, 4.
Mr. Acland.		Mr. Akroyd.
Mr. Bazley.		Sir C. Lanyon
Mr. Dixon		Lord R. Montagu.
		Mr. Powell.

Word inserted.

Question, That the section, as amended, stand part of the paragraph.—The Committee divided:

Ayes, 3.		Noes, 4.
Mr. Akroyd.		Mr. Acland.
Mr. Dixon		Mr. Bazley.
Lord R. Montagu.		Sir C. Lanyon.
		Mr. Powell

Section 4.—Amendment proposed, by leaving out " 16 " in order to insert " 14 "—(Mr. Acland), instead thereof.—Question, That 16 stand part of the section—put, and *negatived*.—Question put, That the word " 14 " be there inserted.—The Committee divided :

Ayes, 6.

Mr Acland.
Mr Akroyd.
Mr Bazley.
Mr Powell.
Sir C. Lanyon
Mr Read.

Noes, 2.

Mr Dixon.
Lord R. Montagu.

Section, as amended, *agreed to*.

Section 5 amended, and *agreed to*

Section 6 —Amendment proposed, by leaving out the section, in order to insert the following section —That it is desirable that certain endowed schools should be selected in favourable situations for the purpose of being reconstituted as science schools, having in view the special requirements of the district, such schools to be rendered available to the surrounding districts by the establishment of exhibitions open to public competition, so that the children of every grade may be able to rise from the lowest to the highest school—(Mr Acland), instead thereof.—Question, That Section 6 stand part of the paragraph—put, and *negatived*. Proposed section inserted.

Sections 7 and 8 amended, and *agreed to*.

Section 9 —Amendment proposed, by leaving out from the word " received " to the end of section, in order to add the words " a sufficient proportion of the State Grant for scientific education "—(Mr Dixon), instead thereof.—Question, That the words proposed to be left out stand part of the section—put, and *negatived*.—Question put, That those words be there added.—The Committee divided .

Ayes, 5.

Mr Akroyd
Mr Bazley.
Mr Dixon.
Sir C Lanyon.
Mr. Read

Noes, 2.

Lord R. Montagu.
Mr Acland.

Question, That the section as amended, stand part of paragraph.—The Committee divided .

Ayes, 5

Mr Akroyd.
Mr Bazley.
Mr. Dixon.
Sir C. Lanyon.
Mr. Read

Noes, 2

Mr. Acland.
Lord R. Montagu.

Section 10 —Amendment proposed, by leaving out the words " such a redistribution of the public grants as will afford them increased aid, supplementary to the funds which they may raise in their own localities for the purpose of promoting scientific instruction," in order to add the words, " increased Government aid for the promotion of scientific instruction "—(Mr Dixon), instead thereof.—Question put, That the word " such " stand part of the paragraph.—The Committee divided .

Ayes, 4.

Mr Acland.
Mr. Bazley.
Sir C Lanyon.
Mr. Read.

Noes, 3.

Mr. Akroyd.
Mr. Dixon.
Lord R. Montagu.

Further Amendments made.—Question put, That the section as amended, stand part of the paragraph.—The Committee divided :

Ayes, 4.

Mr Akroyd.
Mr. Bazley.
Mr Dixon.
Mr. Read.

Noes, 3.

Mr. Acland.
Sir C. Lanyon.
Lord R. Montagu.

Amendment proposed, after last section, to insert the following section: "The grants of money from the National Exchequer for local scientific instruction should be chiefly designed to promote local activity and a better use of resources otherwise available, should be regarded as occasional or temporary"—(Mr. Acland).—Question proposed, That this section be there inserted—Amendment proposed, To leave out from the word "available," to the end of the proposed section—(Mr. Akroyd)—Question put, That the words proposed to be left out, stand part of the proposed section—The Committee divided:

Ayes, 3	Noes, 2
Mr. Acland. Mr. Bazley Mr. Read.	Mr. Akroyd Mr. Dixon

Question put, That the proposed Section be there inserted—The Committee divided

Ayes, 3	Noes, 2
Mr. Acland. Mr. Bazley. Mr. Read.	Mr. Akroyd. Mr. Dixon.

Sections 11, 12, 13, 14, 15, *agreed to*, some with Amendments.

Paragraph (40), as amended, *agreed to*.

Postponed paragraph 1, amended, and *agreed to*

Paragraph 2, postponed.

Paragraph 3—Amendment proposed, by leaving out from the words "elementary schools" to the end of the paragraph, in order to add the words "but the amount of education which they, in many instances, possess, is not sufficient to enable them to profit by a scientific instruction"—(Mr. Akroyd), instead thereof.—Question, That the words proposed to be left out, stand part of the paragraph—put, and *agreed to*

Paragraph amended, and *agreed to*

Paragraph 4.—Amendment proposed, to leave out the words "in this statement the children educated as half-timers under the Factory Acts, must, as a rule, be included," in order to insert the words, "these defects are but partially removed by the Factory Acts"—(Mr. Akroyd), instead thereof—Question put, that the words proposed to be left out, stand part of the paragraph.—The Committee divided.

Ayes, 3.	Noes, 2
Mr. Acland. Mr. Bazley. Sir Charles Lanyon.	Mr. Akroyd. Mr. Dixon.

Paragraph *agreed to*.

Amendment proposed, after paragraph 4, to insert the following paragraph—

"In many instances the educational provisions of the Factory Acts are rendered practically inoperative by the short and uncertain attendance of children at school during the half-time period, and in other cases, where a sufficient supply of children above 13 can be obtained, employers refuse to take any short-timers, or to provide means for their education. It has been stated, by Mr. Wright, of Birmingham, that the new Factory and Hours of Labour Regulation Acts have had the effect of throwing out of employment 2,000 to 3,000 hands in Birmingham, and that there are not more than 200 to 250 receiving education under the half-time system; so desirous are employers of ridding themselves of all trouble as to the educational clauses of these Acts.

"It has, however, been admitted by several witnesses, that if children at and above the age of 13 were not allowed to work full time until they had passed an elementary examination in reading, writing, and arithmetic, and obtained a certificate of competency, then the parents and employers of such children, out of regard to their joint interests,

would endeavour to secure the requisite standard of elementary knowledge at an earlier age.

"It has further been suggested that as an incentive to attendance at infant schools previously to entrance on half-time work, a rudimentary examination in simple reading might be deemed a necessary qualification for a half-timer.

"With these additional safeguards against the evasion of the educational provisions of the Factory and Hours of Labour Regulation Acts, it is contended by the advocates of factory education, that these Acts, so amended, might be the means of extending primary education amongst the labouring classes generally."—(Mr. Akroyd)

Question, That this paragraph be there inserted—put, and *negatived*.

Paragraphs 5, 6, amended, and *agreed to*

Amendment proposed, after paragraph 6, to insert the following paragraph —

"(7.) *As respects the Instruction of the Industrial or Artizan Classes in Elementary Science*—After the formation of the Science and Art Department in 1853, attempts were made in various forms to afford the working classes opportunities for instruction in the elements of science. These experiments do not appear to have met with much success till, in 1859, a general minute on the subject was passed by the Lords of the Committee of Council on Education. This minute, greatly enlarged, and with various modifications which experience has suggested from time to time, forms the code of rules termed the Science Directory, and according to its provisions the grants in aid of science schools are administered. It is a pure system of payments on the results of instruction, as tested by the annual examinations of the department. The payments are only made on account of the instruction of students of the artizan or industrial classes. The prizes are open to all. Under this system a steady and rapid increase has been maintained, both in the number of classes and the students under instruction. This will appear from the following Table :

	Number of Schools.	Number under Instruction.
1860	9	500
1861	38	1,330
1862	70	2,543
1863	75	3,111
1864	91	4,668
1865	120	5,479
1866	153	6,835
1867	212	10,230
1868	300	14,600

"In this each separate institution in which scientific instruction is given is treated as a school, but the subjects taught and the number of classes in the different schools vary much. In some cases a school consists of but one class, and there is only one subject taught, in others there are as many as nine and ten classes in different subjects. The general results, as compared with the two previous years, are given below "

"RESULTS of the SCIENCE SCHOOL EXAMINATIONS, May 1866, 1867, and 1868.

	1866.	1867.	1868.
Number of schools under certificated teachers	153	212	300
Number of classes in the same	400	560	789
Number of individuals under instruction in certificated teachers	6,835	10,230	14,600
Number of the above who came up for examination	2,960	4,520	—
Number examined in addition to the above in schools under certificated teachers	170	400	300

" Results of the Science School Examinations, May 1866, 1867, and 1868—continued

	1866.	1867.	1868.
Number of Papers worked in —			
Subject			
I Practical, Plane, and Descriptive Geometry - - - - -	517	783	1,337
II Mechanical and Machine Drawing - - - - -	469	764	1,671
III Building, Construction, and Naval Architecture - - - - -	233	467	1,206
IV. Elementary Mathematics - - - - -	290	778	1,890
V Higher Mathematics - - - - -	24	36	33
VI. Theoretical Mathematics - - - - -	178	228	353
VII Applied Mechanics - - - - -	86	110	167
VIII Acoustics, Light and Heat - - - - -	327	590	769
IX Magnetism and Electricity - - - - -	353	738	1,038
X Inorganic Chemistry - - - - -	1,043	1,082	964
XI Organic Chemistry - - - - -	121	121	123
XII Geology - - - - -	194	207	309
XIII. Mineralogy - - - - -	21	34	38
XIV. Animal Physiology - - - - -	497	599	1,132
XV Zoology - - - - -	79	127	298
XVI Vegetable Physiology and Economic Botany - - - - -	138	100	112
XVII. Systematic Botany - - - - -	114	79	73
XVIII. Mining - - - - -	22	38	41
XIX. Metallurgy - - - - -	62	63	81
XX Navigation - - - - -	118	144	219
XXI. Nautical Astronomy - - - - -	77	88	87
XXII. Steam - - - - -	95	121	106
XXIII. Physical Geography - - - - -	409	931	1,516
TOTAL Number of Papers worked - - - - -	5,466	8,213	13,113
Number of provincial centres where examinations were held - - - - -			
	121	152	241
Number of metropolitan centres where examinations were held (including South Kensington Museum) - - - - -			
	13	15	23
Number of 5th Class - - - - -			
	778	1,587	2,359
" 4th " - - - - -			
	713	973	1,044
" 3rd Queen's Prizes - - - - -			
	1,228	1,576	2,475
" 2nd Queen's Prizes - - - - -			
	501	1,122	1,692
" 1st Queen's Prizes - - - - -			
	342	755	1,079
TOTAL Number of Successes - - - - -	3,562	6,013	8,649
Failures - - - - -			
	1,904	2,200	4,464

" From the evidence we have had before us, and from the reports made by the examiners to the Science and Art Department, it appears that there is a marked improvement as well in the nature of the instruction given as in the number of students. That this progress should have been made in eight years, cannot but be considered highly satisfactory, when it is remembered that during that time a knowledge of the existence of the system has had to be diffused in the country, necessarily a slow operation, and not only the classes, but the teachers to be treated. The payments on the results of the May 1867 examination amounted to 7,976 *l.*, being at the rate of 15 *s* 7 *d.* per person under instruction, or nearly 1 *l.* per examination paper worked, or nearly 1 *l.* 15 *s.* per individual student examined. In recent months these payments are increased at least 10 per cent.

" That the country has not more generally taken advantage of the aid offered by the State can be due only to the apathy and indifference on the subject which has unfortunately hitherto obtained.

" We find that under existing rules large payments can be earned in well-organised secondary schools, such as the Bristol Trade School; and in night classes, as at Heywood, Droydsden, Bolton, and Bury, though these do not occupy the whole time of the teacher, who may devote his day to other occupations."—(Lord Robert Montagu.)

Question, That this paragraph be there inserted—put, and *negatived*.

XXX PROCEEDINGS OF SELECT COMMITTEE ON SCIENTIFIC INSTRUCTION.

Remaining paragraphs *agreed to*, some with Amendments.

Postponed paragraph 2, further considered.

Amendment proposed, at the end of the paragraph, to add the words—"3rd. The duty of the State with reference to the promotion of scientific instruction"—(Mr. Dixon).—
Question, That those words be there added—put, and *negatived*.

Question, That this Report be the Report of the Committee to the House—put, and *agreed to*

Ordered, To Report, together with Minutes of Evidence and Appendix.

EXPENSES OF WITNESSES.

NAME OF WITNESS	Profession or Condition.	From whence Summoned	Number of Days absent from Home, under Orders of Committee	Expenses of Journey to London and back.	Allowances during Absence from Home.	Total Expenses allowed to Witnesses
Sir Robert Kane	President, Queen's College, Cork	Cork	4	9 - -	4 4 -	13 4 -
Mr Thomas Coomber	Head Master, Trade School	Bristol	2	1 18 -	2 2 -	4 - -
Mr Thomas Lawton	Agent of Lancashire and Cheshire Union	Manchester	4	3 10 -	4 4 -	7 14 -
Mr John Angell	Head Master, Mechanics' Institution	Manchester	4	3 10 -	4 4 -	7 14 -
Dr John Watts	Ph D	Manchester	4	3 10 -	4 4 -	7 14 -
Mr John Henry Chamberlain	Architect	Birmingham	1	1 18 6	3 3 -	5 1 -
Mr Charles Hibbs	Gunmaker	Birmingham	2	1 10 -	2 2 -	3 12 -
Mr W H Stopford	Schoolmaster	Halifax	4	3 7 6	4 4 -	7 11 -
Mr George Grubb	ditto	Halifax	4	3 7 6	4 4 -	7 11 -
Mr G Jarman	Science Teacher	Huddersfield	4	3 4 -	4 4 -	7 8 -
Mr. W Cochrane	Engineer	Newcastle-on-Tyne	3	4 13 -	9 9 -	14 2 -
Mr Henry Watson	ditto	Newcastle-on-Tyne	3	4 13 -	9 9 -	14 2 -
Mr J Daglish	ditto	Newcastle-on-Tyne	3	4 13 -	9 9 -	14 2 -
Mr R. C. Clapham	Chemical Manufacturer	Newcastle-on-Tyne	3	4 13 -	3 3 -	7 16 -
Dr Stevenson Macadam	Lecturer on Chemistry	Edinburgh	3	6 6 -	3 3 -	9 9 -
Mr. John Mayer	Science Teacher	Glasgow	3	6 6 -	3 3 -	9 9 -
Mr William Baird	Ironwork Contractor	Edinburgh	3	6 6 -	3 3 -	9 9 -
Mr Robert Gill	Manufacturer	Inverleithan, Glasgow	3	6 15 -	3 3 -	9 19 -
Mr Henry Sales	-	Leeds	-	2 15 -	- - -	2 15 -
						162 13 6

MINUTES OF EVIDENCE.

LIST OF WITNESSES.

<i>Thursday, 23rd April 1868.</i>		<i>Thursday, 11th June 1868.</i>	
Henry Cole, Esq, C.B., and Captain Donnelly, R.E. - - -	PAGE - - - 1	Mr. Anthony John Mundella - -	PAGE - 232
<i>Monday, 27th April 1868.</i>		Mr. Henry Ashwell and Mr. Thomas Isaac Birkin - - -	243
Captain Donnelly, R.E. - - -	22	Mr. James Kitson, jun. - - -	247
R. R. W. Lingen, Esq. - - -	37	Mr. Henry H. Sales - - -	251
<i>Thursday, 30th April 1868.</i>		<i>Monday, 15th June 1868.</i>	
Henry Cole, Esq, C.B. - - -	45	Mr. John Watts, PH. D. - - -	256
Captain Donnelly, R.E. - - -	56	Mr. Thomas Lawton - - -	266
Dr. Lyon Playfair, C.B. - - -	57	Mr. John Angell - - -	269
<i>Monday, 4th May 1868.</i>		Mr. J. F. Iselin, M.A. - - -	273
Trenham Reeks, Esq. - - -	69	<i>Thursday, 18th June 1868.</i>	
John Frederick Iselin, Esq. - -	74	Professor Henry E. Roscoe, F.R.S. -	276
Dr. John Percy - - -	76	John Platt, Esq, M.P. - - -	290
<i>Thursday, 7th May 1868.</i>		<i>Friday, 19th June 1868.</i>	
Joseph Whitworth, Esq. - - -	85	Mr. Robert Rumney - - -	297
Robert Hunt, Esq, F.R.S. - -	94	<i>Monday, 22nd June 1868.</i>	
<i>Monday, 11th May 1868.</i>		Mr. John Henry Chamberlain - -	308
Dr. W. B. Carpenter - - -	104	Mr. William C. Aitken - - -	315
Professor John Tyndall - - -	118	Mr. John Bragg - - -	319
<i>Thursday, 14th May 1868.</i>		Mr. Charles Hibbs - - -	324
Professor Fleeming Jenkin - -	122	<i>Thursday, 25th June 1868.</i>	
<i>Monday, 18th May 1868.</i>		Captain Donnelly, R.E. - - -	330
Professor Robert Bellamy Clifton -	143	Mr. James Chance - - -	330
Sir Robert Kane - - -	152	Mr. Alfred Field - - -	335
<i>Thursday, 21st May 1868.</i>		Dr. George Lloyd - - -	341
Rev. Dr. Joseph Woolley - - -	164	Mr. John Skurrow Wright - - -	343
Edward J. Reed, Esq. - - -	168	<i>Monday, 29th June 1868.</i>	
<i>Monday, 25th May 1868.</i>		Sir Charles Lanyon, M.P. - - -	349
John William Cunningham, Esq., and Dr. William Allen Miller - -	173	Mr. R. Calvert Clapham - - -	351
Rev. Edwin Abbott Abbott, M.A. -	182	Mr. William Cochrane - - -	357
<i>Thursday, 28th May 1868.</i>		Mr. John Daghsh - - -	364
Rev. Canon Moseley - - -	192	Mr. Henry Watson - - -	368
Thomas Coomber, Esq. - - -	199	<i>Thursday, 2nd July 1868.</i>	
Rev. John G. Cromwell, M.A. - -	206	Dr. Stevenson Macadam - - -	370
<i>Monday, 8th June 1868.</i>		Mr. John Mayer, F.C.S. - - -	382
Mr. Henry William Rapley - - -	210	Mr. Robert Gill - - -	386
Mr. George Gibb - - -	222	Mr. William Bain - - -	390
Mr. William Henry Stopford - -	225	<i>Friday, 3rd July 1868.</i>	
Mr. George Jarman - - -	227	Captain Donnelly, R.E. - - -	392
		Right Hon. Lord Robert Montagu, M.P.	395
		Professor Thomas H. Huxley, L.L.D., F.R.S. - - -	397
		Dr. Edward Frankland, F.R.S. - -	403
		Mr. John Charles Buckmaster - -	411

MINUTES OF EVIDENCE.

Thursday, 23rd April 1868.

MEMBERS PRESENT.

Mr Bagnall.
Mr Bazley
Mr. Henry Austin Bruce.
Lord Frederick Cavendish
Mr Dixon
Mr. Graves
Mr. Gregory

Sir Charles Lanyon.
Mr. M'Lagan
Lord Robert Montagu.
Mr Edmund Potter.
Mr. Samuelson.
Mr William Lowther.

BERNHARD SAMUELSON, Esq., IN THE CHAIR.

HENRY COLE, Esq, C.B, and Captain DONNELLY, R.E., Examined

1 *Chairman.*] You are Secretary of the Science and Art Department, are you not?—I am

2 That department is an enlargement of the Practical Art Department, and that enlargement was made in 1853?—It was

3. At that time Mr Cardwell was President of the Board of Trade, was he not?—He was I have a letter of the Board of Trade reporting the intention of the Government to enlarge the department at that time The Board of Trade write

“ My Lords have had under their consideration, by desire of the First Lord of the Treasury, the question of the best means of carrying into effect, so far as this department is concerned, the announcement contained in the speech delivered from the Throne at the commencement of the present Session of Parliament. The advancement of the fine arts and of practical science will be readily recognised by you as worthy the attention of a great and enlightened nation. I have directed that a comprehensive scheme shall be laid before you, having in view the promotion of these objects, towards which I invite your aid and co-operation. Their lordships understand that the object in view is to extend a system of encouragement to local institutions for practical science, similar to that already commenced in the Department of Practical Art; that the systems should be combined on an enlarged scale, and that arrangements should be made for furnishing, through the instrumentality of one department in connection with the executive government, having the support and being subject to the control of Parliament, the means for mutual co-operation and correspondence to every district of the kingdom where the local intelligence and energy

072.

of the inhabitants shall create schools of industrial science and art. My Lords can have no hesitation in stating that the time has now arrived when the consideration of the important question of supplying scientific and artistic instruction to the industrial classes of this country in a more systematic manner than has hitherto been possible can no longer be postponed” That is dated in 1853 Then they go on to the end with the reasons for that opinion

4 I see that the words made use of there are the industrial class, and not the working class, do you think there is any distinction to be drawn between the two classes?—In one sense, none, in a limited sense, a broad distinction The action of the department from the very beginning has been, without discouraging any good that it might confer on the middle and upper classes, to make public payments directly only on behalf of artizans,—the definition of the word “artizan” being a man who gets his bread by manual labour, and who is not assessed to the Income Tax.

5 In fact, you have understood the term industrial class to mean artizans?—Yes.

6 *Mr. Bruce.*] Was not the word probably used in order to distinguish it from the words used in the Minutes of Council, where the words “labouring poor” were used, and so as to show that the system was not to be confined merely to those who could not assist themselves, but to be extended to rather a higher class?—Probably. When the schools of design were first formed, about the year 1833, Mr. Poulett Thomson being President of the Board of Trade, any persons but artizans, strictly so, were prohibited from coming to the schools, and it was only in 1852, when the Practical Art Department superseded the

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the schools of design (Mr Labouchere beginning the work, and Mr Henley carrying it on), that it was thought good policy to allow the middle and upper classes, if they were willing to pay adequate fees, to participate in the benefits of the instruction. The whole question has gone rather along with the public desire, and with no other theory than that of the commencement of the plan, namely, that of aiding the industry of the country, and making public payments on behalf of the working classes. It began with that idea; it now gets broader, more or less, every day, but no payments are made directly to the teachers or to the students themselves on behalf of the middle and upper classes. Medals and prizes are given, and those classes are conceived to pay a fair value for their instruction. In the case of the School of Art at South Kensington, they contribute more than 2,000*l* a year for what they get out of the school.

7 *Chairman*] You reward those classes which are of a higher grade than the working class by prizes and distinctions, but you make no payment to the teachers on behalf of such pupils?—Yes, but no payment to the teachers.

8 In fact, we may say that the persons on whose behalf you make the payment are of a higher grade than those who receive assistance from the Committee of Council for Education in respect of primary instruction?—I apprehend some rather higher.

9 Will you be kind enough to tell the Committee whether you put a very strict interpretation in practice on this limitation to the industrial classes?—I should say we do not; broadly speaking, we certainly do not. If an applicant appear to be well able to pay for his own instruction, it does not signify that he is a craftsman of some kind, or that his father is a craftsman of some kind. If he tries to defraud the department, we look sharp after him, but otherwise the rule is rather leniently administered.

10. If the son of a person in the middle class were apprenticed to a craft, you would consider him to be an artisan?—I think he would be accepted without inquiry.

11 Do you consider that that is generally known throughout the country, so that there might be no unfairness with regard to one locality compared with another?—I think so. I think if a man puts his name down as a stonemason he would be accepted generally as such.

12 Mr *Potter*] You would accept a clerk's son as a poor student?—Yes.

13 *Chairman*] You would also accept a manufacturer's son if he were apprenticed to his father?—Yes, if earning his own livelihood, and receiving less than 100*l* a year; if dependent on his father, not.

14 In the first instance, when the aid was extended from art to science, two secretaries were appointed?—When the department was enlarged, two officers were appointed who were called secretaries and inspectors-general. Doctor Playfair was appointed to hold office in respect of science, and I retained the office which I had formerly held in respect of art.

15 That arrangement is not in existence now?—That arrangement was abolished after a few years' experience, it was found to be practically unnecessary and somewhat inconvenient to have two secretaries; it rather divided the responsibility. Before Doctor Playfair resigned, the

offices were consolidated into one secretary and one inspector-general.

16 Who became the inspector-general?—He was made inspector-general, and Doctor Playfair secretary.

17 At that time, of course, the labour of the department and the responsibility of the department was very much less than it is now?—Infinitely less than it is now.

18 Is there still an officer who is called the inspector-general, and who performs those duties?—No, that office is abolished. The present organisation of the Department of Science and Art has a secretary and assistant-secretary, two official inspectors (as distinguished from professional inspectors), and two official examiners. In the conduct of the work, the aim generally is to keep the permanent staff of the department as low as possible, and to get all the clerical and accidental work, which accumulates very much at certain times of the year, done by provisional assistants. To illustrate that, I may say that at this time the science examinations are coming on, they are going on at 300 centres at one time, at the same hour, at probably 250 places, the examination in chemistry would be going on; of course it is quite impossible to have a body of inspectors permanently appointed to see that the office rules are obeyed for a month only. Recently the War Department have allowed officers stationed in different districts in various localities during May, in the evening, to go round to the respective committees and see that the examinations are conducted according to the rules, those are officers of Engineers.

19 Lord *Robert Montagu*] For a stipulated payment?—£ 1 a-night. Although, even in that organisation will not include systematic visits to every one of the 300 centres, still a gentleman going in accidentally will see at once whether the rules are being properly followed out or not. It may be possible, perhaps, to give one visit to each of the 300 centres; but there being 23 or 24 subjects, and it being possible that one centre may have those 23 or 24 subjects, the number of visitors required to be present at every examination would be beyond any possibility.

20. *Chairman*] The duty of those gentlemen is only to see that the rules laid down by the department are complied with?—Yes, to see that two members of the committee are present, and that the students sit far enough apart, and that the work is done fairly; that inspection is a very necessary thing.

21. I understand you to say that the office of Inspector General was not found to be one that could be usefully continued?—It was thought unnecessary; before the office was abolished two inspectors general, under a different idea, were created. Dr. Playfair became Inspector General for Science, and Mr. Redgrave became Inspector General for Art, with one secretary.

22 Dr. Playfair fulfilling the duties of secretary at the same time?—No, he had given up that, and I became secretary. There was another change; in fact, at the start, we could not go on for a year without finding out a necessity for some reorganisation, but since Dr. Playfair retired, the organisation has got settled, and it is now working well.

23 Will you kindly give us the names of the gentlemen who now fill the offices you have just mentioned?—The secretary is myself; the assistant secretary is Mr. Macleod; in the Science Division,

Division, the official inspector for science is Captain Donnelly, R. E.; occasional inspector, Mr. Iselin, M. A., and wrangler of Cambridge; Dr. Sidney, who is in Ireland; and, for navigation, Captain Harris. The official examiner (which means the officer to see that the payments are right, rather than to exert any professional knowledge), is Mr. Bartley, he happens to have taken many certificates in science, but he is a lay administrator, the professional examiners for science now are Mr. Anderson, C. E., Professor Ansted, Professor Bradley, the Rev. Mr. Cowre, Dr. Frankland, Professor Huxley, Professor Ramsay, Mr. Warrington Smyth, Dr. Thompson of Kew, Professor Tyndall, and the Rev. Dr. Woolley.

24. What are the duties of the official inspectors for science?—In the first instance, all letters whatever relating to science are referred to him; his function is to draft minutes and to see that the whole matter is going on according to the orders of the Board, his function is also to make recommendations to the Board, and, in fact, to see that the Governmental part of the work is carried on properly. He also arranges with the professional gentlemen about the examinations. His duty is to see that the papers are prepared in time, that the examinations are made in time, and to see that all the official rules are properly obeyed.

25. When you say "make recommendations," are the Committee to understand that it is part of his duty to make recommendations as to the subjects in which the candidates are to be examined?—No, that is fixed by a Board minute. Suppose a letter comes, on which it is important to have an opinion the first point is, is it out of the usual rules? He knows that, and he is responsible for saying whether it be so; whether it demands that some new rule should be made. Then he forms an opinion as to what should be done, his business is to endorse a Minute upon that letter. In fact, you might call him a sort of assistant secretary, if you pleased.

26. In such a case as this, for instance, if there were an opinion expressed either by the public or by a professional examiner, that some change should be made in the nature or extent of the examinations, by whom would that in the first instance be considered?—I do not quite put into a concrete shape what the "public" is, but if one of the professional examiners thought that some change should be made, he would write a letter, and it would be referred to Captain Donnelly, who would probably confer personally with the examiner, and then bring the matter before the Board.

27. Is there no Board of Examiners?—Yes, what I have read to you constitutes the Board.

28. Do they act as a Board?—In any case where it is desirable.

29. Lord Robert Montagu.] You are speaking not of the Board of Examiners; you mean a Board at South Kensington, do you not?—I meant the Board to be the Lord President and the Vice President. As to any scientific opinion, it would be referred either to the professional examiner, or if it went beyond his speciality, then it would be brought before the Lord President, and he might request two, three, or more gentlemen to report specifically.

30. Chairman.] But the matter would be referred in the first instance to the official Inspector for Science?—It is passed to Captain Donnelly; 0.72.

then it is brought to the Lord President, and then, if he thinks fit, it is referred to any professional inspector.

31. Practically, the opinion of the professional Inspector of Science would be taken in the first instance?—Yes.

32. Captain Donnelly's is an office of very great importance, then?—Yes; demanding great discretion and common sense.

33. Captain Donnelly is an officer of the Engineers, is he not?—He is, I would impress on the Committee the distinction between lay or unprofessional administration and professional knowledge, which is held to be very important in the department. A man may be an excellent chemist or mechanic, and a very bad man of business, it is necessary to draw the line sharply between what is really professional knowledge and what may be called "red tape," if you please.

34. In fact, we may say that there is no professional authority that would be immediately consulted on such subjects as I have named?—Certainly, there would be, the highest professional authority would be consulted whenever it was wanted, of which the Lord President would judge. If anything happened, for instance, about the geological survey, the Lord President would request Sir Roderick Murchison to come to the Board, if the Lord President thinks it desirable to have a professional opinion, it is referred by writing, or an examiner is asked to attend. On any question in navigation, Dr. Woolley, for instance, is asked to attend the Board.

35. But there is no permanent professional council, the tendency of which I apprehend would be to give unity to it all?—Certainly there is the most perfect council, and the most perfect unity. I cannot conceive any organization more comprehensive, or more complete, or more instantaneous in action, bearing in mind the distinction which I have pointed out, the Lord President in all cases referring to professional advisers on professional questions.

36. But I understand you to say that he would refer to them in detail, do I not?—There have been occasions where Lord Granville has thought it right to invite several, and to preside over them, and other occasions have arisen where professional gentlemen have been asked to form a committee or commission; at this moment we have got a strictly professional commission inquiring whether the lighting at Kensington is damaging to the pictures. If a question ever arises which involves professional knowledge, the Lord President refers that subject to one, two, three, or four professional gentlemen of eminence to report upon.

37. But a permanent professional council forms no part of your organization?—Yes, this body of examiners, a professional council which is called into action whenever it is wanted. If you ask if they meet every week, they do not, there is no occasion for it.

38. I understood you to say, that the Lord President, or the Vice President, called in such a professional man as he thought most likely to advise him; but not that there was any professional council comprising members definitely appointed beforehand who would, as a matter of course, consider professional questions?—There are no professional questions to consider until they arise.

39. Mr. Bruce.] But have you a permanent body to whom you refer all such questions, or do you

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you prefer to submit the questions as they arise to selected persons out of the list of your examiners?—In one sense the body of professional examiners are permanent, and go on from year to year, but when questions arise, the Lord President refers the particular question to one or more examiners. If any question of general policy about a change in the examination, for instance, arose, he would refer it to either one or all of those examiners, as he thought fit. It does happen generally that at the end of the annual examination there is a kind of general conference among them if any suggestion is to be made. that goes on as a matter of course. I wish to show that the organization in the department provides for all the work that is going on in an effective way; as to a permanent body of professional gentlemen sitting every week; what would they have to do? But they have definite work to do when it arises.

40 *Chairman*] The question was not so much whether it was desirable as whether it existed?—I have only gone into detail to make it clear.

41 Will you kindly tell us what was done for science instruction up to the year 1859, which I think was the year in which Dr. Playfair resigned?—Almost all the measures taken at the beginning were experimental, and something like an analogous system to that for art was attempted in two or three places, that is to say, either paying an absolute salary to teachers, or guaranteeing them an income, that was tried, I think, in Birmingham, Aberdeen, Bristol, Leeds, and Stoke-on-Trent, besides being tried in several navigation schools. Before 1859 almost every school had more or less a variety of its own, and we could hardly be said to have formed the system until 1859. I think I have mentioned all the places where there were any science schools at that time. Examinations were held, and prizes awarded.

42 This payment of salaries was not continued after 1859, was it?—No, about 1860 the actual abolition of direct payments to teachers as guarantees or salaries ceased, Mr. Lowe was Vice President at the time.

43 But in 1859 the new system was organized which included payments to teachers, a capitation grant, and payment by results?—Yes, at first.

44 The capitation grant was subsequently abandoned?—Yes. I recollect an expression of the late Marquis of Salisbury: he said, "You seem to have very little science, and unless we can get a scheme to make science common wherever the public want it, I shall abolish the name." The result of that was that, in obedience to his orders, we set about trying to invent a system which should be common to the whole country, and although it is a little modified every year, when the necessity for modification arises, the system in the main is very much what was established in 1859.

45. Who were the principal persons consulted with regard to that system in 1859?—Everybody that we thought could give us any advice, Sir J Kay Shuttleworth, Canon Moseley, &c. We never do anything without trying to find out beforehand how it will act. First, there was a declaration of the Board of Trade upon the general principles of the department. The exact subjects to be taught at that time were matters of considerable interest to Mr. Adderley. The subjects were limited at the time. *Mathematics* were not included in 1859; that subject was added

afterwards. I do not think that any commission was appointed at that time to devise a plan, as done lately, for a science college. Within the last three years a commission has been appointed to devise a plan for a science college in Dublin, but nothing of that kind took place in 1859.

46. A new Minute was passed in 1859, was it not?—Yes.

47 Under the presidency of Lord Salisbury?—Yes.

48. Can you give the Committee briefly the heads of that Minute?—The heads are these. First, to have an annual examination to which anybody might come to be certificated as a teacher; he would get a certificate when he passed the examination. Then it was provided that there should be an annual local examination throughout the country, and that prizes should be given in connection with it; that they should be open to all classes; and that payment should be made to the master for holding a certificate, and also payment in respect of the students who passed the examination, those payments being graduated according to the grade of the examination in which the students passed. I think those were the broad features of the arrangement.

49 Can you state what changes have been made in the system since that time?—The subjects of examination have been much enlarged. Captain Donnelly will speak precisely as to what new subjects have been introduced. A better definition has been given to the term "artisan," the payments to teachers have been modified, and they have on the whole been made more liberal lately; the proportionate payments to the certificate have been abolished, as a maximum the prizes have been increased in value, and they have also been greatly increased in number; scholarships have also been introduced.

50 In individual value, have the prizes been increased?—I think in 1859 there were not as many gold or silver medals as there are now, the little prizes of books and so on are much the same, I think.

51 As to the payments on teachers' certificates, I think you said that that payment was abolished in 1860?—I think so.

52. Can you state the reason why that payment was abolished?—It was part of the general policy of the Government at the time. The payments in respect of teachers' certificates for primary instruction were abolished, and so were those on account of science. When the Revised Code came into operation, although it did not directly relate to the Science and Art Department, it was considered good public policy to make its action as uniform as possible.

53. Do you think that the subjects of scientific teaching and elementary teaching are precisely on all fours as to the remuneration to the master?—I think it is very desirable to insure that the work is done for any payment that may be made. I think the payment of salaries in a very broad local action is so much waste of public money. I think it is a very difficult problem to know how to administer public funds in distant parts of the country, and get the work done.

54. But in point of fact is the abolition of the payment on teachers' certificates generally satisfactory to the teachers?—I should say, whatever may be the case with lazy fellows, to industrious men it is not unacceptable.

55. You have not lost good men in consequence of it, and their energies have not flagged?—No. I should

I should say the best men have got a great deal more money. At the Bristol School, where they have an admirable teacher, I am under the impression that the teacher gets double the income he used to get when he had a salary of 80*l* a year.

56. But he was paid on results also, was he not?—His payment did not amount to what he receives now. Captain Donnelly will give you the precise figures. I do not call to mind the case of any very good teacher being pecuniarily damaged, in fact, the system of payments on results for hard working teachers seemed to promise rather alarming consequences to the Exchequer at one time, and it became necessary to make rules that they should not earn too much.

57. It was the hard working men, not the lazy men, who were earning too much?—I recollect that the question was mooted in the House of Commons five or six years ago. It seemed a little absurd that a man teaching in an elementary science school should be getting 300 *l.* a year from that, besides other things. If every place was to get that amount, the department did not see its way to having reasonable estimates to lay before Parliament.

58. Did not that rather affect the scale than the mode of remuneration?—Of course, but on the other hand what may happen is this,—the highest payment a master gets is 5 *l.* for a very successful student. It is very desirable throughout the country, particularly in small places, that there should be one or two such very successful students bringing in 5 *l.* each to the master, but in very large and populous places the number of those 5 *l.*, as well as the number of other payments, would amount to a very large sum. I do not mean that it would be an unfair sum when it is fairly earned, but you have to consider the question of the estimates.

59. Mr. Gregory.] I think there are 57 payments of 5 *l.* in the Bristol school now?—The Bristol school earns much and is the type of the school that any place with 20,000 people in it might have if the locality pleased.

60. Chairman.] But they had a building to begin with?—They had a building to begin with, otherwise that school has no special peculiarity. They have an excellent teacher, they are rent free, and two or three subjects are well worked out. The fees, too, are within the reach of the persons who want the instruction. If those principles were fairly carried out in any town throughout the country, with 20,000 inhabitants, you would have the State paying 500 *l.* or 600 *l.* a year for results in those places.

61. The payment on results is, I believe, alike for all subjects?—I think so, I think it is divided into grades.

62. Each subject is divided into grades?—Yes, I think there are five grades.

63. The direction of my question was this; you would pay the same sum for a pupil who passed in the first grade, for instance, in such a subject as animal physiology or botany, as if he passed in mechanics, or mining, or metallurgy?—Yes.

64. Have you quite considered the propriety of that?—We have considered the propriety of it. It would be extremely difficult to say that physiology was not worth as much as mechanics, and perhaps it is worth more. But of course each professor can state much better than I can what he considers the relative value of what he teaches.

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65. Would not the labour of passing a pupil in one subject be very much greater than that of passing one in another?—(Captain Donnelly) That depends on the standard of the papers.

66. But standard for standard, how would it be?—I think the professors try to make them all fairly alike. I do not think that one subject is easier to pass students in than another.

67. You think that to pass a student in the third grade in organic chemistry would not be much easier than to pass one in the third grade of pure mathematics?—No, certainly not. It so happens that Professor Hoffman has made that particular subject very difficult. That particular subject happened last year to be much more difficult than any other subject. It would have been more difficult at that examination to get 3 *l.* for a pupil in chemistry than perhaps in any other subject.

68. I speak of inorganic chemistry?—Yes.

69. Comparing inorganic and organic chemistry, would you say that the difficulty was equal?—The per-centage of failures in inorganic chemistry, last year, was 35.76. The per-centage of failures in animal physiology was 22.53; that is enormously less. The per-centage of failures in elementary mathematics was 27, there was, therefore, a difference of nearly 10 per cent in favour of elementary mathematics. In the higher mathematics it was larger—38 per cent.

70. Was there not another change made lately, namely, the abolition of examinations for teachers' certificates?—(Mr. Cole) Yes, a special examination. It was thought that the first and second grade examinations sufficiently covered the ground, and that it was only an unnecessary expenditure of time and money to have a second examination, for the teachers there seemed to be no particular advantage in it, as all the payments were on results.

71. But was not it reported that there was a deficiency of teachers?—I should say that that change was rather a mode of increasing the number of teachers.

72. At the same time, is it not the case that the number of persons holding teachers' certificates was very largely in excess of the number of teachers?—Yes.

73. Can you tell us in what proportion?—(Captain Donnelly) I do not know that, but there is a great deficiency of teachers. We find that many obtain good appointments, and are taken off. The great difficulty experienced in the country is in finding people to teach. We have constant applications for teachers, but we cannot get them.

74. Mr. Bruce.] That is to say, men have obtained certificates, but do not apply themselves to the teaching?—They teach for a year or two, and then they get good appointments and go off. (Mr. Cole) I think the demand for anybody who appears above the horizon with any scientific knowledge applicable to industry is so great, that few of those people, comparatively speaking, turn into teachers. (Captain Donnelly.) Comparing the returns from one year to another, we find there are constantly cases in which the schools are closed; nine out of ten, or more perhaps, of those cases are because the teacher is taken off, having got a good appointment of some kind or other.

75. Chairman.] In fact the register of the persons holding teachers' certificates is no indication of the number of persons actually willing to teach?—

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teach?—(Mr. Cole.) No (Captain Donnelly) A great many persons who have obtained teachers' certificates are found to be very bad teachers. Many never had any intention of teaching

76. Mr. Dixon.] In the case which you have just referred to, where a certificated teacher leaves the schools and takes some position, perhaps in a manufactory, do you think it is simply a question of salary, and that a higher salary would induce him to remain as a teacher?—A great deal of the question is salary, no doubt, but if a man obtains a better position, he is apt to look upon teaching as great drudgery, which indeed it is, after a few years. (Mr. Cole) It is mostly teaching in the evening

77 Mr. Bruce.] And other appointments outside the school hold out to an able man greater prospects of rising in the world?—(Captain Donnelly) Yes; for instance if a man gets into a chemical works, he sees his way to becoming a partner in the end perhaps, whereas all he could make as a teacher would be 200*l* or 300*l* a-year.

78 Chairman] But the majority of the classes are evening classes, are they not?—(Mr. Cole.) The majority.

79 If a reasonable supplementary income could be derived from scientific teaching, you would suppose that persons would be found holding certificates, who, in addition to their daily avocations, would be willing to teach those classes, would you not?—(Captain Donnelly.) A good teacher can now easily make 150*l* a-year by teaching in the evening, and there are many men who do it, and they do not occupy their whole time in teaching

80 But in order to make that income, a man would have to teach in several localities, would he not, for instance, a man in Lancashire would have to go to Wigan and Preston and three or four towns in order to accommodate a sufficient number of persons to pay him that income in evening classes?—Yes, where the classes are small, but in other towns, for instance, at Oldham, or other places where they have organised science classes on a large scale, I have no doubt a man might make 130*l* or 140*l* from the Science and Art Department by evening tuition.

81 Mr. Bazley] Not being employed in the daytime at all?—Not being employed in the daytime at all

82 Chairman] The Minute abolishing examinations for teachers' certificates, and enabling those pupils who pass in the first and second class to become teachers, is a recent Minute, is it not?—(Mr. Cole) It is a Minute of about two years' standing

83 Can you state to the Committee that you have as yet any experience of the working of that Minute?—(Captain Donnelly) We have several cases of people teaching under that Minute, and probably the examination which is now coming on will give us a larger result to judge from

84 It would be quite possible, after this examination, you think, to distinguish the teachers who hold certificates, and those who merely passed the first examination?—Yes, I think it would be possible.

85 So that a comparison could be made with regard to the success of the two classes of teachers?—Yes, the payments made to them would determine that.

86 But the directory would not show, in its present form, which teachers held teachers' cer-

tificates, and which teachers had simply passed the examination in the first or second grade would it?—No.

87 Lord Robert Montagu.] The report would show also the payments which those teachers had received?—The payments they had received are given in the next annual report. It is a great advantage of having done away with the November examination for certificates that it has been to remove the difficulty persons wishing to be certificated meet with. We could not expect committees to hold two examinations in the year therefore we had to have a special examination of teachers by officers of the department in London, Dublin, Manchester, and Edinburgh; and many teachers found considerable difficulty in going to those places to be examined. (Mr. Cole) They went to those places at their own cost, and when they passed their examination they were paid, but if they failed to pass the examination, they had to pay their own travelling expenses. The present system, however, opens up 300 centres for the examination to them instead of the 100 coming to the examination.

88. Chairman] But that examination conducted wholly by papers, is it not?—The greater part of our examination was paper work there was only a little *vivâ voce* examination (Captain Donnelly) The *vivâ voce* examination was only in very early days, when teachers were examined only in London. As soon as examinations were held in Dublin, Edinburgh, and Manchester, this was necessarily dropped. The examiners found that the *vivâ voce* examination was not of much-use.

89 They do not in fact approve of an extended *vivâ voce* examination?—They found it did not answer much purpose, if you had a great number of candidates, it would be almost impossible to carry out a *vivâ voce* examination unless you could keep them three or four days in London (Mr. Cole) The system of payment on results in respect of science has led some to think that the certificate might be abolished altogether, I do not quite hold that opinion, but it is a fair subject for discussion.

90 Mr. Gregory] Can you say what was the date at which the new system practically came into force?—(Captain Donnelly) Last year.

Mr. Bruce] It was in February 1867.

91. Chairman.] In point of fact, no examination has yet been held of pupils taught by this new class of teachers?—(Captain Donnelly) Yes, last May there were several classes examined who had been taught by people who had passed in the previous May, and who did not get payment on results, this will be the first examination at which any of them will receive payment on results

92 An examination was held in May 1867?—Yes, there were several teachers who made application that the Minute should be retrospective, and who applied for payment.

93. But no payment was made?—No, the Minute was not made retrospective

94 Were those applications numerous?—I think there were five or six.

95 Those would be made, I suppose, by the men who had the greatest confidence in their ability to teach?—Men who had taught before and had not got certificates.

96. Mr. Graves.] Do you keep any record of the alleged causes which have led to the resigna-

tion of teachers since 1859?—(Captain *Donnelly*). No, there is no such record kept, we hear every autumn that a particular class has re-commenced; they send up their form, they tell us that the class is re-opened, but if the teacher goes away we hear no more of the class, I could perhaps get the information in certain cases, but as a general rule we do not know what becomes of the teachers

97. I understood you to say that many of our teachers were lost in consequence of their obtaining more remunerative appointments, and I inferred from that that you kept a record of the teachers who departed?—No, no official record

98. May not those resignations be considered to take place in consequence of inadequate remuneration as well as from the teachers getting other employment?—(Mr *Cole*.) I think there are a great many of them who do not succeed as teachers at all, they are incompetent, and do not succeed in forming a class. (Captain *Donnelly*.) A teacher in science has to do other things beside teach, he has not only to instruct his class when it is formed, but he has got to stir up the town and induce people to come, and there are many teachers who have not sufficient energy for that.

99. I understood you to say that after obtaining a certificate and having taught for a year, many of the teachers had abandoned the work?—I have in my mind at this time two of those teachers who have succeeded, and then we have heard that their classes have suddenly ceased, and we generally find, on inquiry, that the teacher has got something better. There were two successful men at Burnley who did very well, both of them got good situations

100. Then the teachers apparently do not give any reason when they abandon the teaching, or, at least, your department does not hear of it?—They do not officially assign any reason

101. Lord *Robert Montagu*] Have we, as a department, got anything to say to the engagement of teachers, or is that left entirely to the committee of the locality?—It is left entirely to the committee of the locality

102. *Chairman*.] But I believe you have two or three inspectors who visit the different schools, have you not?—Yes

103. And also an official whom you call an organizer of science schools?—There is a gentleman who was a science teacher, and who now goes round the country wherever his services are applied for, to assist in organizing the classes, and I get a good deal of the information as to why classes cease, which I am giving the Committee, from him.

104. The general result is, that your best teachers leave you because they get better remuneration elsewhere?—Whenever the good teachers do leave us, I find it is generally on that account, but I do not say that all the good teachers do leave us, because some of them have continued teaching with us from the very commencement; there is one at Bristol, and there is Mr *Angell*, of the Mechanics' Institution, at Manchester

105. With the exception of the one at Bristol, and one or two day schools, I suppose the number of teachers earning a fair income, say 150 *l.* a year and upwards, is not very great?—No, but the late Minute will give them rather a larger payment I see down in this list here, Mr *Angell*, 75 *l.*; Mr *Brady*, 103 *l.*, and then passing over minor items, Mr. *Collins*, of Manchester,

126 *l.*, and so on, all that information is contained in the Annual Report of the Department. The recent Minute, in fact, will increase those payments considerably

106. In the second grade?—There was a reduction made where pupils passed in a second subject, and that has been abolished

107. Mr *Dixon*] In those cases where the teacher resigns, is that resignation generally followed by the giving up of the class?—Perhaps the class cannot lay its hands upon another teacher at the moment; it is sometimes abandoned for six months; and then resumed

108. Do you think the number of the classes is great that have been discontinued from that cause?—It cannot be very great, because the numbers have continually increased from the time when the system began in 1859, at that time it was next to nothing, but at the present moment, from the returns just come in, I see there are 14,600 pupils under instruction. To make that a fair estimate, you must take off 1,000 or 1,500 from the pupils in the Navigation Schools, who are not really learning science, but when that deduction is made, there still remain 13,000 pupils at the present moment under instruction in the country, and that is really a large number when the system only began in 1859. (Mr *Cole*.) In 1860 the number of science classes that had created themselves under Lord *Salsbury's* minutes, were nine, and there were 500 students, while at the present time there are about 13,000 students under instruction, and 300 schools, and it is important to say that this is entirely spontaneous action on the part of the country, the department does not act as a missionary in any way; it does nothing but what it is asked to do

109. Mr *Dixon*] Does it not frequently happen that these classes are of a very ephemeral character, and that the accident of getting hold of a good and energetic teacher causes a large class to spring into existence, while, if he is afterwards called away, the class ceases to exist?—It does happen.

110. *Chairman*] You are doubtless aware that our inquiry has reference more especially to industrial teaching, that is to say, to scientific teaching which is applicable to industrial pursuits?—Yes

111. Can you state what proportion of the 13,000 persons you have spoken of, is being instructed in subjects which may be said to bear directly, or indirectly, on industrial occupations?—(Captain *Donnelly*.) I will hand in an explanatory memorandum, which was issued with the recent Minute, and which gives the system of the department as shortly as possible, and I have had the statistics up to the present moment added in the margin, so as to give the number of persons under instruction at the present moment. (Mr *Cole*.) I should say that when the Board accepted those subjects of teaching, they were all thought, in a greater or lesser degree, to have a bearing on industrial occupations. (Captain *Donnelly*.) Of course the people of any particular place determine what branch of instruction is most useful to themselves, but, on the side of the department, one subject is not given any advantage over another subject.

112. Still the inquiry of this Committee relates to teaching on those subjects which bear directly on industrial occupations?—Perhaps it might be said that animal physiology did not bear directly

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on industrial occupations, or that zoology did not, yet there are applications of zoology to industrial occupations, vegetable physiology and economic botany have such applications, perhaps systematic botany has not, though it is difficult to draw any line at which it can be said absolutely that a science does not bear upon industry. (Mr. Cole) The business of a gardener may be considered as an industrial occupation, and, undoubtedly, a gardener's knowledge of botany would improve him as a gardener. (Captain Donnelly) The gardens at Kew are maintained at a large expense on the part of the State, and with a certain amount of industrial purpose. (Mr. Cole) The museum at Kew is purely industrial. (Captain Donnelly) It is impossible to say that any science is not capable of industrial application; perhaps animal physiology would rank lowest in the scale of direct applicability.

113. *Chairman.*] Then with regard to the scientific classes, do you not find that those classes have a greater hold upon some districts than they have upon others?—Yes

114. And that to a very remarkable extent?—Yes; in some districts the people have taken the subject up, and put a good deal of energy into the matter, and worked up the classes thoroughly; in others, they have been either opposed to the thing, or else they have been indifferent. It is entirely a matter for each locality itself, and a question of energy or want of energy in the locality.

115. Take the large industrial centres, and, beginning with Staffordshire, can you tell us whether the system has spread much in Staffordshire?—(Mr. Cole) Years ago there was a chemistry class started at Stoke, but the teacher went to the bad, and the school never revived; it is now proposed, I believe, to re-establish the school. But if the localities themselves, having this machinery at hand and these public payments for their reception, are not sufficiently alive to the subject, I hardly know by what process you can make the people alive to it. (Captain Donnelly) There is the Lancashire and Cheshire Union of Mechanics' Institutes; the previous and present secretary have worked the system, and the present secretary stated that he believed by next year he would have a science class in connexion with every one of the mechanics' institutes in his union. The Yorkshire Union have, on the other hand, scarcely done anything up to the present time in the matter.

116. Mr. Bruce.] Can you give the number of science classes in connexion with the Lancashire Union, and the number in connexion with the Yorkshire Union?—About 60 in the Lancashire and Cheshire Union, and 12 in the Yorkshire Union.

117. *Chairman.*] Can you, in fact, at a subsequent time, state in what counties this system of instruction in connexion with the Science and Art Department has made much or little progress.—(Mr. Cole.) It would be quite possible to make a return showing how far the system has been adopted in each county throughout England, in fact, I have a rough proof here of the examinations that are now going on. All the manufacturing towns that have adopted the system are contained in the list which I now produce, and that list can be classified in any way that the Committee desire, indeed it might be classified according to the industries, taking, for instance, the centres

of the cotton trade.—(Captain Donnelly.) I can state some particulars with regard to the Lancashire and Cheshire districts. The number of schools is now about 60, and Mr. Lawton, the visiting agent and chief mover of this union, told me that he hoped and thought that he saw his way to establishing science classes in all the institutions in connexion with the union by the Session of 1869-70; that would be little short of 150 schools. The number in Yorkshire is very small.

118. In Staffordshire also I believe the number is very small, is it not?—(Mr. Cole.) I think there are not many.

119. There is a very small school at Wolverhampton, I believe?—Yes.

120. And is not that the only school in what is called the Black Country?—At Wolverhampton there are four classes; at Walkall there is a class at the Grammar School.

121. With how many pupils?—There are 24 pupils under instruction.

122. In more subjects than one?—In inorganic chemistry.

123. Have you any schools at all in the county of Durham?—Apparently but one.

124. Is there not a school at Darlington?—Darlington has 10 pupils under instruction.

125. The subject is what?—The subjects are applied mechanics, magnetism and electricity, inorganic chemistry, and metallurgy.

126. That is the only school in Durham county is it not?—Yes.

127. There is none in the city of Durham Gateshead, Sunderland, or Stockton-on-Tees, is there?—At Gateshead there are 39 pupils under instruction in geometrical drawing, mechanical drawing, building, construction, and theoretical mechanics.

128. Is that a recently established school?—am unable to say. The list of each year shows the schools then existing which desire to be examined and we could, by going over the history of the place, find out whether it has lasted more than one year.

129. Can you give the Committee any information with regard to Northumberland?—Yes I find there is a school at Alnwick where the learn elementary mathematics.

130. I think there is none at Newcastle-upon-Tyne, is there?—There is none at Newcastle-upon-Tyne.

131. Is there anything at Tynemouth?—None.

132. Is there anything at Morpeth?—None.

133. In Derbyshire is there any?—There is on the Grammar School at Derby where they teach inorganic chemistry.

134. Your assistant inspectors report to you on science instruction, do they not, in the country generally after they have made their annual tours?—Yes.

135. And I believe the character of those reports has been, that instruction is proceeding rapidly in the country in general?—(Captain Donnelly) I think that has been their general purport.

136. Have those reports called your attention to the entire absence of science schools in the great industrial localities?—The inspectors only go and visit the schools that exist, in order to see that they are going on properly.

137. They make no inspection of the country in order to ascertain what is doing?—No.

138. There is a navigation school at Plymouth

is there not?—Yes, at Plymouth the navigation school is simply a cramming school for the Board of Trade examinations. The masters and mates who go there do not come up to our examination.

139. But that school is included in your directory, is it not?—Yes, the school makes a return of the number under instruction, and we cannot cut them out, but it is always pointed out when such schools are not examined by the department.

140. But the Hull navigation school is examined by you, is it not?—Yes, and they are very successful there.

141. The Plymouth school is of a different character from the Hull school, is it not?—Entirely. The Hull school takes boys and brings them up, and teaches them, and then sends them to sea, whereas the Plymouth school takes in scarcely anything but masters and mates, and seamen who have just gone in there for a few days to brush themselves up for going before the Board of Trade, and getting passed in an examination which does not go much beyond a rule of thumb knowledge. In order to meet the position of the navigation schools in this special subject, examinations are held four times a year, so that pupils who may belong to ships only in port a short time, may have every opportunity of coming up to the departmental examination, but those examinations are not largely attended.

142. It is in reference to schools of that character that you said that the deduction of a 1,000, which you previously referred to, ought to be made?—989 is, I find, the precise number of students in the navigation schools who are not examined in May. Then the returns are perhaps rather improperly swelled by the returns which are made from two large institutions in Glasgow, the Andersonian University, and another place which return a large number of students under instruction. The greater proportion of those merely attend lectures in those institutions, and but few of them come up to the department examination.

143. Can you tell us whether there are many day-schools in existence in the country which may be properly called science schools, in connection with your department?—I have a return here of day classes at Andover, Birmingham, Bromsgrove, Cheltenham, Durham, Derby, Hull, Yarmouth, and other places, some of them being in London, and with the permission of the Committee I will hand in that return (See Appendix.)

144. *Chairman.*] Can you point out any school or schools which you would consider model schools, in connection with your department?—(Mr. Cole) Emphatically Bristol, Bristol is an excellent example of a secondary school, which, I should say, proved the good working of the present system (Captain Donnelly) Manchester is another example, there is a school there in connection with the Mechanics' Institution, taught by Mr. Angell, and there is a similar school at Glasgow.

145. Who is the teacher there?—Mr. Mayer. (Mr. Cole) In a day school, science instruction is a continuous thing going on every day, but in a night school it is more or less interrupted. That it is possible to establish day schools by the present system is proved to us by those cases which are very successful.

146. Those are instances of schools for the artizan class, or for a class nearly coinciding with the artizan class?—At Bristol, I think the fee

varies from 3*l.* to 4*l.* 10*s.* or 5*l.* per annum, and it is paid by the session, or quarterly.

147. Lord *Frederic Cavendish*] What sort of age are the students?—They go to the Bristol school at an early age for general instruction, and I think they remain there until 14 or 15 years of age.

148. Mr. *Gregory*] The annual fee is 3*l.*, is it not?—Yes, and I think the master gets a little more for some subjects in certain cases.

149. Do they get anything for the evening lectures?—Yes; you can enter separately for them only.

150. Mr. *Lothrop*] Why do you consider the Bristol school a model school?—It earns so much public money, that is one reason. I attribute the success of the Bristol school to two causes. One is that it is not overcharged with rent for the building and local expenses, and, above all, there is an excellent teacher with an excellent staff, thirdly, I should say that it assesses an amount of fees sufficient to make a revenue for the school, which it finds a sufficient number of people in Bristol to pay.

151. Are those who attend that school properly artizans?—They are either very small tradesmen or artizans, or the children of artizans.

152. Sir *Charles Lanyon*] Are you aware that there was a great falling-off in that school between 1865 and 1866?—I was under the impression that it was flourishing at that time.

153. Mr. *Gregory*] There is an increase in the results of the science teaching from 264*l.* to 285*l.*?—There are always fluctuations (Captain *Donnelly*) At the present moment they return 145 under instruction.

154. Sir *Charles Lanyon.*] And that is 30 less than were under instruction in 1865, I believe?—(Mr. Cole) Their annual receipts from the department are not diminishing.

155. *Chairman.*] Is there not this peculiarity about the Bristol day school, that the building is provided free of expense?—That is one peculiarity, another is that they are not afraid of charging a reasonable fee, and the third and best reason is that they have an excellent master.

156. Taking the first reason for the moment, I believe that in respect of art schools a grant is made towards the cost of erecting the buildings?—Yes.

157. And also towards the cost of fitting up the schools?—Yes.

158. But I believe that is not the case with regard to science schools?—With regard to science schools, no building grant has yet been made, but with regard to apparatus, an apparatus grant of 50 per cent. is made, it will be obvious that an art school requires special accommodation to be distinctly applied to its peculiar objects, while a class for mathematics requires no special premises or arrangements, in fact, one virtue of our system is that any one may teach in a garret or a cellar, or wherever he likes.

159. Experimental chemistry, for instance, do you think that could be taught in a garret or cellar?—Possibly it might.

160. Mr. *Bruce*] How would that apply to mechanical drawing?—Mechanical drawing as good drawing is taught in art schools.

161. Is it not taught in science schools also?—I do not think they ever require illustrations as fine as they do in art schools, science, generally speaking, can be taught anywhere. I am not

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prepared to say that a building grant for science, where science was taught as a serious daily business, might not be a proper thing.

162. *Chairman*] We will assume, then, that science is taught as a serious thing when a Government grant is made, what should you say then?—You could hardly say that the 300 classes throughout the country are all of the character which would justify the expenditure of public money on them in building grants

163 Then it would be very desirable, would it not, to have some means of distinguishing between the serious and illusory teaching of science, if classes of both kinds receive Government money?—Without saying that any science teaching is illusory, I should say that whenever substantial premises are maintained and permanently devoted to the teaching of science, it might be a proper subject of consideration whether a grant should not be made

164 *Mr Potter*] The highest amount of grant made for an art school has been 500 £, has it not?—Yes

165 Was that contrary to the recommendation of the Committee that sat in 1854?—I think so.

166 *Chairman*] But grants are being made to art schools, and have been made to art schools for building purposes?—Yes, I am sorry to say that they are not very eagerly accepted.

167. *Mr Dixon*] Is there any such condition attached to the making of a grant as to prevent its being asked for?—For several years past only the sum of 1,000 £ a year has been taken in the Votes for the purpose of assisting art schools with buildings, and I think in some cases the conditions attached prevent a locality from accepting the grant, but I am of opinion that it is rather the apathy of the localities than the conditions of the grant which prevent their being sought for.

168 *Chairman*.] At all events, science schools have this disadvantage, as compared with art schools, that they cannot obtain the building grant, whereas art schools can obtain the building grant?—Yes

169. *Mr. Bruce*] Is it a condition attached to your grant to art schools, that the building shall be fitted for the purpose?—Yes.

170. And no such necessity with respect to the building is attached to scientific teaching?—No.

171 *Chairman*] The second reason which you gave us a few minutes ago was, that there was some hesitation with regard to charging an adequate fee for instruction?—Yes.

172 Then you gave us a third reason, you said that the teacher of the Bristol school possessed peculiar qualifications?—Yes, and I might add a fourth, which is, that the instruction goes on daily

173 I believe it is the fact that Mr Coomber was trained at the School of Mines, in Jermyn-street; is it not?—He came up for a short polishing, but my impression is that he had been framed in a training school, and had a love for science, and was found to be a likely sort of man, and then had a year's teaching or so at Jermyn-street, which, no doubt, was very beneficial.

174. With regard to the Navigation School at Hull, that you would also call a successful example of the science school?—Yes.

174* *Mr. Scapng* was also instructed in Jermyn-street, was he not?—(Captain *Donnelly*) I think not, I believe he was taught in the Greenwich Navigation School.

175. Was he not also taught in Jermyn-street?—I do not think so. (*Mr. Cole*) I fully agree with the inference to be deduced from the *Chairman's* question, namely, that a science teacher ought to be properly trained

176 Can you point out any successful day science school which is conducted by a master of whom you do not know that he has received a competent training?—(Captain *Donnelly*) Yes; *Mr. Mayer*, at Glasgow, is not a trained science teacher, and certainly *Mr. Angell*, at Manchester, is not a trained science teacher; those are two cases. I do not remember any other at this moment.

177. But the two most successful schools are that at Bristol, and the Navigation School at Hull, and those two are conducted by trained masters, are they not?—As far as my recollection goes, *Mr. Scapng* was taught in the Greenwich Navigation School, and I do not think he had any special science training, though he may have had.

178. Is there any institution, at present, for training science masters?—(*Mr. Cole*) None

179. Is there any institution that you could point out that you think might be made available for that purpose, if it should be thought desirable to train such masters for science schools, as you have indicated by the distinction which you made between serious science schools and mere science classes?—I think most of the existing training colleges throughout the country might, with a very moderate assistance, be made thoroughly fit for training teachers of science in secondary schools

180. *Lord Robert Montagu*.] Does not St. Mark's College at Chelsea obtain grants for science teaching?—(Captain *Donnelly*.) Yes.

181. *Chairman*] Under what minute is that?—Under the general minute, paying for results.

182 You would consider them poor students'—Those that come within the rules would be paid so.

183 *Lord Robert Montagu*] Was not a letter written to the principals of the training college the other day on that subject?—(*Mr. Cole*) Yes

184 Will you put that letter in?—Yes, I put it in.

"SIR,
"February 1868.
"I AM directed by the Lords of the Committee of Council on Education to forward to you the accompanying copy of a science directory, the recent Minute creating scholarships, and an explanatory memorandum, and I am at the same time to point out to you that the students in a training college are on the same footing with regard to the aid given to science instruction as any other students

"Their teacher or teachers can earn payments on results on exactly the same conditions as for the instruction of students not in a training college."

"In order to carry out the rules of the Science and Art Department, and to give the teachers the necessary vouchers, a committee must be formed. This committee amongst other duties superintend the examination of the students in papers furnished from the Science and Art Department. The question has arisen in one or two cases whether the principal or instructors of the training college could be on this committee. My Lords have in all cases decided that this could not be allowed. The reason for this decision will be evident, and it need scarcely be said that no imputation thereby cast on the fairness and impartiality."

the officers of the training college. All the examinations are conducted by local agency, and both as regards medals and Royal Exhibitions schools are competing with one another. In order to give perfect confidence, and to avoid the slightest ground for unpleasant comments, it is necessary to adhere strictly to the rule which has been laid down, that no person should serve on the committee who is in any way connected with the students, or can be considered interested, even remotely, in their success.

"However well qualified the principals of training colleges might be personally, and however natural it might appear that they should superintend the examination—especially when the students had been taught by some one entirely unconnected with the training college—to make an exception in their favour would place them in a very invidious position with regard to other schools where the rules are strictly enforced.

"I am, &c

"*Norman MacLeod,*
"Assistant Secretary"

My answer is not to be taken as suggesting that sufficient is done for training science teachers in training colleges, the training colleges are gradually adopting the present system.

185 *Chairman.*] But you would perhaps consider that for a day school for elementary science teaching, a teacher of a higher grade would be required than those who might be considered simply competent for conducting science classes?—Not higher, but more systematized teaching.

186 *Mr Potter.*] Have you not stated that there are no schools for training masters for science?—Yes.

187 You have schools for training art masters, and have had for years, have you not?—Yes, we have one central training school at South Kensington, and all the schools of art throughout the country partially train teachers.

188 Could you give any opinion with regard to the number of art masters who have been trained in the central school, who have remained in the profession?—I think I could give you a return of that, pretty accurately, I could give you a very accurate account of those who have been trained, and are still practising as teachers.

189. Will you put that in?—Yes

190 *Chairman*] On the whole, you think that sufficient encouragement is not being given to the training of science teachers?—Certainly

191. In answer to a previous question, you said that although payment on results is not granted to teachers in respect of middle class students, those students obtain prizes, and I think you stated that the value of those prizes has been increased, can you give the committee any more definite information upon that subject?—I will put in a return which will show the progress which has been made in that direction.

192. What does the State pay at this moment through the department for science instruction?—The direct payments to schools in 1867 amounted to 8,000 *l.*, in the previous year they were 5,000 *l.*

193. *Lord Robert Montagu.*] Can you give the Committee the estimate for this year?—In the present year it is proposed that the corresponding sum shall be 13,500 *l.*

194 *Chairman*] That is a very large increase upon the estimate of last year, is it not?—Yes.

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195 How do you account for that increase?—There is a relaxation of the rules which prevented a man receiving the full value for teaching more than one subject, another reason is that the classes are increasing largely

196. *Lord Robert Montagu*] There has been a general relaxation of the rules wherever it was thought advisable both for science and art, has there not?—Yes, with regard to science the whole vote proposed this year is 18,900 *l.* as against 8,600 *l.* in the preceding year

197. *Chairman*] What does that vote for science cover?—Payments to teachers on results, prizes of books, &c., grants for examples, local secretaries for examinations and scholarships, the sum of 2,000 *l.* is put down for the creation of new scholarships of 5 *l.*, 10 *l.*, and 25 *l.* a-year

198. That is under the minute of the 21st of December 1867, is it not?—Yes

199 Can you explain the proposed operation of that minute to the Committee?—The minute of the 21st December 1867 provides for two forms of scholarships in connection with elementary schools, whether receiving State aid as such or not, the first of them is an elementary school scholarship at 5 *l.* 5 *l.* is granted to the managers of any elementary school for the support of a deserving pupil if the school undertake to keep him for a year and subscribe 5 *l.*, also if the managers of the school wish to select from the students one pre-eminent among the best, and will undertake to provide 5 *l.* in order to keep him at school, then the department, upon certain conditions, will pay another 5 *l.*, the object being, in fact, to compete with the labour market, and to keep the boy at school for a year

200 *Lord Robert Montagu*] They are to select any boy in a poor school by competition, in order to give him a science training?—Yes, the managers can arrange as they please, subject to the approval of the department, they can keep the boy at school, and pay the 5 *l.*, and the department will pay the other 5 *l.*, provided he comes up and passes in the science examination ensuing

201 But this is previous to the education in science that he is to receive?—Before he receives any education in science

202 *Chairman*] I thought he was bound to pass in some subject at the May examination as a condition of receiving the grant?—Yes, afterwards; they begin by selecting a student, and they engage to pay 5 *l.*, and to keep him at the school, and he has to come up and pass in some subject in science, and then on his passing the examination, the department will pay the Government 5 *l.*

203 He does not receive the 10 *l.* unless he passes in one subject, does he?—Not the 10 *l.*; he may receive the local 5 *l.*, but not the Government 5 *l.*

204 What is the second scholarship?—That is a more advanced scholarship; it is called the Science and Art Scholarship; like the other scholarship there may be one for every 100 pupils, but it is granted without any corresponding contribution on the part of the locality

205. *Lord Robert Montagu.*] Will you explain that point a little more fully?—In the former case the school had to find 5 *l.*, but in this case they are relieved from that obligation, the Science and Art Department making the grant of 10 *l.* towards the maintenance for one year of the most deserving pupil or pupils in the elementary school

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who may have taken a first grade in elementary geometry and freehand or model drawing, and passed in some branch of science; if he has accomplished those two feats, of doing something at a low point in drawing, and something at a low point in science, then he may obtain one of those 10*l* scholarships.

206. Will you explain why we do not require the locality to subscribe an equal sum to that which we subscribe in this instance?—The rationale of that is, that you have got a promising youth, and you wish to encourage him to go on, while in the other case you rather pay for the results at the end of the year.

207. The object before was to give him a chance, while in this case we have got him, and our object is to educate him?—Yes.

208. *Chairman*] You think a boy who has got the 5*l* will then go in for the 10*l* next year?—Yes

209. *Mr Bruce*] That minute is the only one in which the science school exists side by side with that elementary school, is it not?—The elementary school may be in a town, and the science class may be held apart, but the minute contemplates the access of the student to some scientific teaching.

210. If the student were living at home, unless the science class were somewhere near, then there would be no advantage to be derived by the elementary scholarship?—No

211. *Lord Robert Montagu*] Must not all these scholarships be contemplated in succession one to the other, the boy at a poor school, which, perhaps, does not receive any grant from the Government, gets the first scholarship, and he is taught science, and then that very boy can go in for the second scholarship, is not that so?—Yes, he can go in for the second scholarship, and again for the third

212. *Chairman*.] But he must continue to be under instruction in the elementary school, and must be a poor scholar?—Yes.

213. *Mr Bruce*] But he may have ceased to be an elementary scholar, may he not?—He must attend the school during the day, that is the condition

214. *Chairman*] He must continue to be a scholar, in fact?—Yes.

215. *Mr Bruce*] Supposing the case of a boy who has done well at an elementary school, and has earned this 5*l*, can he only enjoy the advantage of the 5*l* as long as he is a day scholar?—That is all, it is to support him while he does not go to work.

216. *Chairman*] And the same condition attaches to the 10*l* scholarship?—Yes.

217. *Mr. Bruce*.] Do you think there is any reason why a boy who has left school, having qualified himself to get this 5*l*, and taken to some employment, and who yet wishes to attend the science school, should not have the payment continued to him?—He could attend the science school during the evening, but the object of the scholarship was to afford a boy some support instead of his being compelled to go to work.

218. But the object of the scholarship is not simply to support, but to encourage boys to apply themselves to scientific training?—(*Mr. Cole*) Certainly.

219. Do you see any reason why a boy of 12 or 13 who has left school, and has obtained this scholarship and taken to some employment, should not so long as he attends the science classes,

have that payment continued to him?—No, on the contrary, I think that a student should be provided with the means of continuing his instruction, and not be taken away from it too early.

220. You do not limit the age at which he may obtain this scholarship, do you?—Yes, for receiving the 10*l* to be paid by the department he must be from 12 to 16 years of age.

221. *Chairman*.] But is it not the case that the time of a boy of the age of 15 or 16 who should be kept at such a school would be simply wasted because there would be no means of giving him corresponding instruction in other subjects?—Pupil-teachers are kept at the elementary schools up to a late period.

222. Do you not except pupil teachers from the advantages of these grants?—Yes, but the boy could still get some good at the school, the Committee will understand that this Minute is only just beginning to summer, and I have no doubt that there is a good deal of instructive experience to be got out of the working of it. *Mr. Bruce*, however, raises another question.

223. *Lord Robert Montagu*.] Was not this the object of the Minute; it was supposed that there were certain clever boys in different poor schools throughout the country?—Yes.

224. And we wished to give those boys an opportunity of learning more than under ordinary circumstances they would be likely to learn at their school?—Yes

225. And in order to do that, we had to compete with the labour market which would, in its natural course of things, take them away from school?—Yes

226. And the elementary school scholarship was instituted in order to give this 10*l* a year, so that a boy might continue at the elementary school, and also obtain some instruction in science?—Yes

227. And, then, having got the boy so far our object was to cull out of this mass of boy throughout the country the best of them all, and enable them to obtain some higher scientific instruction?—Yes

228. And with that object, we instituted this Science and Art Scholarship?—Yes

229. This Science and Art Scholarship, then, must be taken in succession to the other scholarship?—Yes

230. The boy is supposed to rise from one to the other, and he is induced to remain at the school by what he will get by remaining?—Yes; the words of the Minute were, "The scholarship is intended to maintain the student while remaining at the elementary school, and the exhibition is to support him while pursuing his studies at some central institution where instruction is of a high grade"

231. *Mr. Bruce*.] Have you considered the advisability of keeping a boy's superior talents at the elementary school from 12 to 16?—That point, except in the way stated in the Minute, has not been specifically considered.

232. *Lord Robert Montagu*] Do not the pupil-teachers remain at elementary schools until they are 16 years of age?—Yes.

233. And do they not every day undergo at least an hour and a half of instruction?—Yes.

234. Therefore, it is possible, is it not, that boys up to 16 years of age might continue to receive instruction suitable to their age in an elementary school?—I cannot doubt it.

235. Then

235. There is no reason, is there, why those boys should not continue to receive instruction suitable to their age in elementary schools, up to the age of 16?—None

236 Mr. Bruce] But is not a pupil-teacher who continues at the elementary school until he is 16 years of age, receiving a payment which may be taken at an average of about 5*l* a year in return for his services?—Yes.

237 Is there any analogy between the case of a pupil-teacher in that position and that of an ordinary scholar?—It might be reasonably inferred that if there be a teacher at the school able to continue the instruction of the pupil-teacher as he is bound to do, the pupil-teacher staying till he is 18 years of age might be capable of giving proper instruction to a boy up to 16 years of age

238 Chairman] But the instruction given to the pupil-teacher is not given during the school hours; the pupil-teachers during school hours are employed in teaching, whereas the Minute requires that the boy should be at school during school hours, is not that so?—If it were found, as experience will show after a year or two, that the scholars did not get their other 5*l*, of course that would prove that something in the plan required modification.

239 Mr. Bruce] Your argument is that if the master is capable of instructing a pupil-teacher between 13 and 18 years of age, he is also capable of carrying on the instruction of your scholars from 12 to 16 years of age?—Yes, coupled with the test that we apply, namely, that he cannot obtain the 5*l* unless he passes in science.

240. The school would be receiving no payment for him, he being over 11 years of age, would it?—No

241 Mr. Potter.] Would it not, in your opinion, be desirable to extend the advantages of those scholarships to a lad of 14 who had obtained the 5*l* previously, and had gone to work at 14 years of age, supposing he chose to devote himself to working it out in an evening school?—I think that is desirable, but it is a distinct proposition

242. Lord Robert Montagu] Are you not aware that boys at elementary schools can obtain payment at those schools up to 21 years of age?—I am not officially aware of the existing rules

243 But do you not suppose that what the honourable Member is thinking of is rather this, that the payments for evening schools begin at 12 years of age, and that the payments for day schools do not cease at 12 years of age, but go on to 21 years of age?—I suppose so.

244. Chairman] The third grant, I believe, is an exhibition of 25*l*.?—Yes.

245. Will you kindly state to the Committee the conditions of that exhibition?—“The Science and Art Department will make a grant of 25*l* per annum to the managers of any school or educational institution, or any local committee formed for the purpose, who will raise the like sum by voluntary contribution, for the maintenance of a student at some college or school where scientific instruction of an advanced character may be obtained. The exhibition may last for one, two, or three years. Conditions: The exhibition must be awarded in competition in one or more branches of science at the May examination of the Science and Art Department. The managers may select any branch or branches of science for the competition, and if more than one be taken they may

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fix any relative amount of marks they consider best to assign to them. The place where the student is to pursue his studies may be fixed by the managers, subject to the approval of the Science and Art Department” That is to say, you may send a youth to Glasgow, or to Owens College, Manchester, or to Dublin, or anywhere where scientific instruction of a specific character is afforded “If a Government institution be selected, such as the Royal School of Mines, or Royal College of Chemistry, London, or the Royal College of Science, Dublin, the fees of the student will be remitted” Those institutions being under the control of the Lord President, he is able to say that they shall not pay any fees. “The exhibitor must be of the artisan class, or a poor student, as defined by the Science Directory The grant of the department will be paid from year to year on condition that a like payment has been made by the managers or local committee, and that the student has pursued his studies satisfactorily, according to regulations fixed by the department”

246. You understand by that, of course, that the department will engage to make the payment for three years at the least?—The Minute fixes one, two, or three years.

247 But if the locality granted the payment on its own account for three years, I presume the Science and Art Department would make the grant for the same time?—Yes, I should think so.

248 Changes have been rather frequent in your department, have they not?—Every change has been a beneficial one, in my opinion, the work is comparatively very new at this time of day, notwithstanding all we know France is beginning to contemplate something like what we are doing in this country, therefore I hope that the Chairman and the country will excuse us for finding it necessary to learn the business slowly.

249 Mr. Potter] Do you think that any locality is likely to guarantee 25*l* for three years?—(Captain Donnelly) I am pretty nearly sure that there are six cases of applications (Mr. Cole) I have reason to think that it will very soon be done in 30 cases

250 Lord Robert Montagu] Some communications have been made to you upon the subject, have they not?—Six different localities have written, and some of the places have specifically offered to establish scholarships

251. Chairman.] In fact, unless the localities were prepared to do something, you would scarcely think the Government will be justified in making the grant, I suppose?—That is the principle upon which we have always proceeded

252 Now with regard to the competition in May for the purpose of those exhibitions, have any regulations been determined on?—The forms for obtaining those scholarships have been prepared, and they are about to be submitted to the Lord President The thing, in fact, works itself The examinations are established in May, the subjects are settled, and the managers of the different localities will select the subjects upon which they themselves set a value.

253. But the Minute does not state clearly whether the competition is to be throughout the country at large, or confined to certain localities only; neither does it state in what grade the competitors shall be expected to pass? (Captain Donnelly) Let us suppose that Manchester raises 25*l*. for one of those scholarships. Manchester has then power, under the Minute, to say, “We

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will confine this to the artisans of Manchester," or, on the other hand, Manchester has power under the Minute to say, "We will extend this to all the artisans of Lancashire."

254 *Chairman*] But would Manchester have the power to say thus, "We will be content if the students pass in the fourth grade?"—Yes, as far as the department is concerned, there is no limit put with regard to the grade; it is for the locality to say whether they will prefer a student who passes fourth in chemistry, and first in mathematics, or whether they will prefer a student who passes fourth in mathematics, and first in chemistry.

255. In fact, they are to attach their own value to each grade and each subject?—Just so. This scholarship is based upon the impression that the locality will know exactly what class of advanced students it is desirous to aid, and what are the subjects it is particularly interested in, the only condition is that they must pass our May examinations.

256 That is to say, the localities assign the value, not only to the subject, but to the grade, and all the department has to do is to say what the summing up of the numbers has been?—Yes, practically it comes to that. I do not apprehend that the locality would put any absolutely indefensible number on a low grade, though a locality might say, for example, that it attached more importance to passing low in chemistry than to passing very high in physiology.

257. You would not refuse to grant the scholarship, simply on the ground that the grades in which the pupil had passed were not sufficiently advanced?—No.

258 The payments to universities are not made through the Department of Science and Art, are they?—(Mr Cole) No. I made, for the information of the Vice President, a summary of those payments, which I will put in, the information is collected from the votes "University of London examinations, in mathematics, natural philosophy, chemistry, experimental philosophy, botany, geology, physiology, and zoology, 1,700*l.*; University of Saint Andrew's examinations in natural philosophy, mathematics, and chemistry, 384*l.*; University of Aberdeen, examinations in chemistry and botany, 490*l.*; University of Glasgow, examinations in mathematics, natural philosophy, natural history, chemistry, botany, civil engineering, and mechanics, 1,258*l.*; University of Edinburgh, examinations in mathematics, natural philosophy, natural history, botany, and chemistry, 980*l.*" I am unable to explain why the subjects were chosen, or why the sums appear to vary in different places; if you take it according to the subjects, the State contributes, through the universities, in respect of mathematics, 951*l.*; chemistry, 1,315*l.*; natural and experimental philosophy, 751*l.*; botany, 710*l.*; geology, 150*l.*; physiology, zoology, and natural history, 660*l.*; mechanics and civil engineering, 275*l.*

259 Mr Bruce.] Is this outside of the science schools?—Yes; those are on the votes, and I do not know whether any parliamentary responsibility looks after them; those do not include the payment for science in respect of the Queen's Colleges in Ireland, which do not come annually before Parliament.

260. *Chairman*] Nor the payment in respect of Jermyn-street?—No.

261. But in connection with the department, you have payments for the college in Jermyn-

street, and for the Royal Colleges of Science in Dublin, have you not?—Yes.

262 All those payments, I suppose, you would say were not payments in respect of the artisan or poor students?—I apprehend that, in Edinburgh, the class of students are many of them very poor, Dr. Playfair told me that a student can pay his fees in Edinburgh, and live very well for 50*l.* a year.

263 But the payments are to the professor, irrespective of the grade of the students whom he teaches, are they not?—Quite so.

264 They are not also exclusively payments to metropolitan institutions?—No, Glasgow is not.

265. Nor is Saint Andrew's?—No, nor Aberdeen, and I do not think you could call the London University metropolitan, it is national.

266. Then we cannot say, can we, that the rule has ever been strictly adhered to, that for teaching science no payment shall be made, except to artisans, or to metropolitan institutions?—No. Like elementary education, this secondary education, which has been promoted by the Science and Art Department, has been promoted on behalf of those who could not pay for themselves.

267. Lord Robert Montagu.] These grants are not administered by the South Kensington Department?—No.

268. Mr. Dixon.] I think you stated in answer to a previous question that money was given by the State for the education in science of the superior classes?—Undoubtedly, to take it broadly, it is nearly 5,000*l.* a year, or more than that.

269. But you say that the money given through the Science and Art Department is limited to the education of the poor?—Yes, except so far as prizes are concerned.

270 *Chairman*] And except so far as Jermyn-street and the Royal College of Science in Dublin are concerned?—Yes.

271 Lord Robert Montagu.] The object in view is the education of the artisan class, is it not?—I think you would say that the Jermyn-street School was organized on the principle of mixing without reference to persons, and that the Royal College of Science is certainly on the principle of aiding the subjects rather than the persons requiring the information, at the College of Chemistry the students pay a fee of about 30*l.* a year; therefore it is obvious it is not for working people, though it may be said to be for the benefit of industry in a broad sense.

272. *Chairman*] You have prepared some notes, I think, on education at the request of the Vice President, and you have also prepared a paper by the direction of the Lord President, have you not?—Yes; the Vice President requested me in November last to state any opinion which I might hold on the subject of education, and I prepared a paper at his desire.

273. It relates to the education in science of the industrial classes?—In one section I venture to express curtly a few opinions on primary education, and then on secondary or technical instruction; then, thirdly, on public libraries and museums, which, in my humble judgment, have a most important bearing on technical instruction.

274. And those notes refer to the question before this Committee, do they not?—Yes, and with the Vice President's permission I hand them in (see Appendix).

275. You

275. You also prepared a paper by the direction of the Lord President, did you not?—By the direction of the Lord President, I prepared a kind of brief history of the department, which I also hand in (*see Appendix*).

276 You have, no doubt, considered what improvements might be made in the general regulations of the department, in order to give full effect to its object as far as science is concerned?—It is the duty of the department, and the earnest wish of all the officers employed in it, to perfect the existing system, and I dare say some of us have our own personal views about what might be done in the way of improvement. I have the permission of the Lord President to give any evidence on the subject here, it being understood that, with regard to the future, my opinions are only my own opinions.

277 Lord Robert Montagu] The word "poor," or the term "artizan class," applying to those to whom we give grants in the Whitehall Department, includes not only men who support themselves by manual labour, but also those who are on the same level with regard to affluence, does it not?—Yes.

278. So that the children of policemen, or the children of small shopkeepers, can bring aid to their schools?—Yes.

279 Then, what did you mean to convey by saying that aid is given by the Science and Art Department to a higher class than aid is given to by the Whitehall Department?—A peer's son might obtain the prize of a colour box in the Science and Art Department, and get nothing in the Whitehall Department.

280 Then, except with regard to prizes, the aid given is to the same class in both cases, is it not?—Yes.

281 Medals and prizes are given to the middle and higher classes, in order to induce them to attend examinations?—Yes.

282 What is the reason why you are anxious to induce them to attend the examinations?—There are several reasons, it is highly important, for the sake of supporting the schools, that high fees should be paid, and it is the interest of those who want the instruction to come and obtain a better kind of instruction, in the art schools particularly, at a comparatively moderate sum. It is a point of the highest importance, and was held to be so in the reconstitution of the Practical Art Department, that if you want to improve the manufactures of a country, the best thing is to create a demand for improved manufactures, and that in proportion as the upper and middle classes, who are the consumers to a great extent of such things, were willing to be instructed, in that proportion you would induce producers to respond to their wants.

283 Chairman] That applies to art more particularly?—Yes.

284. Lord Robert Montagu] Then, this small payment that we make to the middle and upper classes is not for the sake of the middle and upper classes, but for the sake of the poor, our intention being not to aid the education of the middle classes, but to aid the education of the working classes, is not that so?—The direct object, based on old tradition, is to aid the artizan class.

285 We give the medals and prizes, in order that we may thereby obtain a better support for the schools in which the poor are taught?—Exactly; at the first foundation of the schools of — was the rule at Somerset House that

nobody above the grade of an artizan should be admitted.

286 Mr Potter] The schools of design in the country could not exist without payment from the higher classes, could they?—They could not exist under the old system 20 years ago, the theory being that only the working classes should be aided, the middle and upper classes being prohibited from going to the schools, the funds of the schools had to be got by taking the hat round in each locality, that was found to be an extremely precarious source of revenue, and when the Practical Art Department was formed, Mr. Henley assented to the principle that it was far better to induce richer people to come in and be taught, than to take the begging box round, the result of that has been that the schools are not extravagantly supported by the State, and there are nearly 20,000*l* contributed by the upper and middle classes.

287 Are you correct in saying that the middle and upper classes were prohibited from attending the schools 20 years ago?—I think that was so, I cannot undertake to answer for every one of the schools, but most distinctly that was the view of the subject taken in Somerset House.

288. Lord Robert Montagu] The policy of all parties has hitherto been to allow the middle and upper classes to obtain their own education and pay for it, but to assist by means of the funds of the State the education of the poor, is not that so?—That has been the policy, and still is the policy.

289 Do you consider that a sound policy?—As far as it goes, I think it is very sound.

290 Chairman] But I think an answer which you gave to a previous question indicated that the State does give aid to science teaching in the universities and to the higher schools, partly through the Department of Science and Art, and partly by means of other grants over which the department has no control?—Yes.

291. Aid for the education of higher classes, than those to which the Vice-President alludes; is not that so?—Yes, to make my own personal answer quite clear, I will add that I am of opinion that the principle of State aid for the encouragement of certain sciences, as sciences, without regard to any particular class of persons is an expedient thing.

292 Lord Robert Montagu] But do you think that all parties in the State have hitherto been right in giving assistance towards the education of the poor, and refusing State funds towards the education of the middle and higher classes?—Certainly, and I think that, unless you want to pauperise the whole country, it would require extreme caution if you were to take any future action as to dealing with the middle and upper classes in this matter.

293. With regard to the education of the poor it has always been the policy of the department to encourage local energy and local institutions, rather than to force those institutions upon the localities?—Clearly, the department considers itself the humble servant of all the localities.

294 Chairman] But is there not some discrepancy between that answer and a previous answer of yours; in answer to the questions of the Vice-President, you say that the aid of the State has been confined to the poor, but in answer to previous questions, I thought you stated that the aid of the State had been given to institutions which provided for the education of classes above

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the poor?—Any very general statement might convey an incorrect impression. The direct aid of the department has been conferred for the instruction of the working people and the poor; but even that is not an exhaustive statement, because aid has been given to Jermyn-street and to the science college at Dublin. Then, again, no doubt the State, extrinsically to the department, has given aid for the promotion of certain sciences at the universities which I have mentioned.

295 Mr Bruce] The aid given to the education of the upper classes is utterly insignificant, but that given to the education of the poorer classes amounts to nearly a million a year, is not that so?—That, if it were made to include elementary education, would be true, but it must be qualified with regard to science and art, for instance, the existence of the museum at Kensington is for the technical instruction of all classes of persons that go to it.

296 Mr Gregory] The general answer which you would give upon these questions is, that you think it is sound policy to extend on certain subjects the instruction or education to other classes than the working classes?—Yes, to allow them to receive benefit from the aid of the State.

297 Lord Robert Montagu] But did I understand you rightly to say, that you would allow the middle and upper classes to obtain the aid of these schools; but that if they were to obtain the aid of these schools they must pay for it?—Yes, clearly.

298 With regard to the poor, on the other hand, you would give the assistance of the State towards their education?—Yes, I should say that the State might fairly take the risk of the adventure.

299 Making the richer classes pay for the education conferred, but letting the State give, or partially give, an education to the poorer classes?—Yes.

300 But, in the second place, do you think that the State should not force these educational establishments on any locality, but wait till the energy of the locality has established an appropriate institution?—Clearly, I think that the locality must woo the State.

301 And, thirdly, with regard to industrial teaching, when you say that the South Kensington Department aids industrial teaching, you do not mean to say that we endeavour to teach special trades, do you?—No, certainly not. With the exception of naval architecture, we do nothing of that kind. We do teach something technical and specific in naval architecture, in order to provide for the wants of the Admiralty.

302 With that exception, which is based on an exceptional reason, you would not teach special trades?—Certainly not.

303 Your object would rather be to educate the mind of the artizan than to enable his fingers to earn money?—Certainly, the utmost you can do is to teach all those general principles of science which tend to improve the industry of a country.

304 Your object being, not the work, but the intelligence of the man in his work?—Certainly.

305 Was there not a change of policy in 1853; formerly we endeavoured to give special instruction in trades, and we had special masters and special classes, did we not?—When the Practical Art Department was formed, there was very freely an expression of public opinion that the

school of design was of no direct benefit to manufactures. Owing to the unfortunate translation given to the words, *Ecole du Dessin*, they called our own school the School of Design, and the popular opinion was that its business was to make designs (not merely drawing). To show that at least it was possible to teach a technicality, I may say, that in 1853 four classes were formed to teach specialties—one to teach wood engraving, one for metal working, one for woollen fabrics, and one for porcelain painting. So far as training students to higher employments than they had reached before, the result was satisfactory; but then, having trained the students, we found that the manufacturers did not want them; we found that four students having been got up at a cost of something like 80 L a year each, for three or four years, turned out admirable painters on porcelain, but people did not want their labour, only one of them ever got back into the trade, and he is now the principal painter at Milton's, the other three are living in London. They came away from the Potteries, and one of them is the man who obtained the chief prize in Paris for what I believe was the best piece of porcelain painting in the Paris Exhibition. With regard to woollen fabrics, three or four young women were taught designing. One of them went to Dunfermline. She remained there a year or two, and Mr Beveridge employed her in his factory, but after a time he gave up business, and she became a teacher. The conclusion forced upon us by these facts was, that you could not dictate to the country what it wanted. We concluded that we could do something, however, namely, that we could teach generalities, and make good draftsmen or good painters; but as to decreeing that there should be a demand for porcelain painters, or for good designers, we found that the whole thing was a failure.

306 The French Imperial Commission, I believe, has recommended the Emperor to give up the plan which had been adopted in France, and merely to give scientific instruction, not special instruction in trades?—Yes.

307 Are they not giving the thing up in Germany too, or rather, have they not actually given it up in Germany?—I am not aware, there are some places in Germany where they promote a special action for the purpose of benefiting the locality, as, for instance, in the Hartz Mountains.

308 But I think the Chairman of this Committee has stated, in his letter on the subject, that in Germany the idea is pretty nearly given up, has he not?—I think so, my own impression is, that at the present time you have a good illustration of the effect of the State trying to make manufacturers in what is going on at Sevres and Meissen in Saxony. My belief is that they are there below the chief manufacturers of other parts of Europe.

309 Chairman] When you say that you would not teach a trade, you do not mean to say that you would not give technical instruction at all, do you?—I would give technical instruction in the sense of teaching the principles of the various sciences applied to industry.

310 For instance, you would teach mechanics drawing?—Yes.

311 And mining?—Yes, but that is exceptional.

312 With regard to civil engineering, the Government has agreed to contribute towards the stipend of a Professor of Engineering at Edinburgh, and I believe it is also contribut-

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towards the stipend of a similar professor at Glasgow?—I do not object to call that technical instruction, and I think it a right thing, but I would not teach China painting or specific designing for manufactures or any actual trade I do not think that the Government should undertake to keep a workshop

313 *Lord Robert Montagu*] You would teach the sciences which are applied to trades, but not the trades to which the sciences are applied?—Just so

314. *Chairman*] I suppose you would teach the sciences in their application to trades?—If I were to say yes, without qualification, my answer might be misunderstood.

315 *Mr Bruce*] At a place like Oldham, mechanical drawing is no doubt a great deal more learnt than it is learnt in places like the cotton districts, for instance?—Doubtless.

316. There would always be a tendency in each particular science school to learn those sciences which were of immediate application to the arts which were practised in the district?—Certainly, take the case of calico printing, you might make a manager of a calico print-works a good chemist and a good draftsman, and perhaps if he also knew something of geometry it would be so much the better, as well as if he knew a little of mechanism, but to teach him all those intimate details of practice which are involved in the successful application of certain sciences to calico printing would seem to be a most unwarrantable thing.

317 *Chairman*] Quite inexpedient, and quite impossible, you think?—Yes, and I think if the State were to attempt it, it would be ignominiously beaten

318 *Lord Robert Montagu*] Our object is to cultivate the intelligence of the worker, and to teach him natural laws?—Yes

319 *Chairman*.] But do you not go beyond that in teaching mechanical drawing?—No That is not a trade

320 But to teach mechanical drawing is not to teach natural law, is it?—No It is a special form of geometrical drawing

321 *Lord Robert Montagu*] But would not the value of drawing consist in the education of the eye, unless it were merely scientific drawing, which would be the education of the eye combined with scientific knowledge?—Yes, I might here read a passage from Lord Ross's Commission, with regard to that college in Ireland, which is, I believe, the best organised place of the kind in the country "We do not consider that the practical applications of science to industry, or the arts themselves, should be undertaken by the new college of science, as a special part of its teaching; its aim should rather be to impart a sound and thorough knowledge of those branches of science which may be so applied, leaving it to the student subsequently to specialize his knowledge, and turn his attention in the direction he may find most suitable, but practical subjects, when capable of being rendered illustrative of scientific principles, should in all cases be introduced in the course of instruction."

322. And that expresses your opinion, does it?—Fully.

323 *Mr. Dixon*] Chemistry is applied in various centres of manufacturing industry in very different ways; for instance, in Birmingham, Manchester, and further north, now, would you let the

teaching be the same in every one of those centres, or would you vary it so as to have a special application to that branch in the science of chemistry, which was acquired in that particular locality?—I think the utmost the State could do, would be to teach broad principles; I think it would be quite competent for each locality to go into the more minute application of those principles, and to afford specific instruction according to its sense of the want of it. At Owens College they have already a professor of mechanics, but Manchester being a centre of machinery of very various kinds, that is to say, that there is tool-making there, locomotive making, the making of weaving machinery, each of those different branches constitutes a speciality of its own It seems to me that the application of the general principles of mechanism to each speciality is the special business of the locality I do not think in a training school you could train people for loom making, or locomotive making, or the making of sugar refining machinery, all you can do is to teach what is at the base of those different matters, and then each locality must supply anything special, according to its own views.

324. *Chairman*] How would you teach mechanism without teaching the construction of machinery?—You would teach the principles At South Kennington we have a set of models illustrating the construction of buildings of all kinds, and the principles of mechanism.

325 But those you would illustrate by their application to special machines, would you not?—We should illustrate the broad principles.

326 *Lord Robert Montagu*] You have been asked some questions with regard to the employment of the Royal Engineers for the examinations, that plan was adopted merely as the cheapest way of preventing undue grants of public money, was it not?—Yes, certainly the cheapest mode by which we could obtain scientific inspection

327. Any other way of obtaining scientific inspection, and preventing grants of the public money from being wasted or misapplied, would have been much more costly, would it?—Very much more so, in fact, you could hardly find a numerous corps of scientific inspectors, at present, except in that particular body.

328 That was your only object in employing them, was it not?—Yes

329 Your Board consists of the Lord President, the Vice President, or either of them separately?—Yes

330 You, Mr Macleod, Captain Donnelly, and Mr Redgrave always attend the Board?—Yes

331. When any question has arisen, you have all, or some of you, investigated it, and reduced it to its proper issue, and then that issue you lay before the Board for its decision?—Yes

332. And when you find it necessary, you obtain professional assistance in order to enable you to arrive at the proper issue?—Yes, in commonplace cases, such as the purchase of subjects, we obtain professional assistance in the first instance; in more complicated cases the Lord President takes the initiative, and directs what shall be done.

333. But when you lay a question before the Board, you are always in a position to state the views which are entertained on the one side or the other of the question?—I always endeavour to obtain whatever information I can.

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334 And if that information does not seem to be sufficient, the Board order a further investigation, or employ professional assistance?—Invariably.

335 So that unity is maintained, although the questions are more thoroughly investigated than they would be if there were a council or board of examiners to decide upon them?—I think that the organisation of South Kensington ensures the highest amount of Parliamentary responsibility and the greatest promptitude of action, and, in all cases where a council is required, it is obtained to the full extent. I cannot conceive any piece of organisation better adapted for its purpose.

336 *Chairman*] Are you acquainted with any other organisation for scientific instruction of which professors of science do not form a permanent and necessary part?—As I understand it, the professional examiners at South Kensington are permanent. I do not know in what sense you could make them more permanent.

337 Could you not make them more permanent in this sense; can you conceive your 25 illustrious men sitting regularly as a board?—I think it would be a great interruption to public business, and incur a great cost, to keep 25 illustrious men sitting there every week.

338 But could you not at least conceive a selection from the 25 illustrious men sitting once in three months?—They do, and still oftener.

339 *Lord Robert Montagu*] Are not the Lord President, the Vice President, and the persons whom I have mentioned, a permanent committee?—Yes, I am neither scientific nor artistic, my business is simply to carry out to the best of my ability the orders of my superiors; if I am supposed to represent anything, it is common sense, that is all that I affect. With respect to science, I do not think Captain Donnelly affects to be an Admirable Crichton, he simply happens to have undergone a scientific course of instruction, and from a general point of view he knows something of science, but he would hardly affect, for instance, to pass judgment on a difficult question in chemistry; he would rather refer it to Dr Frankland, or to Dr Hofmann. With regard to art, Mr Redgrave is undoubtedly a man of considerable judgment and eminence, he is a Royal Academician, and in almost all cases of the doctrine of art, his opinion is about the best that could possibly be obtained. He comes to the board whenever he is summoned. If it were proposed, along with the present action of the department, to constitute a board of illustrious men to sit every now and then, unless there were some specific work to be done, I think you would be creating a costly impediment to public business.

340 *Chairman*] What is the precise office of Mr Redgrave?—He is Inspector General for Art.

341. Is there any gentleman who holds a similar position with regard to science?—No, and there could not be with any advantage, because science consists of at least 25 different subjects, while art is but painting, drawing, and modelling.

342 But it is usual, is it not, that there should be a director of a science school?—If you wish to create a science school, unquestionably you must have a director, but the executive and the council necessary for the carrying on a scientific teaching establishment are two different things.

343. Take the University of Lough, which is not a science school, but is very analogous to the science branch of the Science and Art Department, has not that a scientific chief?—I think not; it has a secretary and a senate, and so have we a secretary and a senate, if you like to call our body of professors by that name.

344. But is there any analogy between your body of examiners and the senate of the university?—A precise analogy, I think.

345 But your professors are not a consultative body?—I should call them so.

346. But at all events they are not constituted as a consultative body, are they?—They are used as a consultative body, I think there are frequent occasions when a consultative body is of the highest importance, and the practice of the department has been *ad hoc* to create a consultative body always whenever it was required.

347. *Mr Bruce*] Your system enables you to select, for purposes of consultation, the men who are most immediately capable of giving you advice upon the matter in hand?—Yes.

348. If you had, on the other hand, a fixed body, it might not include the very men whom you wished most to consult?—Exactly, in the case of the College of Science, that being a very difficult thing to attempt to organise, the following gentlemen were constituted a commission: “Lord Rosse, Lord Talbot de Malahide, Dr W. B. Carpenter, Dr. B. M. Cowie, Mr John Fowler, President of the Civil Engineers, Dr. Ed. Frankland, Mr. W. H. Gregory, M.P., Colonel H. D. Harness, R.S., Dr. A. W. Hofmann, Professor Thomas H. Huxley, Dr. J. Beete Jukes, Sir Robert Kane, Mr. Myles O'Reilly, M.P., Dr. Lyon Playfair, Lieutenant General E. Sabine, R.A., Professor Warrington W. Smith, Professor William K. Sullivan, Professor John Tyndall, Captain J. F. D. Donnelly, R.S.,” who also acted as secretary.

349. *Lord Robert Montagu*] Since the system of payment for results has been introduced, and the augmentation grant or payment on certificates has been abolished, have you observed any tendency on the part of the teachers to pay attention to the middle classes who pay them for the instruction, to the neglect of the poorer classes?—I think in the schools of art, yes, I am inclined to think the more open system that was adopted three years ago has had rather a mischievous tendency, by making it the interest of the teachers to get all they could out of the middle classes.

350. Has it had a tendency to make us miss the mark, and fall short of the end which the department has always put before it, namely, the teaching of the poor?—I think, until lately, the Minutes arising out of the last Committee have been rather disadvantageous to the schools of art.

351. That does not apply, does it, to the schools of science, because the teachers in the schools of science have not to be certificated?—I should not say that, in the case of science, the middle and upper classes have had a preference given to them, or that the work was not done with perfect equity between both parties; in the case of art, undoubtedly, the middle classes want what we consider rather an improper mode of teaching. They like to have it very rapid and very loose; they do not like to be pulled up strictly to the test of accuracy, and as a teacher

has to depend on them to a considerable extent for his income, he does a good many things which he would not be permitted to do to artisans.

352 Mr. *Potter*.] The department has advanced the rate of the emoluments, and is advancing the rate of emoluments, to the masters every year since the Committee of 1864, I believe?—It has advanced them, and is advancing them

353 Sir *Charles Lanyon*.] With regard to the payments to masters, what regulates the number of schools in any given locality?—The locality itself, unless the locality wanted a grant in aid of the building, there would be only one building grant for the locality, but in the case of the science classes in Birmingham, there are five or six of the schools themselves which make their own arrangements for holding their examinations, and they are themselves the judges whether they will teach and hold the examination or not.

354 Do you not think that it would be more desirable in those localities to limit those schools, so that you would insure a better class of masters and a greater amount of competition I see there are no fewer than 12 schools in Belfast?—As far as we dare exercise any kind of despotic action, we are going on the plan of trying to reduce the centres in Belfast, the inspector is going to Belfast to try and induce them to get into some plan of more consolidated action if possible

355 Does it not strike you with respect to the emoluments to be derived by the teachers, that the more the schools are limited, the better the class of teachers you will get, and the more competition, and that as your scholarships are limited to schools in which there are only 100 scholars, you do not give the best opportunity of obtaining the scholarships in those schools which are so divided?—With regard to the scholarships the limit is under 100

356 Mr *Bruce*] But there would be two for 101?—Yes, that would be so, but the general answer to the question of the honourable member is I think, that the localities are the judges of their own affairs.

357 Sir *Charles Lanyon*.] But do you not think that there might be some supervision with regard to the number of schools?—(Captain *Donnelly*.) In elementary instruction it would not be possible. If the teachers of elementary schools chose to teach science in the evening, it would be very hard to say that they should not do it.

358 Mr *Bruce*] But that limitation could very well be applied in the case of a building grant being asked for, could it not?—Yes.

359. But as you pay for the results, you are bound to pay for them wherever they are produced?—Yes, that is the principle.

360. And to adopt the suggestion of limiting the number of schools would be a departure from the principle on which your institution is founded?—Yes.

361. Sir *Charles Lanyon*.] Do you not think that it might produce a better class of teachers, if in all large towns the schools were limited?—(Mr. *Cole*.) If Belfast itself is not sufficiently alive to its own interest to make one or two substantial places where it may have the best possible instruction, and therefore of necessity compete with any smaller schools, it would be utterly impossible for the department to do it for them.

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362. Lord *Robert Montagu*] You have been asked some questions with regard to the relative difficulty of different subjects in scientific instruction; the ratio of failures in the different subjects taught would depend rather on the standard adopted in the examination papers, would it not?—Yes.

363 So that by making them in each case easier or more difficult, you might make the ratio of failures the same in every subject?—Yes.

364 And therefore no argument can be drawn from that ratio of failures, can there?—Not much.

365. If you have payments for results, it must be pretty well the same throughout; we cannot make a larger payment for some subjects than for others, can we?—No; I think that would be inexpedient.

366 You stated that art schools could obtain building grants, while science schools cannot obtain building grants, can you recall to memory a deputation which was introduced to me by the honourable Member for Lambeth (Mr. *Hughes*), among whom Professor *Maurice* appeared, which had reference to the Working Men's College in London?—Yes

367. Do you remember that that deputation were told that they might receive 500 £. as a building grant?—Yes

368. And are you aware that, nevertheless, in that college it was chiefly science that was taught?—I was not aware whether science was chiefly taught there.

369. They obtained the grant because art was taught also, did they not?—They might obtain the grant provided they conformed to the conditions of the Art Directory.

370. Their teaching science in that college does not preclude their obtaining the grant as an art school?—Certainly not.

371. So that any other college might in the same way obtain a grant, although it chiefly taught science?—Yes, there is one case where a school was established specially as a science school, and performed all the necessary conditions in order to obtain the grant of 500 £ for an art school, but to this day they have not established a proper art school.

372. The only reason why the building grant for a science school is not mentioned in the Directory is this, that any locality will serve for a class in science teaching, while any locality will not serve for art teaching?—Yes

373. We do not wish to preclude science from those advantages which are given to art, but we allow them to obtain a grant for teaching science if they also teach a little art?—Yes.

374. *Chairman*] Suppose a locality were to apply for a grant as an art school, and were to send you up a plan showing a chemical laboratory as part of the building; would you sanction a grant in respect of the space occupied by that laboratory?—No

375 Mr *Bruce*] You would be bound to see that the building fulfilled all the requirements of a good art school?—Yes

376. But they could not obtain the public money for the space occupied by the laboratory?—Just so.

377. Mr. *Gregory*.] Have you anything like an annual meeting of a scientific council in your department, to make general suggestions and re-

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view the whole system of scientific education which has been pursued?—(Captain *Donnelly*.) There has never been a fixed day appointed for it, but I think there has been a meeting of the whole body, generally at least once a year. On various occasions the whole system of examination and other general questions have been brought before the body.

378. But there has been no actual fixed day for the meeting?—No; the meeting has taken place when the occasion for it has arisen, but there is no fixed day for such a meeting.

379. Do you not think it would be an advisable thing if the principle were adopted, of having a meeting on a fixed day?—If there is a suggestion of any kind to be made, the examiner puts it in when he makes his report on the examination, and if any general question arose there would be a meeting of all the examiners, I think the examiners would all say, if they were asked, that whenever they have had any particular views to put forward, they have always had an opportunity of discussing them.

380. Mr. *Lewther*.] With regard to these certificated teachers, who, you say, leave their classes, are there no means of engaging them for certain specified times?—The locality may engage them for a certain number of years, if they please; but the department has no control over that.

381. Do you think the teachers themselves would like to agree to such a thing?—It would be entirely a question for the locality to make it worth their while, the Science and Art Department simply pays on the results of each year's work.

382. Mr. *Bruce*.] Do you think that the success of the science schools suffers from the want of good elementary education being continued for a sufficient length of time?—(Mr. *Cole*.) I have no doubt whatever, that if the elementary education were better than it is, the science schools would be much increased in numbers, and much better attended, therefore I say that science has not prospered as much as it would have done if the elementary education had been better.

383. You have no means of acquainting the Committee with the length of time for which the pupils of the science classes attend those classes?—(Captain *Donnelly*.) I think we could show from the day-book.

384. I dare say you are aware that, from time to time, the Department of Whitehall publishes a statement showing how long the scholars have remained at the schools?—We have not gone into any inquiry of that kind, what we could tell would be the number of lessons that each of the students had received during the year.

385. But you could not say for how many successive years the students have remained at the school?—We could fish it out with some trouble.

386. Are you able to say that any particular number of students have received the substantial scientific education befitting an intelligent man of the class we have in our eye, at any of those night schools?—There have been many people who have competed for the Royal Exhibition at Jermyn-street and the College of Sciences in Ireland, who have obtained their information entirely in the night schools, and they have done exceedingly well in a number of subjects.

387. You think, then, that there is evidence that a considerable number of persons of the artizan classes have obtained at the night schools the amount

of information which I have referred to?—I think so. (Mr. *Cole*.) I could perhaps answer your question thus: You are aware that Mr. Whitworth is proposing to establish some scholarships of 100*l.* a year, and that he proposes, by means of those scholarships, to promote proficiency in mechanical science, which he says shall be tested by the hand power of the handicraftsman and the theoretical power of the scholar. He, I believe, is going to make it essential that both these qualifications shall be necessary for a person who obtains a scholarship, that equal importance shall be given to perfect workmanship and to complete theory, so as to handicap each party fairly. Now, if I have any apprehension at all with regard to the working of that scheme, it is this;—my present impression is that the 10 first scholarships will be taken by handicraftsmen who have got a little theory, rather than by theoretical men who have got a little handicraft. I have been looking into the return of students who have succeeded, and I am surprised to find so many artizans who have been earning their daily bread, who have qualified in a number of the subjects which Mr. Whitworth is likely to insist upon his candidates being examined in. I have in my eye, while I am speaking, a cabinet-maker who is of such an age as to be earning his living. I have no doubt that he has attended only night classes, and we are assuming him to be a good cabinet-maker. He has qualified in mathematics, mechanical drawing, geometrical drawing, mechanics, and physics. I do not know how long he has been going on with his studies, but when I look at facts like these, my expectation certainly is that the artizan will rub away with these scholarships.

388. Do you not think that the effect of the condition attached by Mr. Whitworth will be very much practically to limit the benefit of his scheme to working men, is not, in fact, the number of men belonging to the easier classes who are theoretically advanced in science, and who can also manage an axe or some finer tool, very small?—I should think so.

389. Would not, therefore, the effect be to limit the benefit of Mr. Whitworth's endowment almost entirely to the working classes?—He is about to take some trouble in order to endeavour to bring the thing fairly before all classes; my impression is, however, that for those 100*l.* scholarships, the man of the hand is more likely to win than the man of brains.

390. Will not the effect be, that the men of brains, whom we are so anxious to have as the future instructors of the country, will be almost entirely excluded?—The man of the hand would be also a man of brains, as far as our night classes could make him one.

391. But the effect of the condition would surely be very much to exclude men who were not also handicraftsmen?—I am in hopes ultimately not.

392. *Chairman* (to Captain *Donnelly*).] You stated that a great many artizans had taken scholarships in the higher schools, can you give approximately the number of those artizans?—There are three to each of those places annually three to the College of Science in Ireland, and three to Jermyn-street, tenable each of them for three years. The following candidates obtained the Royal Exhibitions in 1867:—To the Royal School of Mines: Wm. Garnett, aged 16, father a commerçu

a commerçu
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a commercial traveller; Archibald Laversidge, aged 20, student; Alex. W. Bickerton, 25, cabinet maker. To the Royal College of Science. Phineas S. Abraham, 20, chemist; Wm Hunt, 21, teacher in training; James R. Kilroe, 18, engineer. Many of the medals in 1867 were taken by mechanics, joiners, miners, &c.

393. And you believe those men received their instruction in connection with the Department of Science and Art?—Yes.

394 Mr Gregory.] Do we require in our training any proof at all of manual dexterity?—

395. We differ in that respect from the *Ecoles des Arts et Metiers* in France?—Yes.

396. You are acquainted with the course of procedure at the *Ecoles des Arts et Metiers* in France?—Yes, in a rough way.

397. Manual labour, dexterity, and skill are a part of the teaching carried on in those schools, are they not?—I do not know that there is any teaching in manual dexterity

398. I mean joining, framing, fitting, and putting together different parts of machinery, and so forth?—Yes

H Cole,
Esq, c.B.,
and
Captain
Donnelly,
R.E.
—
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Monday, 27th April 1868.

MEMBERS PRESENT

Mr. Acland.
Mr. Akroyd
Mr. Bagnall.
Mr. Bazley.
Mr. Henry Austin Bruce
Lord Frederic Cavendish.
Mr. Dixon.
Mr. Gregory.

Sir Charles Lanyon.
Mr. William Lowther.
Mr. M'Lagan.
Lord Robert Montagu
Mr Edmund Potter.
Mr. Read
Mr. Samuelson.

BERNHARD SAMUELSON, Esq, IN THE CHAIR.

Captain DONNELLY, R.E., called in; and further Examined.

Captain
Donnelly,
R. E.
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399 Lord Robert Montagu] Will you give the Committee a general explanation of the system of education under the South Kensington Department?—The subjects towards instruction in which aid is given by the Science and Art Department are mentioned in the second paragraph of the Memorandum before the Committee They are “practical plane and solid geometry; 2, machine construction and drawing, 3, building, construction, or naval architecture and drawing; 4, elementary mathematics; 5, higher mathematics, 6, theoretical mechanics, 7, applied mechanics, 8, acoustics, light, and heat, 9, magnetism and electricity, 10, inorganic chemistry, 11, organic chemistry, 12, geology; 13, mineralogy; 14, animal physiology; 15, zoology, 16, vegetable physiology and economic botany; 17, systematic botany, 18, mining, 19, metallurgy, 20, navigation, 21, nautical astronomy; 22, steam; 23, physical geography.” The numbers at present under instruction in these several subjects are given in a table in the margin of the Memorandum, they are,—

Number under instruction at present in these subjects —

Subject	No.	Subject	No
I - -	2,946	XIII - -	62
II - -	2,844	XIV - -	1,943
III - -	2,091	XV - -	510
IV - -	2,414	XVI - -	312
V - -	34	XVII - -	220
VI - -	677	XVIII - -	36
VII - -	421	XIX - -	168
VIII - -	1,496	XX - -	1,507
IX - -	1,767	XXI - -	1,245
X - -	663	XXII - -	196
XI - -	664	XXIII - -	2,413
XII - -	2,466		

Total number of schools - - - 300

Total number of individuals - - 14,600 Of

this number 989 are students in Navigation schools not examined in May. Fifty-six of these are students in subject IV, 953 in subject XX., and 842 in subject XXI. Also two large institutions in Glasgow together return upwards of 1,600 students, as under instruction, of whom only 120 wish to be examined.

To place a school in connection with the Science and Art Department, it is necessary that a committee, consisting of at least five persons, should be formed, who will undertake to be responsible for the school, and superintend it.

400 Will you explain to the Committee what is done, if a training college wishes to give scientific instruction, and to get aid in doing so?—They form a committee of their own managers, who sign the required form, and they undertake to see that the examinations are properly conducted, and to certify to the position of the various candidates on behalf of whom payments are claimed.

401. And the managers of the training college become members of the committee of the Science School?—Yes, any of them who like to undertake the duty. Aid is given to science instruction under four separate heads; the first is payment to teachers on the results of instruction as tested by the examination; the successful candidates in the examination are classed in five classes; and the payment for a student of the artizan class who passes varies from 1*l.*, if he passes in the fifth class, to 5*l.* if he is placed in the first class. Medals and prizes are given to successful students, the medals being given in competition over the whole country, and the prizes to all those who get a first, second, or third class. Thirdly, grants are given to schools in aid of the purchase of apparatus; they amount to 50 per cent. on the prime cost of the articles. Fourthly, there are the Royal Exhibition, and free admissions to the Royal School of Mines, and the Royal College of Science, Dublin, and the scholarships and exhibitions which have been created by the Minute of December 1857, namely, elementary school scholarships, science and art scholarships, and scholarships for local exhibitions. For a teacher to be qualified to earn payment on results, it is only necessary that he should have taken a first or second class in the subject at the May examinations. But graduates of universities are taken as qualified without passing that examination; as I am glad to say a large number are now teaching. The payments are only made for the instruction of students of the artizan or weekly wages class and those whose income is less than 100*l.* p. annum

annum. The committee certify that the students come under the different categories that are laid down in the forms, and then the payments are made to the teachers on them. The statistics for the last two years are as follows

	May		
	1866	1867	1868
Number of Science Schools - -	153	212	300
Number of persons under instruction - -	6,835	10,230	14,800
Number examined - -	3,150	4,920	—
Number of separate examinations held - -	483	681	1,250
Number of papers worked - -	5,466	8,487	—

Payments to Teachers.

	May		
	1866	1867	1868
Amount paid to teachers - -	5,002 l. 7 s 6 d	3,000 l.	—
Number of teachers employed - -	123	200	325
Payments made to individual teachers, varying from - -	1 l to 192 l. 10 s	1 l to 220 l.	—
Averaging - -	40 s	40 s	—
Average amount paid on each student - -	14 s 6 d	15 s. 7 d	—

The examinations are held in May, and the examination in each subject is held on the same night all over the kingdom. Besides these classes under certified teachers, any class by whomsoever taught may be examined, a committee is formed, who undertake to look after the examination simply, and the class can be examined just as if it was under a certified teacher; but a teacher, unless he is qualified to earn the payments, receives no payments on results.

402. Any private individual may appear in the class to be examined?—Yes, anyone.

403. Does he pay any fee for examination?—All committees of science classes are obliged to make arrangements to admit outside students, and if they are put to any expense, in taking rooms, and so on, for letting these candidates come up, they are then allowed to charge them a fee of 2s. 6d. I believe that, as a rule, they let them in without charging them a fee. By this means the examinations are carried into the remotest parts of the country; an examination may be held wherever a committee of five people will undertake to look after it. The prizes are given to those who get a first, second, or third class. To the first in each subject is given a gold medal, supposing he does exceptionally well; to the second best, a silver medal; and to the third and fourth, two bronze medals. There are six Royal Exhibitions, of the value of 50l. per annum, tenable for three years, given in competition at the May examinations, three of these are to the Royal School of Mines in London, and three to the Royal College of Science in Dublin. The professors at both institutions give free admissions to any student who has taken a gold medal at the May examinations. These exhibitions are competed for all over the country; for instance, the six best students happened to

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come from the Dublin schools; they would get three Royal exhibitions to London and three to Dublin. The Royal exhibition is not confined to any country, the six most successful students over whole country, obtain them; the exhibitions take the student to the Royal School of Mines in London, or the Royal College of Science in Dublin, which are the only institutions under the Science and Art Department in which scientific instruction of an advanced character is given.

404. The rules apply equally to England, Ireland, and Scotland, no distinction being made between the three countries?—No; I think the first set of Royal exhibitions given were nearly all taken by Irishmen.

405. That happened to be so because the Irishmen passed the better examination?—Yes, just so.

406. I believe, for a considerable time, the advisability of giving building grants to science schools has been under consideration in the department?—Yes, in various forms.

407. That consideration was brought to a head the other day, was it not?—Yes, by a Minute, and a letter has been written to the Treasury for the necessary sanction for the expenditure. It is to extend the same amount of building grant to schools of science as is now given to schools of art, under two conditions. Either that the science school shall be in connection with a school of art, or that it shall be formed under the Public Libraries Act, that is to say, upon the rates of the town. One or other of these two conditions being imposed, with a view of guaranteeing the permanence and satisfactoriness of the trusteeship, as it were, of the school.

408. Under the Free Libraries Act, a rate can be levied for the building of a school of art or science?—Yes.

409. That rate being levied, we should give a corresponding grant for a science school, should we not?—Yes, to the extent of half-a-crown per superficial foot, the maximum being 500 l.; of course under proper conditions with regard to the title, the ground, and so forth.

410. Art teachers are allowed to travel up to London now and then at the public expense for their own improvement, are they not?—Yes; that advantage is given to a certain number of them, by way of allowing them to improve themselves by seeing the latest system of apparatus, and so forth.

411. Have science teachers also been recently allowed to do this?—Yes, it is by a recent Minute, if they have shown that they have taught successfully, that is to say, a teacher who, for two years, has passed 30 students a year, is allowed, to have this advantage, namely, to come up to London, the department paying his railway fare, second class, and, I think, giving him 3 l. for the time which he remains in London.

412. That is for his personal expenses?—Yes.

413. That is with a view to his own improvement?—Yes, in order that he may visit the museums and the schools in London, and see what is going on.

414. For the time which he remains in London he receives 3 l., whatever the time may be. The sum is fixed, is it not?—Yes, it is a fixed sum. There is only this condition, that he shall stay as long as four days at the least.

415. But if he pleases he may stop in London for a whole week or longer?—Yes, formerly the art teacher was allowed his personal expenses,

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10 s. per diem, up to six days, but it was thought better to give him 3 l. fixed at once, and then let him remain as long as he liked.

416. Do you consider that the system of the Science and Art Department is applicable to all kinds of institutions, schools, classes, and so forth?—Yes; I do not know any other form which would render the aid of the State so easily accessible to all kinds of existing institutions without interfering with the form of the instruction already carried on in the institution. In looking through the list of classes I find that you may divide them into six or seven categories; night classes in mechanics and other similar institutions, as at Bury, Bolton, and so on. In other places there are both day classes and night classes, as at Manchester, Bromsgrove, and Liverpool. Then we have night classes in elementary schools, that is to say, the ordinary elementary schools receiving Government aid. The teacher teaches science in the evening to a class in the elementary school, either of the pupils who are then in the school or who continue attending in the evening only. There are classes of that kind at Leicester, Camborne, Middleton, and other places. Then there are other schools which, besides giving elementary instruction, have day classes in science and night classes as well, those we may call secondary schools, such as the Glasgow secular school and the Bristol school, and the Lower Islington public school, which has been very successful in that way. There are several others. Then the aid given is equally applicable to institutions which have been created specially for science instruction, there is such an one at Bolton and another at Oldham, the latter due principally to the munificence of Mr. Platt. At Cardiff they have got institutions under the Free Libraries Act, and there is an institution for science and art at Plymouth. There are places where they teach science under the Free Libraries Act, such as Liverpool, Glasgow, Cardiff, Northampton, and Dundalk. The system has also been applied to quite temporary classes, which, as far as they go, have been of use. For instance, there was a class at Highgate, and there was another at St. Leonard's. The gentlemen who opened them told us that they were only going to teach for a year or two, and they wished to know whether they could receive payment on results. Of course, when they went away after a time, the classes were not continued, but they were very useful while they lasted. The system has also been applied to schools in connection with works and manufactories. A great deal has been said of the Messrs. Schneider's schools at Creusot, in France. The same kind of action might be followed in England, with this difference, that in England State aid would be given to them, while the Creusot schools have no State aid, and I do not know that there is any system adopted by the French Government by which such schools can obtain State aid. There are schools of this nature receiving aid from the Department-schools, that is, in connection with works; for instance, there are the Wolf Hill Mill schools, near Belfast, which obtain State aid; then there are the schools of the Besbrook Spinning Company, near Newry, and the Guildford Mills schools, both Irish. There is a very good school at Nelson in Marsden (Messrs. Eckroyd's), and at Crewe and Wolverton, where the railway company have established schools. All those different institutions, with their various systems of management and education, have been

enabled to take advantage of the Science and Art Departments system without at all upsetting their former courses of instruction: another good example is the Working Men's College in London, which has got science classes in connection with the regular course.

417. They have been promised a building grant, have they not?—Yes.

418. Was there anything peculiar in the Plymouth school to which you alluded?—It is an institution entirely for giving science and art instruction.

419. It appears to be your opinion that under this system elementary science instruction can be very widely diffused?—Yes.

420. Can you conceive of any other system under which it could be equally well diffused?—No; I know of no other way which, at the same time that it insured economy and a proper control of public funds, would enable you to reach every description of institution without imposing all kinds of rules and regulations on them which would hamper them.

421. Can you tell us anything about the recommendations of the French Commissioners which bear upon this point?—I think they have in their recommendations proposed the same kind of system to a remarkable extent. I would call attention to section 8 of the "Report of the Commission on Technical Instruction, appointed by Imperial Decree, 22nd June, 1863—French Ministry of Agriculture, Commerce, and Public Works," which is well worth reading.

422. To which page would you especially refer?—I would call your attention first to page 85: "To succeed in the theoretical part of such teaching, professors must be able to adopt their explanations and their reasonings to the audience they address, and must use every available means to drive them into the mind, even resigning themselves at times to sacrifice strictness of demonstration to the necessity of making themselves understood. Thus arithmetic, for instance, and especially geometry, may and must often be taught by the eye and by the touch as much as by reasoning, and it is chiefly from this point of view that the study and practice of drawing are indispensable auxiliaries in every method of teaching the sciences in their application to industry. These studies, intended for practical purposes, cannot therefore be efficiently directed with all the befitting details of execution, with the explanation of processes and the necessary experiments, except by men who have themselves practised the arts whose principles and rules they have to explain, and who know how to speak the language of the shipyard and the workshop. Hence results the impossibility of establishing for professional or industrial teaching, even from a general point of view, a uniform body of rules and methods, an organised professional staff, in short, a university of industrial education. This consequence is still more evident in all that concerns those technical studies which have for their immediate object the methods, rules, and application of the sciences." Then they go on to say, "The office of teacher having been thus constituted, without making a caste (*carrière hiérarchique*) of it, and considering it always as more or less temporary, and to be resigned in case of failure, it will always be easy to repair the consequences of an unfortunate choice, and the teachers will only be the more interested in securing success. This plan, however, cannot be made absolute nor altogether

altogether general." The report then continues, "To the reasons drawn from the very nature of the teaching, . . . which reasons reject the very notion of creating or employing any special body of professors, may be added some of another order. . . . Manufactures are most numerous in the provinces; country towns and districts will therefore be the first to profit by the new system, and may be fairly called upon to bear a large proportion of outlay. . . . On the other hand, the civil and military engineers of the Government, the profession generally, and well-educated manufacturers, will often consent, as they have done already, to undertake certain branches of this instruction. Such men will combine a knowledge of the principles of science with the moral authority belonging to practical experience: it must, however, be acknowledged, that though the natural consequence of the preceding considerations is to allow the founders of technical schools of every kind all necessary latitude, and almost entire liberty in the management of their own institutions, it would not be possible to leave these establishments altogether to themselves, without aiding them to a certain extent. The habits of our nation are not those of a neighbouring country. The political usages of England have led to the practice of self-government in almost everything, and it is most desirable that similar habits should be introduced and generalised in France, but prudence requires that the change should be effected by gradual means. Already well-timed and laudable examples of the independent and free action of local initiative have been furnished by Mulhouse, Lyons, Amiens, Nantes, and other cities; such a movement cannot be too much encouraged, as it may bring about, without any sudden change, the intellectual decentralisation of the country, by promoting the formation of numerous centres of study and scientific activity; but it is, nevertheless, true that, in the actual state of our customs and habits, the intervention of the State in the way of encouragement and assistance of various kinds will still be necessary for a long time, and this intervention will be to the Government a powerful means of stimulating and exciting local and individual undertakings to make efforts of sufficient importance to entitle them to share in the State assistance. It may even frequently happen, and it is most desirable, that after a certain time, when the institutions founded have been well directed, and success has crowned their efforts, the State, perceiving that its pecuniary or material assistance is no longer necessary, may withdraw it, and give only honorary encouragement, and that the founders themselves may prefer independence to a protection which, however well meant, is always burdensome." That is almost quoting the very comments of the Science and Art Directory on the subject, and then they give the different resolutions which have been arrived at for carrying out their ideas.

423. Then it is, in fact, your opinion that the recommendations of the French Commissioners are as similar as the habits of the people will allow, to the rules which we have already adopted in this country?—Yes; I fancy they are to a great extent based on them.

424. I believe the Commission sent over persons to this country to inquire into our rules, and the operation of them, did they not?—Yes.

425. And you believe they found them so excellent that they determined to adopt them?—

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Yes; the principle being, as far as possible, to induce the different localities to work for themselves.

426. What is your opinion with regard to training persons specially to be science teachers?—I do not think it would be at all advisable to train a person specially to be a science teacher. He would look to the Government to find him occupation; there are very few places where you could at once find sufficient occupation for a man giving science instruction only; and I think you must look more, at all events at the commencement, to find a man in the locality who is already engaged in some other occupation, and who can begin by turning his attention to evening instruction.

427. You would endeavour by every means to give scientific instruction to elementary teachers, or to students in training colleges?—Yes; I think that every assistance and encouragement should be given towards letting the teachers who are going to be teachers in elementary schools have facilities for learning science, so that when they get to their elementary schools they may be enabled to open evening classes, and commence instruction in science in any town they may be in.

428. And the payment they may derive from having those science classes will be in addition to the payment they would obtain in the elementary schools?—Yes.

429. It would be a material increase to their income?—Yes.

430. And we should also in that way probably obtain a better class of teachers in elementary schools, as well as diffuse instruction in science?—Yes.

431. Because it would naturally be a higher and better class of persons who would aim at the office?—Yes.

432. Do you think we ought to have any central colleges for science instruction, such as the colleges of science in Dublin?—I think it would be very advisable that there should be three or four such colleges established. The College of Science in Dublin was established on a very good footing; and I think that some form of college might very well be adopted, perhaps in Edinburgh, perhaps in London, perhaps also in Manchester.

433. The object of those colleges not being so much to make teachers for scientific instruction as to aid those who have a natural aptitude for science?—Yes; but they would act incidentally for the purpose of training teachers also.

434. Would you leave it entirely to the locality to establish those colleges; or would you leave it to the Government to force the colleges on the locality; or would you, in accordance with our present policy, let the locality commence the work by its own energy, and then have it assisted by the Government?—Perhaps in London and in Edinburgh the Government might establish colleges, but I think in other places in the country the locality should do the greater part of the work.

435. You think the locality should take the initiative?—Yes; perhaps the Government might find the building, or take in hand the teaching; but, at all events, the larger portion of the work should be done, in my opinion, by the locality.

436. Would you allow every locality to establish these institutions, or would you confine the aid to towns of a certain magnitude?—I think it is only towns of considerable size which are

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likely to establish them. I think, therefore, it is unnecessary to make any restriction unless it were found that the thing was going too far.

437. Suppose some rule of this kind were made, namely, that in towns of a certain magnitude, say of 100,000 inhabitants or 50,000 inhabitants, if the inhabitants chose to subscribe half the entire cost of establishing such an institution, the Government should supply the other half, should you consider that a beneficial rule?—Yes, with regard to the buildings, and I think another condition should be annexed, namely, that the locality should establish a considerable number of exhibitions or scholarships in connection with it, because it is only by the establishment of exhibitions or scholarships that such a college could be of any use to the working classes, or the poorer classes, I also think that the upper classes should pay fair fees for the instruction they obtain

438. And you think that if a town of the requisite size promised to adhere to those conditions, the Government might promise to bestow a grant to the proper amount?—Yes, I think you might frame a very good system on that basis.

439. Then, in fact, with regard to the formation of these establishments, you would be copying the Jermyn-street institution?—Yes, except that in London it would be better for the Government to establish the college entirely at its own cost

440. With regard to the relative importance of the different subjects taught in schools of science, have you anything to say to the Committee?—That question arose at the last meeting of the Committee, and I did not remember at the moment that botany had been specially recommended as the commencement of scientific instruction by a committee of the British Association, which was appointed to report on the best means of introducing science instruction in public schools, and recommended that the course should be commenced by botany, and then go to physics. A question also arose at the last meeting of this Committee with regard to the difficulty of different subjects. To meet that case many subjects which were considered to be rather large in proportion to others have been divided, for instance, mathematics has been made into two subjects, and mechanics also, so that at present the various subjects given in the science directory are of about equal difficulty for the teachers to teach, or for the students to get prizes in

441. Do you think that the State ought to pay for the elementary scientific instruction of the upper and middle classes?—No, I do not see that there is any occasion for that. The upper and middle classes must obtain their elementary scientific instruction in the ordinary school course, and the instruction of the upper classes is pretty well provided for by existing endowments, which may be very well applied to afford a certain amount of instruction in science, what instruction is not so provided the middle classes can pay for. Of course, the artisan class is in a different position, they leave the elementary schools before they have any chance of learning much science, and therefore they must get their instruction either in the secondary schools, which must be specially established for them, or in evening classes, and there are no endowments to meet such cases.

442. Do you consider that a great number of those educational endowments were originally

established for the good of the poor, and have been gradually absorbed by change of circumstances to the use of the middle and upper classes?—Yes, to a very large extent; and, in fact, almost entirely in certain places.

443. Do you think those large sums of money have been diverted from the education of the poor to the education of the richer classes?—Yes.

444. And you think that is an additional argument against the State, giving its aid to the education of the middle and upper classes?—Yes, perhaps it may be said it gives the working and lower classes a certain kind of claim for State aid.

445. Besides which, you would consider that the middle and upper classes can pay for their own education, while the poorer classes cannot?—Yes.

446. You think that is a reason for the State giving elementary education to the poor, and not to the rich?—Yes.

447. Now with regard to advanced scientific instruction, would you apply the same rule to that also?—That stands rather in a different position there are no existing endowments which are very applicable for that. I am speaking now of instruction as distinct from a course of education, such as would be given at Oxford and Cambridge. I think you may fairly establish such institutions where advanced scientific instruction, both in separate subjects and in organised courses, could be obtained. This instruction would be entirely in science, and not form a portion of general education. The middle and upper classes take advantage of these institutions, paying by fees for the instruction they receive.

448. You think the middle and upper classes should pay full fees in return for their education?—Certainly.

449. Is there not, at all events, this difference between the education of the poorer classes and the education of the richer classes, that the richer classes can go and be educated during the daytime, while the poorer classes have to work during the daytime for their own livelihood?—Yes, with the former, elementary scientific instruction should be a portion of their general education. If afterwards they wished to carry on the study of a special subject or subjects, they might do so at the institution where advanced instruction was given.

450. So that the only time when the poorer classes can be educated is the evening or late at night?—Yes, unless they are aided by exhibitions, or the like.

451. In order to compete with the labour market?—Yes.

452. I think you wish to put in a Paper containing your views upon the subject, do you not?—Yes, the Chairman has asked for it, it is referred to in Mr Cole's Paper. I now hand it in.

453. Mr Gregory] In speaking of provincial colleges, I think you said you were of opinion that in towns of a certain magnitude, half the cost of establishing such institutions ought to be borne by the State in case the locality provided the remainder?—I think it might be done in that way, or else you might allow the locality to provide the building and plant while the Government provided the instruction.

454. But what provision would you propose to make for the maintenance of the teachers?—In the first case, namely, when the locality provides

provides half the cost of the building, it might also provide half the payment of the teacher, while the Government provided the other half; or perhaps, which would be better, the locality might provide the building and the plant, and the Government the cost of instruction. At Jermyn-street and the College of Science in Dublin, the professors receive 200*l* and the fees of students.

455 But you think that with regard to the colleges at Dublin, and Edinburgh, and London, the cost should be entirely defrayed by the State?—Yes.

456. Would you propose to affiliate the London institution in that case with the Jermyn-street institution?—Yes; a staff is there already in existence which might nearly form such a college as there is in Ireland; there are a number of professorships in general science in Jermyn-street which would form the basis of a general course of scientific training which in the third year would run into special lines, such as engineering, manufactures, agriculture, or mining, existing professorships would be applicable to any of those special branches.

457 In colleges such as any of those central colleges, would you provide museums with specimens for technical instruction?—I should think it would only be necessary to provide the absolute lecture specimens.

458 Are you acquainted with the museum of the College of Science in Dublin?—Yes.

459 Would you extend to Edinburgh and London the same system of what I may call technical exhibitions, as they have in Dublin?—In Edinburgh they have an existing museum, which is an industrial museum, and is far more extensive than that in Dublin; of course the specimens in the museums might be used at the lectures.

460 With regard to the upper and middle classes, I think you propose that in all cases where they attend those schools they should pay a certain fee?—Yes, a fair fee; and that would form the principal portion of the professor's salary.

461. I presume you would not allow any of the middle and upper classes to compete for those scholarships, but would confine them to the artizan class?—Yes, I think so; you might allow them to compete for a few.

462 Would it not, under those circumstances, be better to let it be a mere honorary distinction in the case of the middle or upper classes?—Perhaps so; but they are a great attraction to bring students.

463 *Chairman.*] But is it not the case now that all classes compete for the scholarships at Jermyn-street?—The middle and upper classes are allowed to compete for the Royal exhibitions at Jermyn-street if they are under 21 years of age, that of course gives a considerable advantage to the artizan and working classes.

464 *Mr Gregory.*] Have the night science classes in the elementary schools been attended with success, generally speaking?—Yes, I think very much so. In consequence of a question put to me on the last occasion, I have looked out the number of students who have been taught entirely in the evening classes, which struck me as being very successful, and a great many of those students have done exceedingly well in a large number of subjects.

465 *Lord Henry Cavendish.*] Have you any

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reports which show the effect of the teaching of your department in connection with the Exhibition at Paris last year?—All the science and art teachers were given a small sum of money to enable them to go over to the Paris Exhibition, and they have made reports on the Paris Exhibition, but I do not think anything more distinct than that.

466. None of the juries have called attention to that subject, have they?—Yes, with regard to art; of course, in art, strictly, one can identify a thing, and say that such and such a man designed a certain object, which received a medal, and he was taught in the art schools. In science this is not possible.

467 *Mr Bagnall.*] Will you inform the Committee whether you think it is of more importance that the upper and middle classes should learn science, or that the working classes should learn science?—I hardly know what answer to give to that. I think that if the upper and middle classes do not learn it soon, the other classes may come to press very hardly upon them.

468. *Mr Read.*] Did I understand you to say that certain endowments for public schools intended for the instruction of the lower classes were now diverted to the education of the higher and middle classes?—Broadly speaking, I think we may say that that has happened in a great many instances; for example, in grammar schools.

469. But were the funds of these grammar schools intended for the education of the labouring classes?—In many cases; perhaps hardly in all cases for the education of the labouring classes, but I believe, in a great many instances, they were intended for the education of the class immediately above the poorest classes.

470. Do you mean the lower middle class?—Yes; those classes who could not pay for education for themselves.

471 Is not it generally stipulated in the trust deeds that Greek and Latin shall be taught, which would not enter into the education of labourers?—Not of labourers, certainly.

472. *Mr McLagan.*] Was not there a professorship of technology established and endowed in Edinburgh some time ago?—I believe so.

473 Do you know how long ago that was?—When Professor Wilson was the professor.

474 Do you know why that professorship was abolished?—It was abolished after some correspondence between the University and the department, I think. It was considered of no use.

475 Was the extinction of that professorship recommended by the University, do you know?—I think it was, but as the event happened before I was in my present position I am not at all certain.

476 *Mr Bazley.*] You have stated that you do not think it requisite to teach or train science teachers at science colleges?—I do not think it would be advisable that Government should take certain men especially and train them.

477. Am I to understand you to say you think that we have a sufficient number of individuals in this country capable of effectively teaching art or science?—Finding that it pays, they are themselves learning it, and a great number have been taught at the night classes.

478 But have we any special colleges established for training pupils or young men in science for the universities?—Do you mean in science alone?

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479. Yes?—No, not that I know of.

480 That is to say, you think there is sufficient intelligence in the country to supply the preparatory information in science for young men going to the universities?—I think there are a great number of places where they may receive that instruction

481. But there are no specially established institutions for such purposes, are there?—Young men going to either of the universities would be able to come to London and go through a thorough course of scientific instruction at the School of Mines.

482 Are you aware of any such instances?—There are a number of students who do attend in Jermyn-street, that is to say, who take up a special course of lectures, but there are not a great many who go in for the associateships—the full systematic course

483. Are you aware of any instances in which young men study in Jermyn-street by way of preparation for the Universities?—I know of one gentleman who was in Jermyn-street, and who, I believe, did exceedingly well, and who is, I think, now at one of the Universities

484. *Chairman.*] Is he an undergraduate?—I think he is, that is the only instance I know of. I have no doubt there are many others, and that it will be still more common in future, because many of the colleges are opening science scholarships, for instance, two of the colleges had science scholarships competed for the other day, Queen's College and Merton College

485 You have recommended that science institutions should be established by the Government chiefly in the capital cities of the United Kingdom?—Institutions for the advancement of scientific instruction for which you would not be able to obtain professors in out-of-the-way places.

486 But should not the public treasure be equally expended for the advantage of science in every part of the kingdom without being confined to capital cities?—I do not think it could be expended with equal advantage in other parts, of course, if it could be done it, would be better to spread it evenly over the country, but I think it cannot be done You only require a few colleges for advanced scientific instruction, and for those colleges I think the capital cities are the best places

487 But why should not Liverpool, Manchester, Birmingham, Sheffield, and towns of that magnitude, have equal advantages in this respect with the capital cities of the country in the application of the public funds, should not the distribution be made equally for the benefit of all classes in every part of the kingdom?—It is very difficult to make a selection, it would be very difficult to say, for instance, whether you should fix upon Liverpool or Birmingham

488. But why should the public money be expended especially in London, Dublin, or in Edinburgh, when all the other places in the country have had to contribute to it?—The only answer that I can give is this. those are the capital cities.

489. A young man from the country coming up to London for scientific instruction would have to incur the expense of going and returning, and either he or his friends would have to incur the expense of his support while he was in London?—Yes, and so would a person going from London have to incur similar expenses if the college was in Manchester; and London

being larger than Manchester, you make the advantages of the college available to a greater number of people by having it in London.

490. But you can only place such establishments wherever the population is moderately dense, and to give London, Edinburgh, or Dublin a special advantage does not seem just to people in remoter parts of the kingdom, does it?—I think if I were told that I might place one such institution where I thought it would be of the greatest advantage to the country, and where it would, come nearest to doing justice to everybody, I should certainly fix upon London.

491. But, independently of institutions supported by the Government, London possesses both in science and in art professors and other advantages more abundantly than any other part of the country already?—Yes; and it is more available for students from all parts of the country than Manchester would be; it would be of much more use to the student to have the institution in London

492. The people of London having these advantages, you nevertheless say that public institutions should be raised at the public cost, to increase the advantages in question, while the people in the country, who have not the advantages either of professors or of institutions, must pay for them, either wholly or in part?—I think that for a student coming up from the country it would be a much greater advantage to be in London, where he could get instruction of various kinds, and see a great deal more than he would see if he were in Manchester or any other town.

493 But as the public treasury is filled from the contributions of all kinds of people, do you not think it should be devoted to the advantage of all kinds of people in equal proportion?—Yes; and I think London would be the best place to select, looking to the good of the greatest number.

494 *Chairman.*] But notwithstanding these reasons, you have conceded that colleges should be established in some of the large centres of population?—Certainly; and if there are only to be three, I should say that London, Dublin, and Edinburgh ought to be those centres.

495. Still you would not confine them to three only?—No

496. *Mr. Potter*] You expressed an opinion that a science master should derive a portion of his income from teaching the better classes at a certain rate of fees?—Yes, I was only speaking of institutions for advanced scientific instruction. Of course an ordinary science teacher, if he can get upper and middle class pupils to teach in the day, is justified and encouraged in doing so, and in fact it is done to a great extent

497 Do you not think if the teacher were restricted to teaching the artizan class proper, they would be much better taught?—No, the artizan class cannot be learning science during the day, because they are at work; and the more pay you can give to the science teacher the better the teacher you are likely to get; there is no way of supporting the science teacher besides evening classes, but giving instruction during the day.

498. And that system is carried out in the art schools now, is it not?—Yes.

499. Did you not hear Mr. Cole's admission that that system had been very detrimental?—No, I did not understand him to say that. I thought he said that by reducing the payments of the artizan class teachers after the last Committee had

had reported, the art teachers had been driven to looking too much to the fees from the upper and middle class, and had thus neglected the artizan class, but that since then the payments had been increased for the instruction of artizans. I have no doubt that that will have the effect of making art teachers take to that instruction.

500. Do you think that an art teacher who teaches in the daytime in the large schools, and gets large fees, would be competent to teach as he ought to teach in the evening class?—I think it would be a great advantage to the science teacher if he could get employment during the day in teaching science to the upper and middle classes.

501. Do you think the artizan class would be carefully attended to by the teacher who was engaged during the daytime in teaching the upper and middle class?—As a matter of fact, a proportion of the science teachers are employed in the daytime in elementary schools, and they take the science class in the evening, it is only very few teachers in places like Oldham, where there is a great deal of science instruction, who devote their whole time to science instruction.

502. The drift of my question is this suppose a science teacher, paid by the Government, were confined altogether to the artizan class, do you think that the instruction given by that teacher would be much more solid, and much more fairly given?—Yes, only I think the State aid would have to be enormously increased.

503. But would not a corresponding benefit accrue to the artizan class?—I am not sure that a corresponding advantage would accrue to the artizan class. It is a great advantage that you should let the upper and middle classes have the opportunity of getting some instruction from those science teachers if they pay the fees for it.

504. Mr Akroyd] You made some allusion to the "Report of the French Commission on Technical Instruction, French Ministry of Agriculture, Commerce, and Public Works." On pages 44 and 47 you will find references made to the general organisation and instruction given to the apprentices and workpeople, and there are three conclusions at which the Commission arrive: "That for the instruction of apprentices and workmen it is advisable to encourage, in preference to purely oral lectures, the establishment of regular classes to be held on the evenings of working days. That this teaching should not be at all dogmatical, but should make it a rule to explain, in the simplest possible manner, the principles of science by the aid of facts, and by showing their application. Lastly, that drawing, with all its applications to the different individual arts, should be considered as the principal means to be employed in technical instruction." Do you concur in those conclusions?—Entirely so.

505. I find also, on page 52, that there is reference to public lectures inviting the attention of the working classes to the subject of technical education. Now, taking for example the building trade, do you think that anything could be done by lectures to the working classes, to call their attention to the importance of technical instruction?—There is a gentleman connected with the department who was once a science teacher, and for many years he has now acted as an organising teacher, and whenever any town applies for his services, he is sent to that town.

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and by public lectures, or any similar means, gives full information on the system.

506. Courses of lectures are open in Jermyn-street, as we all know, do you not think that it would be desirable to give, in some other large manufacturing town, similar courses, on the ground that the working classes are scarcely alive to the importance of the subject?—Possibly that might facilitate the object which the department has in view.

507. May I refer you also to page 75 in the same Report, on the means of procuring professors for technical instruction. You will there find these words. "It would be useful to open voluntary examinations intended to certify the fitness for technical teaching of all such persons as should present themselves for that purpose. The programmes of the practical and oral tests, and, if necessary, the conditions of probation, should be determined by the minister, with the advice of the superior council, of which particulars will be given further on. The examinations would take place in the localities selected for the purpose before a special board named by the minister. The certificate of aptitude would be signed by the minister. The obtaining of these certificates would not be a necessary qualification for exercising this kind of professorship." May I ask what is your opinion upon that recommendation of the Commission?—I think the granting of certificates by a Government department is only advisable in case of absolute necessity; but the May examination meets your question under the existing rules of the department a person qualifies to teach and to receive payments on results, if he passes in the first and second class of the May examinations, which are held all over the country.

508. Mr Bruce] And any person may offer himself for those examinations?—Yes.

509. Mr Akroyd] Do you not think it desirable to train pupils under the science teachers as you have formerly done under the elementary school teachers; would you not thereby increase the number of teachers?—There are people under instruction and many of them turn to science teachers. I have a return here of men who have become teachers after learning their science in the evening classes.

510. My question referred to apprenticed pupil teachers?—We do not apprentice them, I will hand in a Return or list of very successful science teachers who have received their training almost entirely in the science evening classes, so that it does really meet what your question points to.

511. But hitherto you have never had any apprentices or pupil teachers to science masters?—No.

512. The only museum applicable to technical instruction is at Kensington, is it not?—The best industrial museum is, I think, in Edinburgh.

513. But in England is there any complete collection of the kind except that at South Kensington?—Jermyn-street is to a certain extent industrial.

514. It is quite possible to lend out those specimens to provincial museums for the purpose of technical instruction, is it not?—Yes, that is done now from South Kensington.

515. May I call your attention to page 96 of the Report of the French Commissioners, where they say they have arrived at this conclusion:

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" amongst the useful encouragements which it is the duty of the State to give to persons devoting their attention to technical instruction are — 1 ' Assistance in publishing works specially written with a view to the instruction of the working class population. 2 The distribution of such books at reduced prices, and occasionally gratuitously to establishments founded by the local corporations or private individuals,' " do you approve of that recommendation?—I do, the first recommendation has been carried out to a certain extent by the Science and Art Department, where the case seemed very urgent, which was with regard to practical geometry, plane and solid, there was no work in the English language which met the case, and therefore the Board got Professor Bradley to write a work specially for the science schools. Of course, where it is possible, it is much better to allow the public to provide their own books, and where there is really a demand there will generally be a supply, so that I think anything of the kind should be done with very great care, and only in very special cases. With regard to the distribution of books, it is the ordinary rule of the department to allow 50 per cent. on a copy of a book for a school.

516 With respect to technical education for the working classes in this country, the only mode of carrying on the technical education of the working people is by evening classes, is it not?—Yes, and in what may be called secondary schools.

517. Now, about these scholarships, the amount of the first scholarship is 5*l.* from the department, with 5*l.* added, that is 10*l.* a year, or 4*s.* a week?—Yes.

518. Are you aware that in the manufacturing districts youths from 13 to 18 years of age can earn 15*l.* to 20*l.* a year, and of course more as they advance in age; you can hardly hope to compete with the labour market by scholarships of 10*l.* each, can you?—Yes, but we do hope that, and I believe the scholarship will be taken advantage of, because, though the youths in question may lose a certain amount of money at the time, they must know very well that they will be enabled to earn more afterwards, and their parents may surely be expected to do something towards aiding them to obtain better instruction than they otherwise would obtain.

519 Lord Robert Montagu] And the boy gets something beyond the 10*l.*, he gets his education, does he not?—Just so

520. Mr. Akroyd] In most instances where youths can earn 15*l.* or 20*l.* a year, do you not think the evening classes will be preferred, the young people going to the factory or the workshop, and combining the scientific instruction with technical instruction in the workshop?—Yes, but it must be remembered that this plan is only tentative, and in another year it will be possible to judge whether it has been taken much advantage of, if it should prove that it has not, it will be easy to increase the amount, and it is always better to increase an amount of that kind than to have to decrease it.

521 Have you ever visited the Working Men's College at Halifax?—Yes

522 Are you aware that most of the students are connected with the factories where they are working the greater part of the day?—Yes.

523. Do you not think that by the evening classes throughout the country you might do a great deal towards the scientific instruction of the working classes?—No doubt.

524. Have you considered whether mechanics' institutions might not to a great extent be made available for those evening classes?—It is principally in mechanics' institutions that they are held

525. In many of those mechanics' institutions are there advanced schools for a variety of subjects?—If you were to run your eye down the list in the Scientific Directory you would see that that is the case in a great number of instances.

526. Then, in extending the education of the artizan class, you do not lose sight of the facilities offered to them by mechanics' institutions?—Certainly not

527. A great many of those institutions have been already occupied by elementary school teaching, but now, by means of the Factory Act and the other Labour Acts, they will be made much more available for the purpose than ever they were before?—No doubt.

528 Mr. Bruce] With regard to the question just put to you, how do you interpret the Minute as to the elementary scholarships. The first one is in these words " 5*l.* granted to the managers to any elementary school for the support of a deserving pupil if they undertake to support him for a year, and subscribe 5*l.* for that purpose." Why are those words " if they undertake to support him for a year," inserted?—It is necessary that the student should remain at the school for a year, and I suppose that the managers of the school would arrange with the boy to see that he would be likely to stay at the school for a year

529 The only subscription required from the locality is 5*l.* to meet the 5*l.* paid by the department?—That is the minimum.

530 Is it the purport of the Minute that over and above the 10*l.* there should be such other sum subscribed or found by the locality as should be sufficient to support the boy while attending a day school during the day, and a science school at night?—Yes; he cannot receive the department 5*l.* unless he does attend the school, so that fixes it at once. It would not be sufficient that he received the 5*l.* unless he attended a day school.

531. But the Minute fixes 5*l.* as the sum that should be subscribed by the locality for the purpose of providing for the students during a year?—At the least; the words of the Minute, I think, are, " 5*l.* at least."

532 How often do these science classes usually meet during the year?—The teachers cannot receive payment for the instruction of any pupil who has not received at least 25 lessons from him, that is the minimum

533 Is there any minimum of the nights on which the classes are to be open?—No, he is bound to give every pupil on whom he claims at least 25 lessons

534. Do you know, as a matter of fact, how many nights in the year the classes are usually open?—No; they vary very much; some that are very successful are open a great number of nights, 50, 60, or 70 nights, that is to say, each class in each subject meets that number of times.

535. You consider 50 or 60 nights to be a great number in the course of a year?—No; there are many that give even more than that; some as many as 100.

536 What should you say was the maximum number of nights on which the science classes are

are open?—Two or three nights a week from October to May, as the general thing

537. They are open very much in the same manner as the evening schools connected with the Elementary Department are?—Yes, that is the instruction which the teacher absolutely gives, but in most cases the students work up and teach themselves at their own homes.

538. But the object of my question was to ascertain whether the science teacher might not spare additional time for the education of the middle and upper classes without exhausting his energies, inasmuch as he would only attend 50 or 60 night classes in the course of a year?—Yes, it is the only chance that a small place has of getting science instruction, that the teacher, besides his night class, shall have something else to do during the day to earn money

539. The scholar who presents himself is obliged to have attended 25 times, but there is no minimum fixed with regard to the number of nights on which the school may be open?—No, except that 25 lessons at least is the minimum.

540. It would be utterly impossible for any considerable number of scholars to attend every night?—Just so

541. It has been said that the alteration from the original mode of payment to that adopted by the Minute ascribed to Mr Lowe, "payment on results," was distasteful to masters, and has operated to the injury of science classes; what has been your experience in that respect?—It was no doubt distasteful to some masters who made more under the old system, those were principally people who taught very small classes, and were not very successful it was certainly not distasteful to all, because I remember, in May 1863 (the change was made in 1862), after the May examination all the teachers who had been teaching under the old system were allowed to select whether they would be paid for that year under the old or the new system, and I know that many of the most successful teachers selected the new system because they got more under it.

542. Would it be generally correct to say that the best masters preferred this system of payment by results, and that the less efficient masters preferred the more fixed rate of payment?—Yes, broadly. There were some cases where the certified allowance happened to be very large, and where they selected that payment, but from the beginning the system has really been—"payment on results." The certificate allowance was really a maximum to which teachers could arrive by a moderate amount of success. That is to say, supposing he had got a first class in chemistry to which the certified allowance attached was 20*l*. if he passed five students in chemistry, then he received his 20*l*. he received 4*l*. per student. If one only passed, then he received only 4*l*., and over and above that he received payments for prizes; so that it was really a payment on results from the very commencement. The only difference was, that when the alteration was made by Mr. Lowe, the maximum of certified allowance was done away with.

543. It has also been stated that the department has acted without any concert with the masters who were affected by the alterations in the Minutes, are you aware that an association of science masters was formed in 1864 or 1865?—Yes.

544. When the department became acquainted with the existence of that association, did they 0.72.

communicate with that association?—Yes; I reported it to the Board, and by the direction of the Board a letter was written to say that the department were very glad to hear of that association having been formed; that they thought it might be of great service to the science classes, and that the Board would be always very glad to receive any communication from them on the subject of science schools and classes

545. Did the department receive any suggestions from them for alterations or improvements?—Yes, first of all I received a private letter from Dr. Birkenhead, who was the president, in which he stated the various resolutions that the meeting had come to, and what had been discussed. I reported that to the Board. He stated that an official letter would be written on the subject of these resolutions, but it did not come till the next year, after the second meeting of the teachers. If I remember rightly, there were three points that they asked to have some alteration made in; one was with regard to the syllabus and the text-books, that was greatly revised. I forget the others, but they have all since been carried out, except that they proposed that a certificate should be given to every student who passed

546. But, as a matter of fact, the department did receive suggestions from them, and paid great attention to them, and acted on them in the great majority of instances?—Yes

547. Was it ever suggested by the association that the mode of payment should be altered to that which originally existed?—No.

548. Can you state to the Committee what is the number of science schools in Lancashire at this moment, and what is the number of science schools in Yorkshire?—I have had them taken out in the different counties. Yorkshire has 16, with 476 students under instruction, Lancashire has 60, with 2,492 students under instruction.

549. Will you state what is the number of science schools formed in those two great counties during last year?—I think the number has been six or seven in Yorkshire, that is only speaking from recollection

550. How do you account for the very different state of the case with regard to those science schools in counties that are so similar in many of these characteristics?—One principal reason, I really believe, is that Yorkshire has always been very jealous of Government interference with reference to education, and that Lancashire has not.

551. With regard to the whole subject of education, you do not mean science specially?—I mean with regard to the whole subject of education; they are under a great misapprehension with regard to Government aids and grants. The other day I was at Huddersfield, and was asked to visit the Mechanics' Institute, and I met several members of the committee, who showed me over the whole place; it is one of the best in the country, there are upwards of 700 students there, who are principally receiving elementary instruction. I was shown a night class in drawing, which I fancied was receiving aid from the department, but, from what a member of the board said incidentally, I found it was not. I asked how it was that they were not receiving aid from the department, and they told me that at one time that had been discussed, but it had been thought that if these classes were put under the Science and Art Department, the art inspector

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in visiting them would have the right to examine and inspect the whole of their institution, and the whole of their classes, including the elementary classes. This was, of course, entirely a misapprehension of the rules, there is only a very small science school in the Huddersfield Mechanics' Institute.

552 In fact, you believe that a prejudice exists in the place with regard to the action of the department, which does not exist in Lancashire?—From all I heard, I believe that to be the case.

553 Have you any reason to believe that the ages at which the scholars attend the schools in Lancashire differ from those at which the scholars attend the schools in Yorkshire?—I have heard that elementary education is not so far advanced in Yorkshire as it is in Lancashire, but I do not know it personally.

554 But are you aware that the ages of the science scholars differ, those in Yorkshire being older, and those in Lancashire being younger?—No, I have never noticed it.

555 Do you think that there is anything in the statement which has been made, that the number of scholars in the Lancashire schools is unduly swelled by the admission of very young scholars?—No, as they are very successful, the returns cannot be unduly swelled.

556 Are they in the results quite as successful as those of Yorkshire, whatever may be the age of the student?—I think so.

557 Have you any reason to believe that the age of the scholars is materially different?—Not the least, and I believe they are quite as successful.

558 You were asked, with regard to whether any science scholars at any of these institutions with which you are connected, had availed themselves of the learning they had acquired to enter a university by means of the scholarships, or otherwise; is it not a preliminary condition of entrance into a university, that a considerable knowledge of the classics should be possessed?—I believe all matriculation examinations require classical knowledge.

559 Would not that circumstance alone exclude from the advantage offered by the universities in scientific education, which are very considerable, a large number of those who have really qualified themselves by previous scientific training?—Certainly; I have no doubt that it does act in that way to a great extent.

560 Is that why you suggest that the State should make a considerable outlay, in the manner you have described, for the encouragement of science teaching among the poorer classes of this country?—In the way of advanced scientific instruction?

561 Yes.—I think it is essentially necessary, I do not see any other means of meeting the case, the wants of those who possibly, comparatively late in life, wish to study one or more branches of science independently of classics, or, indeed, of any systematic course of instruction or education.

562 Essentially necessary for what purpose?—That an opportunity should be afforded to the upper and middle classes, those who are going to become heads and managers, of getting advanced scientific instruction.

563 Do you consider that there is too limited a supply of persons adequately trained in scientific knowledge to supply the wants of the great manufacturers of this country?—There is great

want of places for them to receive that instruction.

564. And in consequence is there a want of adequately instructed persons?—I have no doubt there is.

565. Are you aware that in many cases the great manufacturers go to Germany to obtain assistants who have received proper scientific instruction?—Yes, and I know that most of the people who have obtained royal exhibitions at Jermyn-street, and have gone through their course there, have immediately been snatched up for employment in works in different parts of the country.

566 But their number is not sufficient to meet the demand, and you think the manufacturers would gain very much by the creation of a larger class of educated agents and managers?—Yes.

567 Now, upon what ground do you found your view as to the duty of the State to supply means of education to this class of our fellow subjects, which are not given to students in medicine, in law, or (generally speaking), to civil engineers?—I do not know that there is any very good reason, except that the want is very pressing, and unless something is done very soon the trade of the country will be very injuriously affected.

568. The surgeons and doctors of the country are educated without any appreciable assistance from the State, are they not?—That has been going on for a long time.

569. And so are the lawyers?—Yes; their cases are met by the existing institutions and endowments; there are medical degrees at Oxford and Cambridge.

570 Do you believe that if manufacturers, whenever they wanted a properly qualified man, were to advertise that such and such emoluments were at the command of the man who could show himself properly qualified in scientific instruction, there would be any difficulty in getting a supply of such men?—I think there would be no difficulty in time. I should like to add, that I have always suggested that the middle and upper classes should pay very fair fees for their instruction, so that the Government would only supply what may be called the plant, and by means of the fees of the middle class students, you could at a comparatively small expense keep up establishments where artisans and the working classes may receive advanced scientific instruction.

571 But those large public buildings, which you propose to furnish, in some cases, the entire cost, and in other cases by the assistance of the State, are not to be simply for the education of the upper class, but the artisan class should, you think, obtain admission into them by means of exhibitions?—Yes.

572 You propose that those exhibitions should be acquired by the use of many of the endowments which have been diverted from their proper use, and partly that they should be exhibitions founded by the State?—Yes; such as those under the new Minute.

573. Do you not think that there would be a great advantage in these great colleges being situated in places of great population, and especially great industrial population; you said you thought that London had greater claims than Manchester, on account of its population?—Yes.

574. Then, why do you mention Edinburgh rather than Glasgow as the seat of one of those great

great experiments?—In the first place, there is already an existing industrial museum in Edinburgh which would be of great assistance in any establishment which was created in Edinburgh. And again, in considering the site for an institution of this kind, you must look to getting the very highest scientific teaching, and I do not think you are likely, except in the capitals, to attract the very highest scientific instructors.

575 You would at all events suggest that certain examinations should be made of model schools and teachers in the capitals, and that assistance should be given by the State to voluntary action in founding them in large industrial capitals?—Yes.

576 But that no assistance should be given to support of the pupils, except in the case of exhibition?—Yes, evening classes, secondary schools, and so on, may get payments on results, as at present, but with regard to the day classes in institutions for advanced scientific instruction, the only artisans that can attend would be those supported by exhibitions, and having free admission to the courses as a condition of the 200*l* a year, or whatever was paid to the professor as a State retaining fee.

577 Did I understand you to say that there were science classes held not only in elementary schools, but that science was taught by elementary teachers holding science certificates?—Yes, in the evening.

578 Is that allowed in every case?—Yes, the restriction is now removed with regard to the pupil teacher.

579 An elementary teacher having a pupil teacher is not now thereby deterred from holding a science class?—No, there is no such proviso now in the Science Directory.

580 How long is it since that change was made?—It was made by a minute of Lord Granville, I think.

581 Are there many science classes taught now by teachers in elementary schools?—Yes, I think there are a good many; I am not sure that all the elementary schools given in the list of science schools in the Directory are State aided schools, but I think a great number of them are, in the others they generally teach science in the day as well.

582 Have you the means of informing the Committee what is the average age of the students at the science schools?—No, I have not, some of them are very old.

583. You have no report upon that at all?—You would at once see from the list of results the ages of all of them.

584 But you have not tabulated that information?—No; many artisans of advanced age come to the science classes.

585 Mr *Potter*] In reply to Mr Bruce you spoke of the want of the manufacturers in Lancashire, and generally of scientific assistants?—Yes, by common report one learns that.

586. But have you any practical knowledge of the subject?—I know that foreigners have been introduced into works as managers.

587. Taking Lancashire, what kind of assistants should you say are destitute of a scientific knowledge of mechanics and chemistry; are you aware of the amount of chemical knowledge employed in the large establishments in Lancashire?—I do not know how I could define the amount of knowledge.

588 Would you be surprised if I mentioned 0.72.

to you that any amount of first-class chemical knowledge might be obtained for 100*l* a year in our manufactories?—It may be so, but from what I have heard I should say it was not the case, because I have heard of much larger prices being given.

589 But do you not think that a class of very able assistants in chemical knowledge might be obtained at the rate of about 2*l* a week?—I do not think so.

590 But you would not dispute it if I asserted it?—No, I should not do that, but I know that more is given, and I suppose people would not give more if they could get it for less.

591 Referring again to the amount of scientific knowledge in the different manufactories in Lancashire, are you not aware that a good many of the managers and owners of such places are men of great scientific knowledge?—I do not doubt it.

592 Do you not think that is pretty general at these large establishments?—I am not qualified perhaps to say.

593 Then to what class of scientific knowledge did you refer in your previous answers?—I can only speak from common rumour as to the difficulties of getting properly qualified scientific managers for works. We all know that foreigners have been introduced into such works, and I suppose because Englishmen could not be obtained.

594 Can you speak with any knowledge as to the number of foreigners that have been introduced into England for that purpose?—No, I have heard of several at various times.

595 Have you heard of any Englishmen being employed on continental works to any extent?—I have heard of many being employed in engineering works.

596 Are you aware that three or four times as many Englishmen are employed on the continent as foreigners in this country?—No, I do not know the relative numbers.

597 *Chairman*] I suppose, in giving evidence before the Committee to-day, you are rather stating what are the operations of the department, and how you think they might be improved, than offering any sort of theoretical or practical reasons why you think science teaching should be assisted?—Yes, I am assuming that it ought.

598 You did not come here to defend that, but you come here to state to us what is being done, and what improvements in your opinion might be made?—Yes, I assume that it is generally allowed that there is that necessity, otherwise I suppose there would not be this Committee.

599. You desire, in fact, to make the science teaching connected with your department as perfect as possible?—Yes.

600 I believe the translation of the Report of the French Commission on technical instruction was prepared at the request of the Department of Science and Art?—Yes, by Mr Hansoullier.

601. And edited by Mr Iselin?—Yes, he was desired to put in notes to show how far the existing system bore on the recommendation of the French Commission.

602 You are aware that the Report of this Commission deals more especially with what is called professional or industrial education?—Yes, they are careful to keep it to instruction for all persons engaged in industrial pursuits.

603. But the instruction is more of a mixed nature?—Yes, it takes in all the subjects.

604 But are you aware that since the Report

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of this Commission was issued a further inquiry has been made under the direction of the Minister of Public Instruction in France?—I have not seen the Report, nor do I know whether one was issued or not.

605 You have referred to the recommendations of the Report of 1865, one of which is, that there should be no special training for teachers?—Yes

606 Are you aware that the Report of 1865 recommends the establishment of training colleges for teachers of the applied sciences?—No

607. And that a training college has actually been established at Cluny?—No.

608 You know that Notes on Public Education by Mr. Cole have been put in before this Committee?—Yes

609 Your opinions are referred to in these notes?—Yes.

610 I suppose to some extent it is a joint production, but at all events you have had frequent conversations with Mr. Cole on the subject of these recommendations?—Yes.

611 Are you aware that one of those recommendations is that training colleges should be established for teaching practical science?—That places should be established where people might fit themselves for science teachers, I wish particularly to guard myself on that subject, those institutions would afford the necessary training, but it is quite a different thing for the State to pay for a man's education and train him as a master. Those institutions would give all necessary opportunities and those students who come up with exhibitions might turn to teaching afterwards if they pleased.

612 But I thought some of your answers went to show that you found that at the ordinary science classes men qualified themselves as teachers, and that you saw no necessity for their receiving special instruction?—I had no wish to convey that impression, science classes have already produced men who have taught science very successfully, but of course they would be immensely improved by being able to attend at the lectures of some of the most eminent men in the country, and they would get a great deal of instruction which they could never acquire in an elementary class, but, as a matter of fact, men have been turned out by evening classes who have taught successfully.

613. Who have been successful in giving instruction in an elementary science school?—Yes.

614 But it would be decidedly desirable that institutions should exist in which those persons could pursue their studies further, in order to become better qualified as science teachers?—Yes, but I do not recommend that the State should pay for their instruction and training them into science teachers, which is always a difficult thing.

615 But if the 251 exhibitions recently established should be used largely by teachers, you would think that very desirable?—Yes, and those who turned out from Jermyn-street, several of them have taken to teaching until they have got something better.

616. You have stated that the training colleges are now applying themselves to teaching science to persons preparing themselves as schoolmasters?—Yes.

617. Can you state to what extent that has

been the case?—The training college at Cullum has 27 under instruction in theoretical mechanics, inorganic chemistry, and animal physiology. The Battersea Training College has 80 under instruction in theoretical mechanics, inorganic chemistry, and physical geography. Chelsea has 48 students in elementary mathematics. Those have all recently taken it up, they began with elementary mathematics and are going to take up mechanics and chemistry.

618 Mr. Acland] Is it within your knowledge that science has only quite recently been taken up at Chelsea?—It has been for the last three years.

619 I thought it was more like 10 years?—I am merely speaking with regard to the Science and Art Department, it was about three years ago that they first connected their classes with our department.

620 Chairman] An answer which you gave reminds me that you stated to the Honourable Member, Mr. Bruce, that you found that the classes at Huddersfield in the Mechanics Institution were not in connection with the Science and Art Department?—I spoke of an art school, but there is a science school which is in connection. It is in a room attached to the Mechanics Institution, which they have allowed the teachers to use for science instruction, but the Mechanics Institution committee looked upon it rather as a detached thing.

621 You stated that Yorkshire had not availed itself of the grant of the Science and Art Department, owing to some jealousy of Government aid, are you aware whether in Yorkshire there are science classes to any great extent unconnected with South Kensington?—I do not think there are.

622. One of Mr. Cole's recommendations with regard to elementary education is, that the system of inspection and examination might be improved and largely increased with great advantage, and without a proportionate increase of cost, have you considered how that would apply to science instruction, and whether the same thing might not hold good with regard to inspection of science schools?—There is a note which perhaps explains that; "that is to say, for systematically making reports on any deficiency of schools, with a view of adopting such measures as Mr. Lowe suggests."

623 Do you not think it desirable that the science inspectors, in making their tours, should report on the deficiency or absence of science schools?—I do not see any harm in any inspectors saying it is a great pity that such and such a town has not a class, but I do not think it would do much good, on the other hand, people would very strongly object to our department sending somebody to tell them of their deficiency.

624 But you have an organiser of science classes?—He only goes when he is asked for.

625. Does not he occasionally ask to be asked?—I do not know, but the department never does, nor does it direct him to do so.

626. Mr. Bruce.] The allusion to Mr. Lowe shows that the intention was that when it was discovered that a district was insufficiently supplied with schools, a supply of schools should be enforced on the district?—Yes, it is in connection with compulsory education.

627. But do you suppose that Parliament could be induced to enforce a supply of science schools?

schools?—I scarcely think we are prepared for compulsory science instruction at present.

628 *Chairman*] At all events you think that the inspection might be extended, but do you not think it would be desirable to call attention to the absence of schools in a particular district?—If the district did not object to it it might do good but I am afraid they would object to it

629 You say each district chooses its own subjects?—Yes

630 Now is it not the case that in many localities the subjects taught really do not bear on the industry of the town?—That is very likely

631 Subjects which bear practically on the industry of the town are not sufficiently taught there?—Very likely they have not got teachers available, but I would impose no restrictions, certainly not

632 You stated that the examinations in all the different subjects were about equally difficult, so that it would be as easy to pass a pupil in one subject as in another?—That is broadly true no doubt

633 But is it not the case that there are certain subjects which can be taught to boys in masses in schools, while others are beyond the intelligence of boys, and require individual instruction?—There are many subjects which adults only can well take up

634 Is it not the case that those subjects are most generally taught which are within the comprehension of boys?—Yes

635 Consequently teachers taking up those subjects in elementary schools, would get larger payments than they would on those which would require individual instruction, and which could only be taught to adults?—Teachers who taught in an elementary school in the day, and in a class in the evening, would get, *cæteris paribus*, more than men who had evening classes only

636 But I am referring now to the subject rather than anything else?—There is probably no class of boys that you could get to learn such a subject as higher mathematics. If you got them to pass well in elementary mathematics, that would be as much as you could do. You might get a certain number of adults to pass in higher mathematics.

637 But not schoolboys?—No.

638 In fact, then, those people who take up subjects which can be taught to schoolboys, get better paid than those who take up subjects that can only be taught to adults?—No, in the very instance just given, the adult would have first learnt elementary mathematics, and obtained payments for his teacher. As a matter of fact, I think those received the largest payments who were only teaching adults. For instance, geometrical drawing is becoming one of the largest subjects. Boys would not be so successful in that as adults, and those who teach it get perhaps the largest payments. I think the facts tend against the inference to which your questions point.

639 You, of course, are not responsible for the editorial notes in this report?—Yes, I looked at them as they were going through the press, but I did not write them.

640 Do you think that the master of a class who had been educated in a training school, for instance at Cullum, would be qualified to give instruction in a secondary science school. First, with regard to the status of such persons, would they be likely to be accepted in secondary science

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schools?—Not at once; they would most likely go first as assistant masters somewhere else

641. They would be chiefly available for elementary schools?—Yes; in connection with elementary schools they would have night classes in places where there would be no other way of introducing science instruction; you could not support teachers on that alone

642 But I presume for your secondary schools you would prefer to have masters who had received a more strictly scientific training and a better education in other respects?—I think a successful elementary school teacher who went on teaching science, and had had practice in teaching, would be the best man you could get for a secondary school, that has, in fact, been the case both in Bristol and in Glasgow

643 With respect to the institution in Jermyn-street, you are aware that the number of matriculated students is exceedingly small?—Yes.

644 Something like twelve or thirteen, is it not?—Yes

645 Have you considered at all how that arises?—I think one reason why Jermyn-street has not been more taken advantage of up to this time has been the very great deficiency of elementary scientific instruction in the country, another is the great apathy on the subject of science in the industry that Jermyn-street appeals to, which forms only a small portion of the industry of the country, and which is less likely, perhaps, to take advantage of science instruction than any other

646 But the instruction given there is not confined to mining, is it?—No; but the college bears that name

647 In fact if Jermyn-street were to be made more strictly a polytechnic school, do you think it likely that it would be more successful?—What strikes me as the most advisable thing is this to make on the basis of the Jermyn-street College a college like the College of Science in Ireland, when the course of instruction lasts for three years, during the first two it is general, then in the third year it branches off into special lines manufactures, mining, civil engineering, or agriculture

648 Then, in point of fact, do you mean this; that side by side with Jermyn-street you would establish another school, or that you would absorb Jermyn-street?—Speaking off-hand, perhaps the best plan would be to absorb Jermyn-street, one portion going to form the basis of the general instruction, and the other, that portion which is special to mining, forming part of the third year's course in mining

649 You spoke of the advantage of payment on results being made to gentlemen who stated at the outset that they would only teach for a year or two?—Yes. I remember a place in Ireland, where a gentleman said he was going to teach for a short time only; it was Portlaw. He asked if there was any objection to his opening a class for a short time, and he was told "No."

650 You would not consider that desirable, would you?—Yes, I should consider it very desirable that he should teach for a year in preference to not teaching at all.

651 Do you think that a year's instruction is worth paying for?—Yes; besides it might very likely lead to their resuming a class some other time. I think a year's instruction is proportionately as well worth paying for as ten years'. When you pay on results, you pay for exactly

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the amount of instruction the student has obtained.

652 Do you mean that you think ten years' instruction is worth just ten times as much as one year's instruction?—Yes.

653 Do you not think that ten years' instruction is rather likely to be worth 30 or 40 times as much as one year's instruction, and do you not think that three years' study is worth six or nine times as much as one year?—If a person went on with it, no doubt, but in many cases it happens that a student begins a course of study and does not continue it afterwards, and you only pay for as much as he has received, whether it be in one or in ten years.

654. Then do you think that that one year's teaching was really worth paying the Government money for?—Yes; I have not the slightest doubt of it.

655 In the Appendix to the Report of the Commission on Technical Instruction, there is an account of a trade school at Bristol, to which a mining school is annexed?—Yes.

656 I believe a mining school was established at Bristol some years ago, and abandoned, was it not?—Yes.

657 In consequence of the teachers not finding it worth while to continue to give instruction?—I do not think it was ever in connection with the department, but I believe very few ever attended.

658. The mining school has been established again lately, I believe. Is that in connection with the department?—I believe they are going to make it in connection with the existing schools, and of course mining is one of the subjects which they would receive payment for in the ordinary way, according to the Science Directory.

659 Are you aware that the teacher of that school is a mining engineer?—I do not remember his name.

660 At all events, payment on results would be given on the teaching in that school?—Yes.

661 Now I believe it is the case that the gentleman who teaches in that school is a mining engineer, and that after having taught twelve months, he proposes to leave Bristol. Do you believe that teaching of that desultory character is desirable, or would you not rather that that teacher made it a permanent profession, looking forward to a permanent livelihood from teaching?—Of course a permanent school is much better than a temporary one, but a temporary one is much better than none at all, and I do not see how you could bind a man down to stay there.

662 Do you not think it would be desirable that a man should be able to make a living by teaching, instead of making his teaching simply supplemental to some other means of gaining a livelihood?—A man can at present make a livelihood by teaching, if he has people enough to teach. Of course, if any particular locality does not care enough about it, he does not do so, but I see no way of meeting that, unless you make enormously exaggerated payment for scientific instruction.

663 Are there many teachers who are earning more than 150*L*. a year from the Department?—There are not very many who are earning 150*L*. a year from the Department, but there are fees, and other things besides, and there are several who are earning 100*L*. a year and more for evening classes alone, the only time for artizan

classes is the evening, and the teachers must find something else to do during the day.

664 Then the best arrangement, in your opinion, after all, would be that the teachers should devote themselves exclusively to teaching, whether they taught the artizan classes alone or the middle classes also?—Yes, certainly, but I do not see why a man should not be employed in, for instance, some manufacturing works besides his teaching, he would in that way get a certain amount of information, which would be valuable to him for teaching purposes.

665 At all events you run the risk of losing his services unless he is established principally as a teacher?—Yes, but I think the risk is unappreciable, because, as a matter of fact, the schools and the pupils have gone on increasing so rapidly that the amount of failures must be called comparatively nothing; in 1860 there were only nine schools with 500 pupils, while in the present year there are 300 schools with 14,000 pupils, so that the number of failures has really not affected the matter.

666. But has not the increase taken place in subjects which may be called non-industrial, such as physiology and zoology?—I should say that the large number has been in geometrical drawing, practical geometry, machine drawing, and building construction, which are the very foundation of technical instruction, the increase has been most in those subjects, in fact, in the first page of the explanatory memorandum you will see that the number in practical, plain, and solid geometry is 2,846, machine construction 2,844, building construction 2,091, elementary mathematics 2,414; and then, running down the list of subjects, we do not come to 2,000 again till we get to subject No 10, which is inorganic chemistry; No 14 is animal physiology, against which the figure is 1,900.

667 Then you think the instruction is fairly divided among the different subjects, with the exception, perhaps, of organic chemistry, and a few other very difficult subjects?—Yes, there are very few students who would care to take up organic chemistry.

668 In answer to a question from the Vice President, you stated that if science teachers were specially trained for the office, you thought they would look to the Government for employment?—Yes.

669 But is it not rather the case that science teachers are trained, and leave the employment of teaching altogether and going to professions?—We do not now train any science teachers, but I think if we did, when you had trained your teachers they would be likely to look to you to find them something to do, or else they would go into trade, and then your expenditure would be wasted.

670 Are you rather afraid that you would find yourselves paying for the training of teachers who would be apt to cease to be teachers, or that you would be burdened with people who would not take employment as teachers?—Either state of things would be objectionable.

671 But which state of things do you think would arise?—The clever men who could get good occupation elsewhere would go away, I think, and the men who were not so clever and could not get occupation in manufactures would look to the Government to find them occupation in teaching.

672 As a matter of fact, there is an inadequate supply

supply of teachers at the present moment?—Yes; but I must guard myself in saying that. Those places where teachers are wanted would not be supplied by the teachers whom we had trained, because they would be places in out of the way districts where a man could not find a sufficient number of people to teach to support him by teaching alone

673. With regard to building grants, you say that, according to the present minute, building grants would be given to science schools?—Yes.

674. Has that minute been promulgated?—No, I have stated that a letter has been written to the Treasury on the subject, but the minute has not been finally adopted by the Treasury.

675. Lord Robert Montagu.] The minute has been passed at the Board, but the Treasury has not given its final sanction to it?—Just so

676. Chairman.] In fact, those grants would be to science schools of the nature of those which now exist, namely, to buildings for holding science classes?—Yes, 2 s. 6 d. per superficial foot up to a maximum of 500 l

677. But that maximum you would consider quite insufficient for any science colleges for which the building cost 10,000 l. or 15,000 l., so that you would consider that a matter quite apart?—Yes, that is a different subject.

678. Then this minute has no direct bearing on the question whatever?—None.

679. Lord Robert Montagu.] Was not the question as to whether we should give aid to such central colleges under the consideration of the Board for some time?—Yes, in various forms, there were several draft minutes.

680. And the decision of the Board was that we should wait till this Committee had made its report?—Yes.

681. Chairman.] You are aware that on the Continent there are these grades of scientific instruction, or science schools—a higher grade, which we may call the polytechnic school, a secondary or special school, and a school for primary instruction in science?—Yes.

682. Do you consider that it would be a good plan to do in England what is done abroad, namely, that aid should be given in respect of the salaries of professors of secondary schools, on condition that they should hold classes, or give lectures to working men, in fact, that they should give primary instruction concurrently with secondary instruction?—I would not do that for what we call secondary schools. I think that evening classes for the working classes are quite sufficiently provided for by the existing rules. In the colleges for advanced instruction, the State payment to professors might be, as at Jermyn-street, 200 l. a year, which is what may be called the State retaining fee. The professor gives instruction gratuitously for that to the Royal Exhibitioners, and the remainder of his salary is really made out by the fees taken from the middle and upper class pupils.

683. If you were to give any grants to professors in science colleges in large centres of population, you would probably attach to those grants the condition that the recipients should hold night classes, or should give lectures to working men, as is now done in Jermyn-street?—It is done there, I believe, not as an official duty, but as an act of goodwill on the part of the professors; I think there is no condition of the kind imposed on the professors, and I would not be inclined to make such a condition.

684. Mr Gregory.] The Chairman referred a few minutes ago to the indifference of certain localities with regard to science teaching. Are you aware that before the Committee on Scientific Institutions in Dublin, of 1864, it was stated that the provincial scientific lectures which had been given had awakened a very great desire in various localities in Ireland for the establishment of science schools?—I believe it was stated so before that Committee

685. Can you describe to the present Committee the system which was pursued in Ireland with regard to those lectures?—Those lectures are not given now

686. They have been given up some years, have they not?—Since the College of Science was established.

687. Can you inform the Committee on what ground they were given up?—I believe it was because it was thought not necessary that Ireland should be differently treated to England and Scotland, and it was found that the aid given to schools towards scientific instruction sufficiently met the case, much better than those provincial lectures

688. It was not part of the report of the Commission that those lectures should be given up, was it?—I do not remember, but scientific instruction has really gone a-head faster in Ireland than anywhere else

689. Do you think that those provincial lectures had been the means of awakening in Ireland a taste for scientific instruction?—I do not know that, but I know that nearly every county in Ireland has a school.

690. Mr Akroyd.] I observe that the ages of the students vary from 13 up to 40 years of age; do you classify them according to their ages at all?—Yes

691. Are you aware that in the Working Men's College in Halifax, we find it very advantageous to make two divisions of the students?—I dare say; in the examination in May, they are all examined together, without distinction, but I believe the science masters never teach adults and boys together.

692. Do you not think it would be advantageous to divide the students in two classes, namely, those from 13 to 18, and then those from 18 upwards?—Yes; I believe science teachers do not in practice teach adults and the young together.

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R. R. W. LINGEN, Esq., called in, and Examined.

693. Chairman.] You are Secretary of the Committee of Council for Education, I believe?—Yes.

694. In that capacity your attention, I believe, is directed principally to elementary schools?—It is.

695. Can you tell us whether instruction in

science forms part of the curriculum of those schools?—Scarcely ever

696. No scientific subject is obligatory in those schools?—No.

697. But there is a certain connection between the schools which are under your care and the Department of Science and Art, inasmuch as

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drawing, for instance, is taught in elementary schools, and they receive aid from the Department of Science and Art?—Yes, to that extent.

698. And almost to that extent only?—Almost to that extent only.

699. Mr Bruce] Do you conceive it possible that any direct scientific instruction could be imparted in the elementary schools under the circumstances in which they exist in this country?—I think not.

700. What do you think are the principal bars to the imparting of such instruction?—The extremely early age at which the children leave.

701. Could you state the proportion of children that remain after 10 years of age?—I have not got it at hand, but the great proportion of them leave the elementary schools in the 11th or 12th year.

702. It has been the policy of the department, I think, to discourage the payment by the State for the education of children over 11 or 12 years of age?—The standards of examination bear on the question of age in this way, that a child would ordinarily pass the highest standard in its 12th year, and when it has once passed that standard, it can bring no further grant to the school.

703. Here are six standards; the first is passed at the 6th year, and consequently the highest standard is passed in the 12th year of the child's age?—Yes.

704. Is, however, the first standard usually passed, as a matter of fact, in the sixth year of the child's age?—The first standard cannot be passed before the seventh year.

705. That is to say, a child who had completed its sixth year?—Yes.

706. So that payment would usually cease when the child was between 11 and 12 years of age?—It would from this fact, that the majority of the children would leave the school at that age.

707. But also from the fact that they would have passed through the whole of the standards, and having done so, would cease to be entitled to have any payment made in respect of them?—If they passed the first standard in their seventh year they would not pass the 12th standard till their 12th year, that is to say, their 11th year complete.

708. Does the minute, which is called Mr. Corry's Minute, affect the question and prolong the time?—Yes, because it virtually provides a seventh standard.

709. Would you kindly explain to the Committee what instruction is implied by the seventh standard?—The six standards comprise the bare elements of reading, writing, and arithmetic, the seventh standard is not restricted to any one subject, but the managers are allowed to choose among other subjects of instruction, and in the subject chosen they must present one-fifth of their children. Among that one-fifth, if any of the children happen to be found who have passed the sixth standard, they are now treated as if they had passed a seventh standard, and they get another 8s grant.

710. Has the working of that minute in your opinion been successful in drawing the attention of schoolmasters to what may be called higher subjects?—It has not been at work long enough to enable me to speak confidently, but as far as I can judge, I think it has been a very successful minute.

711. Do you think one immediate tendency of payment on results was to direct the attention of a great many schools to the teaching of those sub-

jects only which brought in payment, namely, reading, writing, and arithmetic?—That was the first effect.

712. And it was to counteract that defect that this minute was passed?—Yes.

713. Do you yourself see any means of getting over this difficulty with regard to the age at which children leave the schools?—I can only see it through the operation of the Half-Time Acts.

714. The operation of the Half-Time Act, as now in force, would apply to those children only who were at work?—That is so.

715. I suppose you assume that most children above the age of 10 years in this country would be at work?—There are other parts of the law which ought to be made to apply to children who are not work; namely, the Industrial Schools Acts and the Poor Law, and if those Acts were vigorously enforced, I think the existing regulation would pretty nearly cover the youthful population.

716. You assume that the children who are not at school, and not at work, are the children of parents who are so neglecting their duty, that the children ought to be sent to a different form of school?—Yes, I think so, at all events, that they should be dealt with by the law.

717. There is another mode by which elementary schools may be made to assist scientific instruction, and that is by improving the instruction given in those schools, do you consider that the best instruction is imparted at existing schools, or that improvements might be introduced?—I think undoubtedly the instruction might be improved.

718. Is it your opinion that too much instruction is given in certain departments of knowledge which are of less use than others?—The reading books which are employed in the schools contain a great deal of what may be called scientific information, and if masters were competent to make the most of those reading lessons, as the texts of a kind of semi-technical teaching, I have no doubt that a very great deal might be done in elementary schools to prepare the children for more advanced scientific instruction afterwards.

719. Do you conceive that the time of the children in these schools is actually wasted in acquiring, or endeavouring to acquire, a portion of the knowledge that is offered to them. I remember a minute of the late Lord Palmerston on that subject; perhaps you may have the minute with you?—Yes, the minute was written in 1854, and it came into my hand merely as a minute on the question whether mistresses should be employed to teach boys as well as girls. It bears, however, a good deal on general questions of education.

720. Lord Palmerston was Secretary for the Home Department, and a member of the Committee of Council on Education at that time?—Yes. I will read one passage from the minute:—“The great mistake hitherto committed in schools for the lower orders has been that more attention has been paid to loading the memory than to cultivating and exercising the mental faculties of the children, and, moreover, that the efforts of instructors, especially when acting under the superintendence of clergymen, have been directed to the loading of the memory of children with facts wholly useless to them in any point of view, moral, religious, or industrial. I have witnessed an examination in a national school by an in-

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spector from London, the whole and sole subject of which consisted of the geography of places, and the family pedigree of persons mentioned in the Old Testament. For all useful or industrial purposes the children might as well have got by heart the topography of China or the dynasties of Abyssinia."

721 Do you think that applies to teaching in the present day in those schools?—In a much less degree no doubt, but to a certain extent it does apply.

722 Do you not think that a good deal of time at all our schools, especially our denominational schools, is wasted upon subjects which are good for the children neither in an intellectual nor a spiritual sense?—No doubt time is wasted in getting up such subjects with quite unnecessary minuteness, geographical details, and details of pedigree, which are not really religious instruction.

723 The late Dean of Hereford, Dr. Dawes, did contrive to convey, at strictly elementary schools, a certain amount of rudimentary scientific instruction, did he not?—Yes.

724 Could you explain what was his system and what was the extent of the rudimentary scientific instruction?—There is a detailed report upon the King's Somborne school in the first volume of the Committee of Council of Education for 1847-8, from page 7 to 21, Mr. Moseley, the Inspector, gives a full account of what was done in the school.

725 Do you remember the extent to which the Dean pushed scientific instruction?—I have marked this passage in the Report, which is quoted from the late Dean's own words—"After the school had been opened rather more than two years, I began giving to the teachers, and the more advanced of the school children, short explanations of a philosophic kind, and in a common-sense sort of way, of the things almost daily passing before their eyes, but of the nature of which they had not the slightest conception, such as some of the peculiar properties of metals, glass, and other substances in common use, that the air had weight, and how this pressure of the atmosphere helped them to pump up water, enabled them to amuse themselves with squirts and pop-guns, to suck up water, as they called it, through a straw, why the kettle-top jumped up when the water was boiling on the fire, why, when they wanted to know whether it boiled or not, they seized the poker, and placed one end on the lid and the other to their ear, in order to know whether it actually boiled, why a glass sometimes breaks when hot water is poured into it, explaining the reason of the unequal expansion of the two surfaces. These, and similar things, I found so excessively amusing to them, and, at the same time, so instructive, that I have scarcely missed a week explaining some principle of this nature, and in questioning them on what had been done before."

726 Do you not think that instruction of that kind would exercise the thinking faculties of the children much better than the subjects alluded to by the late Lord Palmerston, in the extract which you read?—I certainly think so, at all events it is a kind of instruction that ought not to be omitted in elementary teaching.

727 But do you think it is very little practised in elementary teaching, as a matter of fact?—To a very small extent only, as far as I have the means of knowing.

728 Would it be your opinion that such

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simple rudimentary teaching, by the interest which is created in scientific subjects, would lead to a great expansion of the more advanced kind of scientific schools?—I think it would go far to prepare the children to take advantage of those schools when they came in their way.

729 Are there any schools now in connection with the Committee of Council in which, to your knowledge, scientific education of that rudimentary kind is imparted?—There may be more, but the only school of the kind which, at this moment, I recollect is a school that was also organised by the late Dean of Hereford, namely, the Blue Coat School at Hereford, chemistry is taught in that school.

730 Is that strictly an elementary school?—Yes, an elementary school.

731 Resorted to by children of the same class as those who attend the elementary schools in a town like Hereford?—Yes.

732 And there a certain amount of chemistry is taught, is it?—Yes.

733 Do you know whether in that school the teaching of chemistry has a good effect on the intelligence of the children?—It is a school which is very well reported of. I looked at the last report before I came down to this Committee; the report merely says that chemistry is taught there, but whether the inspector examined in it does not appear.

734 Has it ever occurred to you that the learning of those higher branches of instruction might be very much encouraged by employers of labour in neighbouring schools?—Yes, certainly.

735 Will you explain how that influence might, in your opinion be brought to bear?—I think if the best boys were taken from the neighbouring schools into employment in works or manufactories, because they were the best boys, and if, after a time, they were found to be in good positions in such establishments, their success would have a very great effect on other children.

736 Are you aware whether any employers of labour make admission into the best positions in their works dependent on the children remaining till a certain age at school, and attaining a certain proficiency there?—I have heard of cases where that has been attempted.

737 Do you think that the boys and the parents of boys would naturally be led to seek for them that information for which they would feel certain of receiving a certain amount of money value?—At all events that would be one way of bringing to bear upon them a very powerful motive, the motive by which they shape the greater part of their actions.

738 Do you think that motive has been put into operation as much as it might have been?—I should certainly think not.

739 Have you reflected much upon the manner in which you think scientific instruction might be more generally imparted than it is to the various classes of the population in this country?—I think in the elementary schools a considerable foundation might be laid in the way I have spoken of, if the teachers were competent to do it.

740 What would be your opinion of the proper action of the State towards the encouragement of scientific education among the wealthier classes of society?—I should think it would be to insist upon it, where it was necessary, rather than to pay very much for it.

741. But what opportunity would the State have of insisting upon it?—The State could only insist

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R. R. W. Lingen, Esq. insist upon it in the sense that people should not be allowed to hold certain positions unless they had passed certain examinations, just as is done with regard to solicitors or surgeons.

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742. You mean that the Civil Service examinations might be made the means of encouraging scientific instruction by demanding a certain amount of proficiency in it?—The State need not be the examiners. I do not think it is always indispensable for the State always to pay for and provide that which it requires, because people of substance are able to do it for themselves.

743. Do you think it would be expedient to make any scientific subject one of those to which Mr. Corry's Minute would apply?—I do not think, myself, it would be desirable to limit the choice of schools, as there are comparatively few schools in which any one scientific subject could really be taught with any great effect, I think.

744. Is that from the fact that the elementary school teachers are not as a rule sufficiently prepared for teaching these subjects, or is it that the boys would not remain at school long enough to receive the instruction if it were given?—From both causes, but principally from the very young age of the children when they leave.

745. Do you observe any very considerable difference in different parts of the country in the age at which children leave school?—No, I do not think I have noticed any very great difference, but I have not lately turned my attention to that particular subject.

746. Have you ever been able to trace the fact that the children have remained for a longer period at one school than another to any particular moral influences brought to bear upon them?—I am afraid that, as far as that goes, experience does not prove that a good school tends to keep children at it for a longer time than an indifferent school. Experience tends to show that there is a minimum of instruction parents want their children to acquire, and that the better the school is the sooner, not unfrequently, the children quit it.

747. The tendency of parents, you think, is to take the children away when they have acquired just a certain amount of knowledge which is enough to fit them for earning money in certain positions?—Or what they think enough.

748. And you think that could only be counteracted by the action of employers in encouraging the further education of the children, by opening to them such prizes in the shape of positions in works or manufactories as they could offer to them?—I have no doubt that if the best boys in a school were selected for employment by a neighbouring employer of labour, you would soon have a very great improvement in that school.

749. And you see no alternative but a compulsory system of education, which would enforce the attendance of children at school, as is done in Prussia up to a certain age?—I think there is no choice except the present system or a compulsory system of education.

750. Mr. Akroyd.] I think you said that the usual age at which children left school was 11 to 12, and that they rarely remained beyond that, but that would not apply to the factory districts, where they are required to remain up to 13 years of age, would it?—No, I spoke only of children who were not subject to the Factory Acts.

751. Under recent legislation, a great many more children will be compelled to remain at

school up to 13 years of age than hitherto?—Yes, if the Workshops Act is operative.

752. Now, with regard to elementary drawing, that is an accomplishment which is quite within the capacity of children under and up to 13 years of age, is it not?—Yes, I think so.

753. With regard to a question put to you about the influence which employers of labour might exercise upon elementary education in schools by selecting intelligent boys for eligible situations in their works, you are probably aware that that influence is brought to bear in many instances with very beneficial results?—Yes, I have heard of it in many cases.

754. Mr. Dixon.] You say that boys generally leave school between the ages of 11 and 12, but is it not the fact that a considerable proportion remain there up to 13 years of age?—A small proportion.

755. Do you think that it would be possible to give to that proportion some elementary scientific instruction?—I think it would.

756. Is it not true that those schools where other subjects than the three R's, reading, writing, and arithmetic are taught, are the most successful, and that even reading, writing, and arithmetic themselves are better taught in those schools?—Yes, decidedly.

757. And when in those schools the teaching goes beyond reading, writing, and arithmetic, might not the teachers adopt as their higher instruction elementary scientific teaching in the manner which you have just now described?—Certainly to that extent they might do so, and even more systematically than they do if you had more competent masters.

758. Are the teachers generally competent to give the kind of elementary scientific teaching which you have described?—My own impression is that they are not.

759. Has anything been done by the State to encourage the giving to teachers this power of science teaching?—To this extent, that every year the students in training, and the other candidates for certificates who are not students, are examined. A paper is given in which parts are taken from the reading books in use, and passages on subjects more or less resembling those mentioned in the quotation I gave from the words of the Dean of Hereford, are put before the candidates, and they are asked how they would treat such subjects in instructing a class of children, that is one of the exercises upon which certificates are given. To that extent the present system encourages schools in giving this kind of useful knowledge to the children.

760. Would it not be possible and desirable that more should be done by the State to encourage this power of scientific teaching by certificated masters in our primary schools?—Experience of the course of study pursued in the training schools suggested, some years ago, that it was absolutely necessary to limit the extent of reading for these students; the greatest objection was expressed, both in Parliament and elsewhere, to the extent of the subjects for examination; and the policy finally adopted, after much discussion, was to adopt a reduced curriculum, and endeavour to get more accurate attainment within its limits.

761. With the information and experience you now possess, do you think that a desirable plan to pursue?—On the whole I think it is, when you come to consider the material you have to train.

762. But

762 But with even this limit, you think the knowledge of science as applied to common things would be too much for these elementary teachers?—Yes, I think so; considering the state in which they come to the college, I do not think you could increase the number of subjects they have to learn, without getting in return shallow and inaccurate knowledge, even to a greater degree than you do at present.

763 But surely the amount of power which must be required to teach reading, writing, and arithmetic in primary schools must be so extremely small, that to give the additional knowledge we have been referring to at present could not over-weight the teacher?—It may seem so, but if you were to try to teach reading, writing, and arithmetic to every child in a school of 120 or 150, and then submit the work to the test of an individual examination, you would find that the task was by no means an easy one. You might produce a single class which would pass, but the individual examination of all the children is a very different test.

764 But surely to overcome that difficulty the practice of teaching is required?—Yes.

765 Not the elements of that knowledge that you obtain at training colleges?—Yes, to a very great extent it is the elements of that knowledge that you obtain at training colleges; namely, the mode of presenting knowledge to children, and the methods of teaching.

766. Mr. *Potter*] It has been stated that there are a million children in England now who are neither at school nor at work; can you state whether that is the case or not?—No, I have not lately gone into the general statistics of education.

767 Would you be inclined to doubt it?—I should require to put in so many reservations as to what was meant by being at work, and what was meant by attending school, that I could hardly give a general answer to the question.

768 The half-time schools do not come under the cognizance of your department, do they?—A large number of the schools that are inspected are half-time schools in all parts of the country where the Factory Acts apply.

769 Have you any idea of the number of half-time children?—I could ascertain that, but I do not know it at this moment.

770. Mr. *McLagan*.] Are you aware of the attempts that were made to introduce the teaching of elementary chemistry in elementary schools in Scotland?—I do not remember any such fact.

771 I mean in parochial schools?—I do not know.

772. You are not aware, then, that the attempt failed entirely?—As far as parochial schools in Scotland come under my official knowledge, the more advanced scholars are taught Latin and Greek, as more likely to facilitate their career at the universities afterwards.

773. Mr. *Read*] Is there any difference between country and town in the age of the children that attend school?—My impression is that there is not a great deal of difference.

774. But perhaps on the whole, in the country, the children leave school earlier than they do in town?—Yes, I should say so.

775. Does that apply to girls and boys alike?—Nearly so, perhaps rather more to boys than girls; boys are required for labour, and the girls are required at home to act as servants and nurses.

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776. Do you think there is any chance of imparting a scientific education to children who leave school so early?—Not of a direct kind, but a great deal might be done in an indirect way, as was done at the King's Somborne school.

777. Could not the first principles of mechanics be taught to a boy who was designed for an agricultural labourer?—He might certainly be taught a great deal about the common applications of mechanical powers, I mean in an indirect way.

778 The girls might be taught cookery?—That is a much more difficult question, because it is exceedingly expensive to provide the food for cooking and to dispose of it afterwards, but, as regards common house-work, much of that can be taught in keeping the school-room itself neat and clean.

779. Did I understand you to state that if the Industrial Schools Act and the Poor Law were more vigorously enforced, you thought you might have a larger attendance at the schools than now exists?—Decidedly.

780 Will you kindly explain to me how the Poor Law could be made to operate in that direction?—There is an Act of Parliament known as Denison's Act which was introduced by the present Speaker, which enables the guardians of the poor to send to school all the children of outdoor paupers; those are a very numerous class indeed, and if the Act were vigorously applied, a large number of children would at once be brought within the reach of school instruction. Then it must be borne in mind that the Industrial Schools Act gives an exceedingly wide definition of vagrancy, there is scarcely a child idling about the streets that might not be got into school under that Act if it were anyone's business to pick up such children.

781 Lord *Frederick Cavendish*.] Is the average age at which children leave school increasing or diminishing?—It is certainly not increasing.

782. Up to what age do you consider that children should attend a good elementary school, viewing it with regard to the elementary teaching of science?—I think if a boy could attend school until he had completed his eleventh year, and then go upon half time after that age up to 14 or 15 years of age, he would obtain a sufficient elementary education.

783 You think there would be much benefit derived from increasing the limit from 13 to 14 or 15, with regard to half time compulsory attendance?—I think there would be a benefit.

784. Have you seen the Minute of the Science and Art Department at the end of last year founding scholarships in connection with elementary science?—Yes.

785. As I understand that Minute, a scholar must be between 12 and 16 years, and must attend an elementary school?—I am not very accurately acquainted with the Minute, but I believe so.

786. Do you consider that there would be much advantage in compelling boys to attend an elementary school up to the age of 16?—I understand the meaning of that part of the Minute to be this, that as, in all probability, his elementary education would be insufficient to qualify him to pursue science without further instruction, he is to be kept at school to improve his elementary education; there are very few schools that I know of in which a boy could learn science.

787. But in many cases a boy who was selected for the competition for those scholarships would

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would have received his elementary education up to 12 years of age?—Yes.

788. How could he employ his time then; would it not be a waste of time if he were to continue at school?—Yes, unless he had an unusually good master, I think it would.

789. Mr Gregory] Are there any schools in which elementary drawing is taught as a seventh standard, under Mr Corry's Minute?—Drawing is not admitted as one of the extra subjects under the Minute, because there are special payments for it from Kensington; so that it stands on its own footing.

790. Chairman] With regard to drawing, have you any experience of the kind of drawing which is taught under the grant from South Kensington?—All the exercises go to South Kensington, so that I should not ordinarily see them at all, but I believe free-hand drawing forms the staple of what is taught in elementary schools.

791. Not mechanical or geometrical drawing?—Some of the older children may learn it, but, speaking at second hand, I believe free-hand drawing is the principal subject.

792. Might not mechanical or geometrical drawing be advantageously taught to children under 13 years of age?—I imagine you must begin with free-hand drawing if you are to teach the command of the fingers, and the accuracy of eye which would enable mechanical drawing to be turned to account.

793. Are you aware that on the Continent children from 12 to 13 years of age are taught mechanical and geometrical drawing?—I am aware of that only from hearing it.

794. Mr Bruce] You are aware that there are as many as 5 per cent of the boys at school who are between 12 and 13 years of age?—It is something like that, I believe.

795. Chairman] At all events about 80,000 children are learning drawing under that Minute?—It is a very large number.

796. With regard to arithmetic, if that could be more satisfactorily taught, and with greater regard to theory, do you not think it would exercise very great influence in facilitating the subsequent instruction in science?—I think arithmetic is ill taught almost everywhere.

797. Do you not think that children of from ten to twelve, or thirteen, might advantageously be taught arithmetic on a much higher system than is now adopted?—I think they might be taught on a very much better system, but that the tendency of a better system would be to teach them more simply than they are now taught.

798. You could teach them the reasons of the rules of arithmetic, for example?—Yes, but there is another side of arithmetic. You have to teach the practice of the rules as well as the reasons. However perfect the scientific teaching of arithmetic may be, there must be a great deal of practice in the working of it before it can be applied.

799. But is it not found that very young children are able to carry out the practical working of the rules at once?—It is very rarely that you get the simplest arithmetical exercise, extending to more than a single sum, done without a fault in it.

800. Is not that more because the children do not understand what they are doing than from any other reason?—The practice of arithmetic, like spelling and some other things, requires a great deal of accurate attention, over and above

the understanding of the theory. There are certain combinations of figures which have to be instantly grasped in practice, but of which you cannot always be recalling the theory; the memory must be trained in order to use them with the necessary rapidity and accuracy, and that requires practice.

801. But, at all events, you think arithmetic might be very much better taught than it now is to children from nine years of age and upwards?—Most decidedly.

802. With regard to the extension of the Factory Act, and the question whether that will not compel children to remain at school to a more advanced age, I should like to ask you whether you think that the half-time tuition of an average child up to thirteen years of age could be compared to full-time tuition up to twelve years of age, assuming the half time to have begun at eight years of age?—Opinions are a great deal divided about that, and I can only give the opinion which I have formed from hearing other people's opinions, because I rarely see schools myself. I should have thought it extremely unlikely that half-time tuition, applied to any subject, could equal full-time. I should think a boy who had attended full time up to twelve would be a better scholar than a boy who had attended half-time from eight to thirteen.

803. Mr. Acland] When you speak of deficiencies in teaching arithmetic, do you mean to say that the mode of teaching arithmetic in our training schools is theoretically deficient?—I do not mean to say that training schools are more deficient than other institutions, probably they are among the best of the kind; but I do not think arithmetic is well taught anywhere, or with sufficient simplicity.

804. Considering that in some of our training schools they endeavour to simplify the teaching of arithmetic, I should be glad if you would state in what respect you think the teaching could be improved?—In order to answer that question fully, I should have to give a lecture on arithmetic, the lessons are not made sufficiently experimental, the children are not kept a sufficiently long time in the rudiments of arithmetic to gain an idea of number.

805. Is it not the fact that in some of our training schools the attempt to teach science has been carried on for a good many years?—Yes.

806. Did not Saint Mark's College establish the teaching of chemistry many years ago?—There used to be an examination in chemistry previously to the reduction of the syllabus seven or eight years ago, it was an alternative, not a compulsory subject.

807. Did not Saint Mark's College have a chemical laboratory some years ago?—Yes.

808. Has not scientific instruction in fact been very much checked by the operation of the changes in the Privy Council management?—Yes, I should think it had been affected by the reduction of the programme of studies.

809. Now, with regard to promoting so much of science instruction in the country as may be desirable; can you point out to the Committee in what way existing institutions may best be improved for that purpose; first, taking training schools, will you point out in what way you think training schools might be best used so as to promote the object which this Committee has in view, namely, the teaching of science with an eye

to the industry of the country?—Their first business, of course, is to train schoolmasters for the instruction of children in elementary schools, whatever promote extreme accuracy in the master's own knowledge, would best enable him to give a scientific tone and temper to the minds of the children that come under his hand. Details must depend on what branch of science was taken up, I should certainly be against attempting to teach the elementary schoolmaster more than one branch of science.

810 Do you think it important that the best methods of imparting information in science should be taught in training schools?—I have myself a very great prejudice in favour of Euclid as the foundation of scientific training for elementary schoolmasters, afterwards you might have elementary mechanics perhaps.

811 When you say you have a bias in favour of Euclid, you are doubtless aware that a recent Commission has expressed an opinion that Euclid is not the best preparation for teaching mathematics for the more ordinary minds in England, that a mode of teaching geometry with practical applications might be better adapted for England in its present state, do you agree with that opinion, or not?—My opinion would not be worth much upon the subject, because I have no pretension to scientific knowledge, but I should have thought that you could hardly put in the hands of a teacher a better text book than Euclid.

812 Do you mean Euclid as distinguishing Euclid from geometry, or do you now speak of geometry in general?—I mean going on from proposition to proposition, and being able to re-produce Euclid's demonstrations.

813 Can you state in what way the numerous grammar schools in England could, in your opinion, be so employed as to promote scientific instruction with a view to the industry of the country?—I should say, ~~much in the same way~~ as the training schools, or as the elementary schools; whatever the subjects of instruction be, that you select, thorough accuracy is the great preparation for scientific teaching afterwards.

814 But seeing that some of them have considerable endowments, and are at present not beneficial to any very large number of persons, should you view with favour a plan for applying, especially in our manufacturing districts, some of those endowments to special scientific instruction?—Certainly.

815. Would you be in favour of drawing a line between different classes of endowed schools, allowing some of them to retain a general character, while some would assume a special scientific character?—I should see no objection to this that if there were funds provided in a town for the education of the townsmen, then their education in the school should be of the kind which was most useful to the town, that is, if any particular branch of science was more useful than another in that town, I should go any length in making the instruction of the school bear on that particular branch.

816 There are dotted all over England certain foundations with very considerable funds, amounting in some cases to 1,000 *l.*, or more, but which foundations are not in towns, and yet not very far from great centres of industry, should you view with favour a plan for requiring some of those to be turned into schools of a scientific character, with a view to the industry of the country?—I should see no objection.

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817 Will you now state how far you think the universities, or any other institutions in the country, are capable at the present time of supplying teaching in science?—I should think the University of Oxford might be very capable of supplying it; there are most admirable professors there, and a man who attended Professor Brodie's lectures, or Professor Clifton's lectures, could not be in a more favourable condition for continuing the subject which he had to study.

818 Looking at other institutions of the kind, such as King's College, University College, Owens' College, and others, should you say it was rather desirable to develop them for the purpose which is in the contemplation of this Committee, or to found an institution at the expense of the Government?—I am always in favour of using what you have got before you add to it.

819 Do you think there is in England at the present time a fair case made out for going to Parliament and asking for grants to establish scientific schools?—I should feel great difficulty in saying yes or no at once to any question of that kind, because I am only acquainted with the subject at second hand, but giving my own opinion, merely as my own opinion, I should think that the people for whose benefit this instruction is to be provided ought to be made, at all events, very largely to contribute to the expense of it, and that the employers who want this kind of knowledge, and the artisans who are to acquire it, being amongst the wealthiest people in their respective classes, a very strong case would have to be made out before it could be deemed just to tax largely the general community for the purpose in question.

820 Do you not think that the Government is capable of giving assistance in other ways than by granting money?—The Government might take the initiative in founding schools, giving the framework of institutions to which contributions might afterwards be made, providing inspection, and so on.

821 *Chairman*] You stated that you thought that no great results could be obtained by teaching science to industrial classes until the instruction given in elementary schools was very much improved?—Yes, I think that is so.

822 You are aware that in France also elementary instruction is very deficient?—Yes.

823 But notwithstanding that, some 80,000 or 90,000 adults are receiving instruction in elementary science in evening classes in France?—I do not know with what effect they are receiving it, but I have no doubt about the difficulty of conveying scientific instruction to much purpose to persons that have not, at all events, tolerable command over the rudiments of elementary education.

824. You would conclude, therefore, that the instruction must necessarily be very superficial? Short of proof that it was otherwise, I should conclude that it was superficial.

825. With regard to the teaching of science at the universities, is it not the case that pure, rather than applied, science is taught?—Chemical lectures are certainly given in the laboratories.

826. *Mr Akroyd*] You have had some questions put to you with regard to the comparative attainments of full-time boys up to 12 years of age, and half-time boys up to 13 years of age. I suppose there is no doubt that the short-

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time is, in proportion to the number of years they attend school, learn more than the full-timers; is that so?—I think my former chief, Sir James Shuttleworth, who is a better authority than I am, has a strong opinion that full-time is more effective than half-time, if they run side by side.

827. Have you ever considered the advantages of the half-time system with regard to what is called technical instruction on the preparation of young people as future workmen, bearing in mind that during the half-a-day spent in a mill

the child acquires habits of industry and application, and some knowledge of mechanical manipulation?—I am decidedly in favour of half-time myself, I only answered the question which was put to me, I consider that even if half and full time are not equal in value for the purposes of instruction, half-time is the sound system, and the only feasible way in which elementary instruction can be generally extended up to 13 or 14 years of age.

Thursday, 30th April 1868.

MEMBERS PRESENT.

Mr Acland
Mr. Akroyd
Mr Bagnall.
Mr Bazley.
Mr. Henry Austin Bruce
Lord Frederick Cavendish.
Mr Dixon
Mr. Graves.

Mr Gregory.
Sir Charles Lanyon
Mr William Lowther.
Mr M'Lagan.
Lord Robert Montagu
Mr. Edmund Potte
Mr Read
Mr. Samuelson.

BERNHARD SAMUELSON, Esq, IN THE CHAIR.

HENRY COLE, Esq, C B., re-called, and further Examined.

828 Mr Akroyd] You have just been down to Wakefield, I believe, at the opening of an institution for promoting technical instruction? —Yes

829. Will you kindly state what is the object of that institution, and what are the special advantages which it affords?—Wakefield has done what few places have done, namely, cleared 3,000 £. profit out of an Industrial Exhibition, and it has applied a great part of the funds, and intends to apply the whole of them, to the establishment of a school of science and art, and a museum of science and art. It has commenced by purchasing some modest premises, which are now opened for a school of art, and it is considering how it shall best introduce science, whether in those premises or in connection with the Mechanics' Institute, or perhaps the grammar school, or possibly in some of the elementary schools. It intends to have a local museum representing the natural history of the district, together with subjects that bear upon the industry of the district. The School of Art is now opened. I went down to the opening of that exhibition, half of which is contributed by the South Kensington Museum, and half by local contribution, and it is at present open in the largest room in the town, in the Corn Exchange. It is intended, after the exhibition closes there, to remove as many objects as may be practicable into one of the vacant rooms attached to the School of Art, as a kind of commencement of what is intended in future.

830 Is there any provision for evening classes as well as day classes in connection with the institution?—The School of Art is intended to be like all other schools of art, making provision for day instruction and also for evening instruction. The arrangements for teaching science are altogether under consideration, and it was part of my object in my visit to say what was possible in that way.

831 And I suppose they would have classes in geometrical drawing?—They have classes in geometrical drawing in connection with the School of Art, and also for mechanical drawing, which

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are taught as art matters rather than science matters, although standing midway between the two.

832. It is often difficult to define distinctly the mechanical drawing which does come under the province of art, and that which does not come under the province of art?—It is extremely difficult to draw the line where science and art are absolutely divided. Take drawing the human figure that is pure science, understanding the bones and muscles, and then it becomes a matter of art to be able to draw them, but both operations go on in the School of Art.

833 Do you allow the same master to teach both art and mechanical drawing?—As far as he is competent, the majority of our art masters take certificates of competency to teach mechanical drawing, and they must have taken the necessary certificates of competency to teach geometrical drawing, as far as the mere drawing is concerned, without reference to scientific theory.

834 You grant a double certificate to the same master both for teaching pure art and mechanical drawing?—The first certificate for the highest grade of an art teacher comprehends an ability to teach what may be called practical geometry as far as drawing is concerned, he cannot be an art master without that. Then it is optional for him whether he will take a special certificate for mechanical drawing, which includes drawing machines as well as drawing for carpentry and building.

835 I suppose you place those students who are learning pure art under the returns of the art department, and those who are learning mechanical drawing under the returns of the science and art department?—No, drawing, *quæ* drawing, all comes under the art division. In a parish school, for example, we have what are called two grades of art instruction, each of which comprehends geometrical drawing, in fact, I should say that more children have taken the earliest certificate in geometrical drawing than they have in what is called free-hand drawing; in fact, how to make a triangle, and how to make an ellipse, mechanically,

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nically, is an easier thing than to draw it with a free hand, that distinctly does not come under what in the arrangements of the office is called science instruction, but under art instruction. Perhaps it might be appropriate just now for me to give the Committee two illustrations, one of which I brought down on a former occasion. These are not drawings from our own art schools, but they have the interest, being illustrations of the course of instruction which is given at Mr. Schneider's schools at Creusot. They show of how very comprehensive a kind a manufacturer's secondary school is in France. We have 100 schools of art throughout the country that could draw that lower figure (*producing some framed drawings*) by free-hand drawing, that is to say, without measurement and without instruments for drawing, and we have a great many who could produce those mechanical drawings in our art schools, but I do not think, within my experience, that there is a single school in the country which is so comprehensive in its object as to include all these, who come from the Creusot school.

836. *Chairman*] What you mean is, that in one art school artistic drawing would have the preference, and in another art school mechanical drawing would be carried farther?—That is possible, according to the character of the locality, in all art schools, I should say now; that mechanical drawing, like that (*referring to the specimens*), and free-hand drawing, like that, is going on, it would be the exception not to find it going on. The fact is, that a man who is no artist may very soon acquire the power of doing drawing which is done by measurement, and which does not involve dexterity of the hand; he will grind away for a year or two to be able to do that, but the moment you come to something that implies an instinct in art, the number of those who have that aptitude is very much reduced.

837. Do you suppose for a moment that the mechanical and artistic drawing executed in the school of Creusot are taught by the same master?—I cannot say what they do at Creusot. But I know what we do. I could give you the names of 100 masters who could teach that (*referring to the specimen*), they could teach that, and do their work quite as well, and better.

838. I thought you said that in England you had no school in which both were taught?—No, I said there was one school. I produce these as an illustration, beginning with A, B, C, and going on with reading, writing, and arithmetic, and all the elements of instruction, all taught in one school; we have that in England in a great many places separate, but I am not aware that we have a single elementary school which could produce such an illustration as I now show to the Committee. Mr. Schneider had the kindness to present them to the South Kensington Museum as specimens of what was doing at a manufacturing school in France.

839. *Mr. Akroyd*] I suppose you would call the lower drawing upon your plan an applied design which would repeat itself?—I take it that this has been drawn from a cast. I do not call to mind that in the Creusot school there are any illustrations of what we call design, meaning by that the invention of a pattern.

840. By applied design, I mean a design applied to some manufacture, a drawing forming a kind of square, which would repeat itself over a

large surface?—Yes, no doubt these would be plaster ornaments. I also produce an illustration of their methods of teaching reading, writing, and arithmetic (*producing some framed specimens*), if any members of the Committee would come to the South Kensington Museum, they would find 50 frames of this kind, illustrating the complete course of instruction, and I believe it is far more comprehensive than anything of the kind going on in any of our institutions in England.

841. Do you think that your department might derive some practical hints from what is done at the school in Creusot?—It is really hard to say where they might not and do not get practical hints, we get them everywhere, we have the same things doing in our department, but in a somewhat different mode.

842. Not collectively in one school?—Not collectively in one school. I am anxious to give the Committee an illustration or two of the closeness with which art and science come together, even when they do not run into one another, in fact, it is so notorious that an illustration is scarcely necessary. At the Paris Exhibition a collection was purchased of Italian peasant jewellery, one main object in collecting those specimens was, that the manufacturers who are accustomed to make jewellery for all the markets in the world might at least see how jewellery was made in Italy. These specimens which I now produce to the Committee (*exhibiting specimens*) are only a twentieth part of the collection, which has been so divided as to allow of our keeping one set of illustrations for the mother museum at Kensington, while the others may be sent out to different places in the country. I think this particular case is soon going to Birmingham. These specimens come under our vote for art, but the production of them involves all kinds of matters that you would call science. If you had to make these artificial pearls, for instance, the art of drawing elementary forms, connected as it is with geometry, which I apprehend may be called science, glides into chemistry.

843. *Mr. Potter*] What would be the cost of these jewels?—The whole 600 specimens cost about 1,200 L.

844. *Mr. Akroyd*] Are not the ornaments you now produce Etruscan?—Some are from Central Italy, some are from Naples, and some are from Magna Grecia.

845. I understand that there are in some parts of Italy traditions of art derived from the ancient Etruscans?—I should think that you could trace the peculiar forms of art exhibited by these specimens back to Egypt, by interceptable degrees.

846. *Chairman*] Just about as much as you trace the English language back to India?—I am really not able to answer that question.

847. *Mr. Potter*] Are those ornaments gold?—I believe so, but my only object in producing these specimens is to illustrate the remark, that what is called art, and what is called science, constantly shade off into each other.

848. *Mr. Akroyd*] Can you state what classes are proposed to be established at the Wakefield school, I suppose inorganic chemistry would be one?—I do not suppose at present they have any definite views themselves; they have discussed mechanical science, and they have discussed chemistry and even physiology, but I think till they have made up their minds that they will squeeze the grammar school to help them (the grammar

grammar school is very fond of Greek), their notions are not very well defined.

849. Mr *Potter*] Has Wakefield a Mechanics' Institute?—Yes.

850 Have you at any time taken cognizance of the mechanical drawings in mechanics' institutes?—Certainly, and in many of these mechanics institutes we have classes in strict connection with our department. All mechanics' institutes, if the students please to come up for examination in May, may come into connection with our department.

851. Though art in general may not be taught in them?—Just so. There are very few places where mechanical drawing is taught unconnected with the art system. In fact, until the Government produced the book on geometrical drawing, which was written by Professor Bradley, there was really no text-book on the subject in this country, although in Germany and in France, year by year, new treatises are made on this particular subject of mechanical drawing. England has been singularly backward on that point. Fifteen years ago a manufacturer in England had to look out for a well-trained German gentleman, in order that he might get mechanical drawing done on his premises.

852 *Chairman*] With regard to an answer which you gave just now to Mr. Akroyd, let me ask you whether you have many masters who are certificated both in art and science?—I do not call to mind one. Yes, one,—Mr Davidson, but the case is so rare, that I cannot tax my memory any further.

853 May I ask whether you have had any complaints from art masters that they were placed at a disadvantage, in comparison with science masters, in respect of the remuneration for mechanical drawing which they received?—I remember nothing definite of the kind. Do you mean that there might have been complaints that the masters feel that science is better paid than art?

854 Yes.—I do not think there are any real complaints. There are always a sufficient number of complaints about everything, but I do not recollect an instance of that kind.

855 But is it not the fact that some subjects are better paid under the Science Department than under the Art Department?—I should say, distinctly not.

856. I am speaking now simply of mechanical drawing as paid for in the art school and in the science school?—Mechanical drawing forms no part of the strict science course. Mechanical drawing is altogether under the Art Department. Not, of course, the theory. The one thing involves the mere power of drawing, and the other the theory or construction of drawing.

857. I understand you to mean that the examples set in one case, and the questions put, would be different in one school from what they would be in the other?—Entirely so.

858. Mr *Bruce*.] They would be taught in a different way?—Yes.

859 *Chairman*.] The denomination may be the same, but the subjects are taught differently?—Just so.

860. I know, as a matter of fact, that the art masters do complain that they are not allowed to teach mechanical drawing, the science, if I may so express myself, now could not some mode be devised by which art teachers could readily be certificated as science teachers for mechanical

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drawing, as taught in the science classes?—It is entirely their own affair. At Birmingham Mr Raumbach is an art teacher, and my impression is that he gets public money every year by teaching the scientific portion of mechanical drawing. I just now instanced Mr Davidson, who is another example in point, Mr. Davidson was a teacher of art at Chester, and when the science system was introduced he qualified himself to take a science certificate for teaching mechanical drawing. There is nothing to prevent an art master from taking a science certificate, it can be done without any difficulty whatever.

861 But suppose the art masters say, "We consider it somewhat derogatory that, being certificated in a high grade of art, we should have to sit at the May examinations with boys, in order to qualify ourselves to take a certificate in science." Could no remedy be found for that?—My impression is that that is utterly unreasonable, it is not boys who come up very largely for these certificates, old fellows come up in great numbers.

862 But they are mere pupils, at all events I suppose so?—In the sense that they are students, but I cannot see anything in that. What is meant by "certificated in a high grade of art"? It must be certificated for being able to draw, but a man may be able to draw, and yet have no brains in the world for the theory of art, there can be nothing derogatory in the showing that he has the brains, because the two things are quite distinct.

863 But in respect to science, you give payment on results to persons who have not passed the South Kensington examination, provided they possess other qualifications, for example, if they are graduates of the universities. Now, do you not think it would be possible that art masters should be allowed to prove their competency for certain branches of applied science teaching at the May examination, without their being required to sit among the students of whom we have just been speaking?—Of course you might make a specific examination to meet this difficulty, but that would involve a very large expenditure of money. You must employ the same high class of professors to prepare the papers, and you must make local organisations all over the country. I think it is entirely the masters' own affair. There is nothing to prevent their coming up and being examined.

864 Nothing, except the feeling that it is derogatory, if done in that way?—If a master does not like to go up in his own town where he is known, he can go up to some other place where nobody knows anything about him. I should certainly think that to be duplicating the system of science instruction, in order to meet the sentimental difficulties of a few art masters, would be putting the country to an expense of 1,200 *l* a year (if it were done broadly on a system), to very little purpose. It is absolutely necessary, if you are to have a national competition, that the competition should be done under precisely the same circumstances for the whole country at one given time. If these papers are to be used the day after, you may have any amount of cabbaging and cribbing that anybody is immoral enough to take up with.

865 Mr *Dixon*.] I have had an analysis made of the cost of the Science and Art Department during the last 11 years, taken partly from the reports, and where there are no reports of their

expenditure,

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expenditure, I have taken the figures from the Civil Service Estimates, and I find that during the 11 years between 1858 and 1868 inclusive, there was spent in salaries and general management for the department 60,000 *l.*, the larger portion of which would, no doubt, refer to the South Kensington Museum. I find that the management charges for the South Kensington Museum amounted to 267,000 *l.*, that the cost of permanent buildings at the South Kensington Museum was 173,000 *l.*, and that the purchases of works of art for the South Kensington Museum amounted to 75,000 *l.*, making a total of 575,000 *l.*, that is to say, for the South Kensington Museum alone about 550,000 *l.* I find that during the last three years the grants to science schools on results, amounted to 33,000 *l.*, to Jermyn-street 30,000 *l.*, making a total of 63,000 *l.*, and that the art grants amounted to 76,000 *l.* during those three years. The question I have to put to you is this: What proportion of the 550,000 *l.* spent on the South Kensington Museum may, very roughly speaking, be taken to be spent on science?—I have no doubt that the honourable Member's analysis is fairly correct, but I would refer him to an analysis of the actual expenditure taken from the accountant's books, which was laid before the Committee sitting on South Kensington in 1860, and I will put into his hands shortly an analysis of the whole expenditure under its various classes from the beginning of the Science and Art Department up to the present time, so that when that is printed I shall be able to answer with much greater precision the question that is now put to me. I shall be able, also, in answer to the honourable Member's questions, to put in a paper showing an analysis of the expenditure for the year 1867.

866 Mr. Bruce] Would it not be to the purpose to say at once that the expenditure on the South Kensington Museum had no immediate reference to the teaching of science?—I might make that answer with this qualification, that there is a good deal in the way of science which is indirectly done at South Kensington, I mean a good deal which is not art. Take, for instance, the education division which may be called science rather than art; the food division is purely science, the animal products division again is science, the collection of naval models and the machinery connected with them is purely science, building construction and models again is all science, so that it would not convey an accurate impression if I were to say that the South Kensington Museum is devoted exclusively to art. Even if you take the question of decorative furniture and look at a beautiful piece of cabinet work, which undoubtedly involves questions of science, you find that art is of course involved in it. It would be extremely difficult to do more in reply to such questions than to say that certain payments have been made directly for promoting science, while other payments have been made directly for the purpose of promoting technical instruction, meaning by that a kind of mixture of the two things, there is hardly any object in the South Kensington Museum which, looked at from a technical point of view, does not embrace both science and art; we eschew National Gallery questions, or the collecting of pictures as pictures which is a matter of fine art. When we at South Kensington have bought a picture it has been from some special connection between it, and the history of science and the

history of art, or for the illustration of some process. We once bought a fresco; I do not think any public collection in this country besides ours possesses a fresco, and that was bought quite as much from the consideration that it was a fresco illustrating painting on a peculiar method as that it was a picture.

867. Chairman] What you mean to convey to the Committee is this, that even when objects in your collection have not a directly scientific bearing, they have a technical bearing?—We have tried with the most religious faith to keep it in that direction, to prevent its going to weed in other directions. But it is a very difficult thing to draw the line very closely; take, for instance, a candlestick, which is called Becket's candlestick; it was made in the 12th century for Gloucester Cathedral for Becket, and it is said to have been taken to France by him, where it remained till the French Revolution, and then came back to this country at a high price; it is certainly not a question of very fine art to possess that candlestick, while it is as certainly an historical object of great interest, but it might be contended that it certainly is an object of high technical interest; about that there can be no doubt, for it is composed of a metal which is very little in use, a combination of metals in fact which is called latten, so that anybody might very well argue that it was a purely scientific object.

868. Mr. Dixon] My question did not refer to what we may call technical education, inasmuch as technical education may apply either to art or to science, but am I to understand from your answer that you consider that the money which has been spent in South Kensington Museum is partly for science (how much you did not say), although by far the larger part of it has been spent for art?—For technical art; I should like to use that word as distinct from fine, or applied art, art applied to industry.

869. Then are you of opinion that the amount of Government money which has been spent on science teaching bears too small a proportion to that spent upon art teaching?—At the present moment, yes, in the past time, not, I am referring now to 11 years ago, I should say that the country was hardly in a frame of mind 11 years ago, and had been hardly in a frame of mind during the past 11 years, to express its wishes about science teaching. It has been proved that it was willing to accept what could be done in the way of art, at the present moment what is being done in science is in my opinion very experimental, you have different systems in use, not only in our own country but in different parts of Europe, and for years to come I think it will be very much a matter of experiment, but there is no hazardous experiment in buying a fine object which illustrates art applied to industry; the objects in the South Kensington Museum would fetch double their price if they were sold, so that there has been no waste, and I do not apprehend that your question leads up to the point of waste.

870. No?—But our policy has been to proceed in the way of purchasing things instead of launching out into great experiments in view of a system which is very much untried, about which all things are very hazy at this moment. Take Wakefield, for instance; Wakefield at this instant does not know whether or not it has made up its mind as to what it wants; and if the State is to administer a system of this kind, I apprehend it must mainly depend

depend on the impulse that is given by State assistance to the locality itself. And if they have not made up their minds, I do not think we can assume that the concrete Government mind can be made up

871. *Chairman*] But is not that precisely what Government did with regard to art?—No, I think not, throughout my experience of the science and art department, it is that they have always had to be the humble servants of the public, responding to the wishes of the public as far as they could. During the last two or three years a new demand has arisen, but at the beginning, when Mr Poulett Thompson established the School of Design at Somerset House, there was a great apprehension that we could not design our own patterns. In 1837 schools of art were specifically invented, not to teach drawing generally throughout the country, for that was altogether repudiated, as I can show you by documents which still exist among our records. Elementary drawing was thought not to be the business of a school of design, their business was said again and again to be to improve the designs of our manufacturers. When I became connected with the practical art department, I recommended Mr Henley to allow elementary drawing to be taught to carpenters, and I drew up a minute for his consideration, which, according to the practice of the time, had to go before the Secretary of the Board of Trade, for him to certify that there were funds for carrying it out. Mr. Porter himself says, in his own handwriting, which remains in our records, that the State has no business to teach carpenters' drawing.

872. *Mr. Dixon*] But suppose the country could see its way to an expenditure of an equal sum of money on science advantageously, would you advocate Government grants being made for that purpose?—I think it would be an extremely profitable expenditure for this country to make, to spend as much money on science as it does upon what is called art, but it would require great care, in order to see that you did not demoralise the country by undertaking work for the localities which the localities ought to do for themselves. Our Government is not a Papacy.

873. But surely it would not demoralise the country to spend a given sum upon science any more than it demoralises the country to spend a given sum upon art?—Certainly not. I only say that it would require great caution in the way of doing it.

874. Could you give me an estimate of the amount of the cost for the year 1867 of the class instruction given at South Kensington; the proportion of management charges appertaining thereto, and the fees received from the pupils?—Do you mean as respects art, and the School of Naval Architecture, those are the only things we carry on at South Kensington.

875. Then, in fact, you mean to say that there is no science besides naval architecture taught at South Kensington?—Just so.

876. *Mr. Bruce*] Lectures are delivered occasionally, are they not?—Yes; and naval architecture embraces several sciences, but those sciences are taught especially with reference to naval architecture.

877. And they are only taught to those who are going through a course of instruction in naval architecture?—Just so; the public out of doors are entitled to enter for particular classes, and they do so to some moderate extent, but the ob-

ject of the school is the promotion of the building of ships.

878. *Chairman*] And more especially with reference to ships of war for the Navy, I suppose?—Half the students are sent by the Admiralty, and half come from the general public, and certain related trades.

879. And the private students pay 20*l* a session, do they not?—I think so.

880. *Mr. Dixon*] How many years has the Jernyn-street School been established?—It was established in 1851, the present being the 17th session.

881. How many students have passed through the school, taking students who remain from one to three years, and students who are only occasional students?—There have been 233 associated or matriculated students, remaining there for more than one year, and 1,113 occasional students.

882. How many have received certificates as Government teachers?—I could at once tell you the number who have received scholarships there, but I should require to look through our books for the names of the individuals in order to trace those who have received any instruction in the Jernyn-street School, and who have subsequently become teachers of science, that point is also partly involved in another question which the honourable Member put to me; I will read this answer "No Associate of the Royal School of Mines, or Royal Exhibitor who has completed his course of instruction in that institution, is at present engaged in science teaching. It may be observed that, although Royal Exhibitors very often supplement their allowances by teaching science classes, graduates of the school obtain appointments in commercial and other pursuits, which are more valuable than that of elementary science teacher. Thus, Mr. Snelus, who obtained the associateship in 1867, is now chemist to the Dowlas Ironworks. Mr. Richards, of the same year, occupies a similar post at some hematite iron works at Barrow-in-Furness, while Mr. Rawden, an associate of 1866, is a master in Clifton Proprietary College. At the present time Messrs Jones, Griffiths, and Bickerton in London, and Mr. Kilroe in Dublin, Royal Exhibitors, are engaged in teaching science classes, and during the last two or three years Mr. Rowden and Mr. Snelus have also taught highly successful classes while holding their exhibitions. Mr. Coomber is the only teacher we know of now teaching who was educated at Jernyn-street."

883. Would that be considered by you an answer also to my question with regard to the occasional students?—We know less about them, but I will try and find out any facts relating to the subject which would apply to your question. One of your questions was with reference to the amount of fees that had been received from the commencement. I will hand in a return, which shows that 11,769*l.* had been received from 1851 to 1867.

884. Can you tell me the number of students in each subject in 1866 or 1867?—I could produce an analysis of those also. In 1865-6, Chemistry had 24 students; in 1866-7, 39 students, Natural History 11, in the next year 5, in Physics 22, in the next year 28, Geology 15, and in the next year 17, Mining 6, in the next year 3; Mineralogy 5, and in the next year 5; Metallurgy 5, and in the next year 9, Applied

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Mechanics 6, in the next year 2. These numbers do not include the associates.

885. Will you now give the number of students in Jermyn-street under the scholarships?—The number educated in Jermyn-street has been 21. Fourteen were Royal Exhibitioners under the Exhibitions established in 1861–62, 1 free scholar from Edinburgh, 2 from Cheltenham, 1 from Truro, and 3 from Bristol. Besides these, 22 certificated masters, or pupil teachers, have been admitted to the lectures on payment of an examination fee of 1*l.*, and 2 gold medalists have been admitted free. The college in Dublin has only been organised a few months, and therefore no results can be shown there at present; but we could show the number of certificated teachers who have derived education under the former industrial arrangements in the school of Irish industry.

886. Will you be kind enough now to give the number of students who are now teaching science classes in connection with the department?—That has been given in a paper which has already been before the Committee. In 1867 the number was 200, in 1868 it is 325.

887. Will you now give the average amount paid to each one on examination in 1867?—We have taken out the amount of payments made to teachers in London, and the districts surrounding London, in science schools. On the results of the examinations in May 1867, the total sum earned by people teaching in London, extending their operations as far as Woolwich and Croydon, and so on, is 1,751*l.* The average earned per scholar was 87*l.* The payments to science teachers before the change of certificates in 1862 amounted to 2,694*l.*, the average payment to each one being 52*l.* At the present time I believe the average over the 325 teachers now employed is about 42*l.*

888. Can you give the number of students in each class of merit on whom such payments have been made?—I apprehend that we can do that, but two or three of the questions put by the honourable Member will take the Department at least a week to prepare answers to (for the details can be only picked out), and we are greatly pressed this week by the preparations for the science examinations to be held in the coming May. One of your questions was the total cost of the Queen's prizes, issued in 1867, for science; the total cost as distinguished from the value. For books, it was 586*l.*, and for medals, 152*l.*; making a total of 739*l.* The total paid for results in 1867 was 8,000*l.* I have now to hand in a paper which answers some of the former questions put to me; it is a rough statement of the expenditure for science teaching under each of the following heads for 1867–8, that has been prepared by Mr McCleod for general management, the total is 8,317*l.*, and it is estimated that the portion which ought to be charged to science would be about one-tenth, in fact, 830*l.* The new buildings at South Kensington were 32,500*l.*; the proportion of expenditure on science schools cannot be stated at present, but a great part of the expenditure now going on is for the science school to accommodate the school for naval architecture, and to provide also for the teaching of chemistry and the purchase of works of art, the estimate being 21,250*l.* That is for the year 1867–8. The direct vote for science purchases is 1,250*l.*, but many objects are indirectly for science, and the amount can scarcely

be stated. Then we come to No 4, the Science and Art Department; we may call it, perhaps, the inspector's portion of the business, for which the estimate last year was 7,850*l.*; the expenditure exceeded it, being 9,720*l.*, of which we estimate that three-fifths ought to be charged to science, that is to say, 5,835*l.* Then we have gas, cost of lighting, and so on, which was 34,225*l.*; the portion for education, food, naval architecture, and animal products, cannot well be distinguished; it would be impossible unless you were to do it roughly by the superficial area. Then there is the National Portrait Gallery, where we have nothing for science, though that, perhaps, would not be strictly true, because portraits of scientific men may be supposed to have some little bearing on the question. Then we come to science schools, the estimate for which was 8,600*l.*, and the expenditure 10,200*l.* For the art schools the estimate was 22,000*l.*, but the proportion for teaching mathematical drawing and geometrical drawing could not be taken out. Then for naval architecture the estimate was 2,800*l.*, and the expenditure is 2,100*l.* The East London Museum, for which there was a vote of 5,000*l.* on account, will be chiefly devoted to science.

889. To what extent do you think the work done in Jermyn-street is of any benefit to the provinces?—As far as that goes, I think it is of great benefit, but that as much is made out of it as might have been expected from the high efficiency of the professor, and generally from the amount of means employed there, I cannot state, for I think very little is made of it in proportion. I do not know to what causes that is to be attributed, except one or two which I may mention; the institution in Jermyn-street is not, in my opinion, sufficiently collegiate, I think parents may not like to send their children up to Jermyn-street, with the chance of their living too much at hap-hazard without anybody to look after them, and then I am bound to say that that kind of union of the mining school at Jermyn-street, with the geological survey, which is a totally distinct class of business altogether, although one grows out of the other, does not conduce to the success of the institution. In fact, to manage a school, is a very specific business, as everybody knows. We have not had a great many Dr Arnolds, if you want to have a successful school you must take all the trouble connected with the incidents of a school.

890. Inasmuch as there have been 1,113 occasional students at Jermyn-street, must not the school have been of great value to the metropolis?—I should say, speaking comparatively, that it had been of the least value to the metropolis, if I had to give an off-hand opinion as to the places to which Jermyn-street had been of the most value, I should say the colonies; a great number of students have spawned off to the colonies.

891. The occasional students we have been speaking of have been from the metropolis, and not from the provinces, have they not?—That might perhaps be assumed, but I do not know that it would be strictly true.

892. Do you not think that if some other schools were established in the metropolis, instead of letting the students come to the schools from such a great distance, very much more good might be done in proportion?—It appears to me that there are two questions which have to be fairly considered with respect to the establish-
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ment of such a school as Jermyn-street; one is the population, in fact that is the chief point; and the second point is the character of the industrial occupations pursued in the district London in one sense is a great manufacturing place. Almost every description of manufacture is carried on in London except calico making and weaving. All the trades that are carried on in Birmingham are more or less carried on in London, and I should say to three or four times the extent. Take into account, for instance, such places as Maudslay's and Penn's. It is very hard, indeed, to say where, on the whole, it is best to put a place of the kind, it depends upon so great a number of accidental circumstances. You would hardly expect that the best secondary school in the country should be found in a little hole at Bristol, but that is so. Now, what are the circumstances which have conduced to that result? I do not know, but perhaps this proposition might be defended, that whatever the State does, it must be prepared to do everywhere, it cannot make any election in the matter, all localities must have the privilege of whatever the State offers; there must be no favouritism in choosing one place or another; it is possible, for other considerations, that it may be right to have things in the metropolis that you could not well have in the provinces, it is a debatable point. I have no doubt that the reason why Dublin has the best college of science is a purely sentimental one, it is not the manufactures of Dublin that are the cause, and it is not the demand of the Irish people, that is to say, it is not the kind of demand that you have at Manchester or Birmingham, it is simply from the circumstance that Dublin is the metropolis of Ireland.

893. But do you not think that that is the principle, namely, that the Government funds should be expended on account of science teaching in such a manner as to benefit equally every portion of the industrial classes of the country?—To carry out that principle has been the most earnest wish of the department since I have been connected with it.

894. But that is not the case with regard to Jermyn-street, is it?—Jermyn-street is a kind of mining school. You would think that one mining school would be enough for the whole country, some people might think it better to have it at Turro or at Wolverhampton.

895. Mr Bruce.] Or at Merthyr?—Yes, or at Merthyr, or at Swansea, or at Cardiff, but I entirely agree that every one of those places which desire to have mining taught should be on an equal footing, and that there should be no favouritism shown to London as London.

896. Chairman.] But how do you make that apply to Jermyn-street?—It is a case of Hobson's choice. Somebody seems to have thought it would be good policy to have a mining school, everybody may dispute about which is the best place for it, but I am quite clear of this, that if a place wants to have one, it ought to be aided in having it, if I dared to express an opinion, that is what I should say; but at the same time Cardiff ought to have precisely the same facilities if it qualified itself to receive the assistance; it would, in my opinion, be greatly deplored that the Government should of its own mere motion, go and do a piece of work in Birmingham, which Birmingham ought to initiate for itself.

897. But my question is rather this, whether the Jermyn-street school is really a national

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school for the benefit of the whole nation equally, or whether, whatever the intention may have been, the result has not been; this is a matter of fact, that it has become a school which is mainly beneficial to the industrial classes of the metropolis?—I do not think London, as London, cares a button about it, but I do know that in a moderate way the people who come to Jermyn-street, come from all parts of the country, for instance, those scholarships are awarded in open national competition; people come up from all parts of the country, having been trained in all parts of the country for the final polish, which they are supposed to get in Jermyn-street.

898. The policy of the Government with regard to science schools, as well as to art schools, should be to make grants where a locality shows an inclination to spend the money properly, and to do some of the work for themselves, is that what you think?—I think that is, broadly speaking, the true policy.

899. Do you think it is just to the taxpayers of other districts, that the Government money should be given for science teaching on the occasion of any accident occurring in a particular district, the accident, namely, of one or more men choosing to come forward to subscribe funds, as was the case with regard to Owen's College?—I think that you might obtain a better test than that of accidental subscription on the part of benevolent individuals, and the fact that the place wants instruction. I would venture to say that a town agreeing to rate itself would be a much better test of its earnestness, but I do not see how the matter is to be settled unless by some kind of process of subscription, or municipal aid, or rates, or something of that kind, why Laverpool should have something, or why Manchester should have something, or *vice versa*, is the kind of question which has to be determined.

900. Do you not think you ought to make a distinction between the desire that may exist in the minds of some people in a locality for a school, and the necessity which may exist in that district for the school; ought not the Government to consider rather the necessity of the case than the desire which may exist in any given district?—That is, at all events, a paternal view of the functions of Government which has not hitherto prevailed in this country, though perhaps it may some day. I should like to say this, however, and I will now speak precisely, if Wakefield really wants industrial instruction, and will only get rid of that useless Greek, and some of the charities which are not only utterly useless, if not demoralizing, Wakefield could at this moment have as good a course of technical instruction as could be desired. If I might venture to make the reference, I should apply that remark to Birmingham, it has got 10,000 *l* or 12,000 *l* a year for the education of the people through the Grammar School and its branches; if it is really heartily in earnest about science teaching, it has only to apply some very little portion of that 12,000 *l* a-year to the purpose, and then it will get it, and that by the aid which the Government offers for the whole country, if it would do that, Birmingham might have a magnificent establishment.

901. Are you aware that the Birmingham people have no power whatever over the spending of the money belonging to that school, that it is vested in 20 individuals, who may or may not take that view?—So much the worse for Birmingham.

902. According

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902. According to that system, the scientific education of the country would depend upon the opinions and liberality of a few individuals in each locality?—I am afraid that that is the way in which we do things in this country. I hope it will not be inferred from my answer that my own personal opinion is adverse to the State aiding the industrial instruction of the country. I have no such opinion, for I think the State ought to do so. But I am very clearly of opinion that the question of deciding whether A., B., C., or D. is to have certain things in those localities is a question which must be settled in those localities, but whether the thing should be done by private subscription or by gift of land, or by a rate, or by an improvement of the charities, I do not venture to say. Of one thing, however, I am clear, the locality must take the initiative.

903. Do you not think that the Government might do more in the way of giving inducement and encouragement to localities to come forward in these matters; as, for instance, by increasing very largely the grants that would be made for the building of schools, say, for instance, increase them to one-half, and even going further than that, and saying, that for the first few years, under difficult circumstances, the payments on results would be increased in order that in poor districts, or in districts where the number of enlightened and liberal people was small, it might be made easier to those persons to take the initiative?—I think that upon a perfectly fair and equitable system applicable to the whole country, it would be wise public policy to spend more for technical instruction than the Government is now doing.

904. *Mr. Potter*] The system being supposed to be formed?—The system being supposed to be formed I have thought over at different times what it might be possible to do, and by the direction of my superior officers, have submitted various suggestions, take the case of a great manufacturing centre like Birmingham, I have thought that if Birmingham would provide the ground to begin with in a proper situation (which is essential), and say half the amount for a building, and if for a certain number of years they would do the benevolent in founding scholarships, the Government might fairly come in and aid them to a large extent. But whatever it does for Birmingham, it is clear to me it must do for Nottingham, if Nottingham comes forward in the same way. The problem is, how much and what should be done.

905. *Lord Robert Montagu*] Has not this matter been actually under the consideration of the Government, and has not the Government decided to await the decision of this Committee?—Yes, the subject has frequently been discussed by the Lord President, and the Vice President, during the last six months. It has been discussed at almost every other board at South Kensington.

906. *Mr. Dixon*] Do you not think that there are a great many manufacturing districts where schools of science and of art would be established if a greater amount of Government help could be counted upon?—With regard to art, I think the Government has done nearly all that it is possible for a Government to do without taking upon itself the full responsibility. The fact that you have more than 100 schools for the whole country is a proof that arrangements have been effected which make it at least possible for localities to

have schools of art if they please, and the same thing applies to science. I have no doubt that some other arrangements might be beneficially made, and recently the Lord President thought it right that a building grant for science should be instituted, and has applied to the Treasury for the necessary authority. That, no doubt, would very much encourage the building of places for science, but in my opinion it would be a complete failure to go further, and build a great many big places to be called science schools all over the country without first leading the country up to the want of them. If you want a science school in a particular place, you must not depend on the accidental attendance of artisans in evening classes; you must have that science business done in the daytime, and it must be connected with secondary instruction. The present system very fairly and liberally provides for that kind of accidental getting of science schools, wherever people want it, but if you really want to organise the thing you must have distinct day instruction. There are two classes to be considered; you may hold out bribes to the artisan class not to take their children away from school.

907. And that has been done, has it not?—It has been done. You may, as at Bristol, couple that with very good instruction, and premises not overcharged with rent and local expenses; and you may get the people to pay 3*l.* or 4*l.* a year, which will enable the master to earn a living, and that, with Government assistance, will enable a good science secondary school to be established wherever you please; but then you come to another class of the community, the gentlemen's children, and the class of persons who will afterwards perhaps become foremen and managers of public works. I believe the great want of this country is in that direction more than anywhere else. No doubt you want first that everybody should read and write, but the next point is that those who go beyond that point should get this secondary instruction in science. The want of the present time, and it is a want which will grow more and more, is that the young men who now go to public schools and learn Latin and Greek which they forget directly they go out into life, and who are now bribed up to the universities to become poor curates, or to go into the learned professions, should be enabled to receive a good industrial education. It is a great want that we have not at present in this country anything like an industrial status similar to that of law, of physic, or the church. My own opinion is, that what you want in order to enable this country in as good a footing as the other nations of Europe, is that its wealthiest classes should have an opportunity of training their children in that higher kind of education. I think that as a young man walks the hospital before he becomes a doctor, a young man who is likely to be connected with the industry of the country in the manner I have just suggested, should walk some workshop or manufactory, where he might obtain an amount of general scientific knowledge bearing on the branch of industry which he would afterwards pursue. That is the object of Mr Whitworth's scholarship with regard to mechanical science, namely, that the foremen and managers of machine shops and manufactories should have the highest amount of theoretical knowledge and the greatest amount of hand skill. I believe we are, for want of scientific knowledge, the most wasteful people in the world. Any advantage which

which the Belgians and the French have had in supplying South Kensington with girders rather than the Staffordshire iron master, who had the contract, is due in a great measure to the superior education of the foremen and overlookers in Belgium, though there are, no doubt, other causes concerned in the result.

908 Mr. Bruce] With regard to Jermyn-street, was not the object of that institution, so far as it is a place of instruction, and not a mere geological museum, to give a complete education in mining?—Yes.

909. And what sciences are taught there are all ancillary to that object?—Yes

910 How many years would it take for a pupil to go through the whole course at Jermyn-street?—I believe the matriculated course extends over three years

911 The education given to a pupil who went through the whole course would be very complete, would it not?—Very complete *quod* mining and geology.

912. The scholarships are open to pupils from all parts of the country, are they not?—Yes

913 And, in fact, the scholarships are gained by pupils from all parts of the country?—Yes

914. London, therefore, has no special advantage, so far as the primary object of the Jermyn-street institution is concerned?—None.

915. I presume that this institution was founded in London rather than in Birmingham or Cardiff; for instance, because, various sciences having to be taught, the ablest masters for those sciences were to be found in London?—I apprehend that must have been one reason; but things in this country crop up by accident in so mysterious a way, that if I were to try to assign the exact reason why the mining school was placed in London rather than anywhere else, I think I should say this Sir Henry Delabeche was at the head of the geological survey, and gradually formed a museum. Then he found that there was a school of mines in Paris, and he thought it would be a proper thing to have one here, and was able sufficiently to impress the different ministers under whom he served with the importance of these mining schools to get the thing done; but I do not think the Cabinet itself had pondered at all upon the question, where a mining school should be established, or whether London should be chosen as the place for it.

916 I suppose no man in the whole of this country knew this country better than Sir Henry Delabeche?—No one, I should say.

917. And no one had more at heart the interest of mining than Sir Henry Delabeche?—I should say nobody.

918. And he was naturally an acute and intelligent man?—Yes, undoubtedly

919. And as a matter of fact, the very best men in the country have been employed as instructors at Jermyn-street?—Yes.

920 Without offence to the provinces, it may be said that it would hardly be possible anywhere in the provinces to bring together such a body of men as are now giving instruction in Jermyn-street?—It would be quite impossible at the present time, and I should say it would be impossible at any time to be foreseen for a long number of years to come.

921. But the experiment in Jermyn-street, although it may have resulted in producing a number of men of very considerable scientific

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attainments, has not as to mere numbers been very successful?—That is so.

922. Do you then think the example of the Jermyn-street Institution would have given any encouragement to the Government in founding, of its own mere motion, mining schools, for example, in other districts in this country?—I think not.

923 Would you therefore argue from that that the demand ought to come from the districts themselves, and that it would be imprudent in the Government to set up a mining school with all the necessary expensive machinery unless evidence were given of the existence of a demand for it?—Unless the localities would take a very important share in the organization and conduct of the business, I should consider it quite unwise for the Government to undertake the business

924 Chairman] You have stated that Sir Henry Delabeche found a mining school in existence at Paris, and was thus induced to establish a mining school in London?—That is my theory.

925 You are aware, I suppose, that there are subsidiary mining schools scattered all over the mining districts of France; that there is one, for instance, at St. Etienne?—I am not aware how far it is or is not in connection with the Paris Mining Schools

926. But such schools do exist?—I accept that from you

927. And there are mining schools in various parts of the Continent?—Yes.

928. Are you aware that those schools are supported in a great measure, if not exclusively, by the localities themselves?—I am not aware of the pecuniary arrangements in respect to those mining schools.

929 Are you aware that the schools at Creusot receive no assistance whatever from the State?—I believe they are mainly due to the Schneider firm, but I am under an impression that they do receive some extrinsic assistance

930 With regard to Jermyn-street, can you inform the Committee how many of the scholarships in Jermyn-street have been taken by pupils of the science schools in connection with South Kensington?—

931 Mr Acland] You spoke just now of “useless Greek,” but as we can hardly suppose you think Greek is, abstractly speaking, useless, will you tell us what relation you wish to establish between the existing foundations of the country, (such as grammar schools), and science instruction?—I must apologise for using the term “useless Greek,” inasmuch as I think in its proper place Greek is very useful, but I do not see the direct bearing of it on our manufactures, nor how it confers much benefit upon the country at large.

932 But have you considered how, in such a town as Wakefield, you would provide at once a liberal education for those who desired to have an education of a literary character and the imparting of that kind of scientific instruction which you think so important for the country?—In the first place I should abolish the trust, which is self-elected, the town of Wakefield has little or no influence over it; I should not hesitate to do that, I should, perhaps, consider it good for Wakefield that there should be some supervision of the funds with reference to the wants of Wakefield; I think I should without hesitation take away half of the funds which are now employed in teaching Greek, and apply that half to science; I should certainly set apart a portion of the premises for science, an illustration which is

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to the purpose, came under my eye the other day through the kindness of the Vicar of Wakefield. He took me to see a little Green School (I think it was called), I found it an old Elizabethan building, about 140 boys learning reading, writing, and arithmetic; and I dare say they were learning them very well. I asked, "What is the peculiarity of this school?" "The peculiarity is that the boys have the privilege of coming here, paying only 1d. a week." "Do the boys learn more than they would at any ordinary national school?" "Nothing at all" I said, "Well, having funds to pay the masters, and giving this teaching to certain people who, through the personal influence of the trustees, have the opportunity of sending their children for 1d a week only, do you not think that it would be a good plan if these penny-a-weekers were scattered all over the other schools of Wakefield, and the 300L or 400L a year belonging to this school were applied for the purpose of teaching secondary science? It is no good having a lot of boys in a special school learning reading, writing, and arithmetic, which they could learn in 20 other places in the town" Then, of course, we came to the question, that this was a part of the trust of Wakefield Grammar School. The vicar said, "How do you think your science would agree with the Catechism?" I said I thought that it would not quarrel with it. "Surely," I said, "there are 140 or 150 people in Wakefield who would be glad to have a good secondary school, and pay 3L, 4L, or 5L a year for the instruction rather than see these premises appropriated to giving a number of boys instruction in reading, writing, and arithmetic, which they can obtain anywhere

933. But my question is rather this I understand you to express the opinion that one of the points to be attained is to give the localities themselves the management of their own endowments. Secondly, that you would divide the existing foundations about equally between schools for science and schools for classics, combined with some other kind of instruction. Am I correct, then, in assuming that your plan would be to divide into separate schools the existing endowments, so as to have classical schools and science schools running side by side, or would you think it better to introduce science as a part of your secondary school education?—And leave the grammar schools as they are?

934. No. Would you think it better to divide the grammar schools into two separate classes, one being what might be called a classical type of school, and the other a scientific school, or would you rather look to introducing more science teaching into the general education of the middle classes of England, without making any such division as I have now spoken of?—I should not hesitate at once despotically to take away half the revenue of the existing grammar schools, and apply that half to industrial teaching, whether it were done in existing buildings, or in new buildings to be made for the purpose, is a matter of detail, but with regard to the question of funds, I should unhesitatingly take the money at once. If you ask if the Jermyn-street Institution ought to propose to Parliament to make extensive grants for scientific instruction until you have taken away at least half of the funds of the existing grammar schools, and applied them to that purpose, I decidedly think not.

935. But what I am anxious to get from you is simply this, with a view to giving the country that advantage of which you have so clearly pointed out the need, namely, giving to the future foremen and managers of manufactories, and of other great works, the best possible education for the purposes of their future life, do you think it would be better to aim at separate science schools, or to give a more scientific general education?—I would say both. I think that you should aim at introducing secondary schools as a preparation, and do that as extensively as possible, and then, in the large towns, you should have large establishments, taking more the shape of colleges. You might have something more costly in a very few other places; and, finally, I think you ought to bestow the same kind of honours and dignities on industry as you now do on other things.

936. You spoke just now of a function which I also thought a very important one, namely, that of science being made a serious work in the daytime, and not merely a kind of relaxation in the evening, do you think that we ought to look to have science teachers under your department trained outside our secondary schools, or that we ought to make our secondary schools much more practical?—I certainly think that we ought to make our secondary schools much more practical.

937. Then, do you think that it would be necessary to set up a hierarchy of science schools all over the country, or do you rather think that we may look to the adoption of the grammar schools and secondary schools which exist all over the country, to the purposes of conveying the kind of education which you want for the classes we have been speaking of?—I think so. You have the case of Bristol, where the people are doing exactly what you want, and doing it for nothing, and that nothing being represented by a school free of rent and free of local taxation.

938. Mr. Lowther.] Is the making and decorating of china taught at South Kensington?—A few years ago we had some instruction given for painting on porcelain, which was very successful, but few of the students taught, and only one in four obtained, any occupation in the provinces afterwards.

939. Would that come under the head of art or of science, I mean the making of china?—The making of china would be science, the decorating of it would, perhaps, be art. To answer your question quite distinctly, we are about to give employment now to some of the female students, and to pay them for it, they are going to paint on china for the purpose of decorating the South Kensington Museum; but we are not doing that as a school.

940. Mr. Gregory.] Do you not think it would be expedient to obtain collections of peasant jewellery similar to those produced to the Committee from India, Scandinavia, Spain, Portugal, Holland, and other countries, where the jewellery and ornaments have a peculiar character?—Certainly; we have some from Spain already; but the whole thing is unquestionably worth taking up.

941. Mr. Lowther.] Did I understand you to say that you thought one mining school was enough for England?—I think one mining college is quite enough, properly managed, and properly encouraged. I think there might advantageously be several secondary mining schools.

942. Which

942. Which would feed the college?—Which would feed the college?

943. Mr. Acland.] Do you not think that, with a view to the promotion of both art and science throughout England, it is of great consequence to increase local exhibitions as well as teaching?—Yes

944. Have you not had considerable experience of the good results of that in what you have already done?—Yes

945. Do I understand your general view to be, that while you must look for the initiative to the locality, what the Government should do is more in the way of organization and superintendence than in that of granting money. Do you think it absolutely necessary to make grants from the public treasury in order to get science teaching locally carried on?—I think grants are necessary

946. Mr. Reid.] In what way, beyond promoting a general knowledge of the science of agriculture, does the South Kensington Museum do anything for agriculture?—Nothing, except so far as its food collection may be supposed to bear upon the subject.

947. Mr. Bruce.] And the machinery?—Yes, a little

948. Mr. Reid.] But there is nothing in the sciences or technical art which is applied to agriculture in your establishment?—No

949. Sir Charles Lanyon.] Could you give the Committee a table in which the summary appearing in Class 4 of the Estimate should be divided so that the results should appear in columns, giving us the expenditure for 1869, divided under the different heads in pursuance of the questions put to you by Mr. Dixon?—I will have the best table prepared that I can.

950. Are you aware of the national system of education pursued in the model schools and Queen's Colleges in Ireland?—Imperfectly.

951. Do you think that the arrangements of the Queen's Colleges might be made applicable to giving certificates to science teachers?—I should apprehend they could

952. Mr. Bazley.] You have a naval school at South Kensington, have you not?—Yes.

953. Can you point out any signal result or benefits which have accrued from your teaching in that school?—The school has been actively at work only for about three years, but I would suggest that the Committee should examine Mr. Reid upon that point, who, I am told, will state that great benefit has already accrued from that school.

954. Mr. Potter.] I think you have referred to the history of schools of art as conveying a warning against any precipitate action in the teaching of science?—

955. You have stated that the commencement at Somerset House failed altogether, that being a school for the promotion of drawing and design?—I consider that it was a partial failure.

956. An experimental failure. That was intended solely to improve design in manufacture, was it not?—That was always laid down as its charter.

957. In 1842 the Government made its first grant of 10,000*l* to the provinces to certain schools, did it not?—Yes

958. Manchester, and Glasgow, and Birmingham, and schools of that class, had all grants made to them not depending on results?—Yes

959. Manchester had 600*l*?—Yes, payable 0.72.

on the understanding that Manchester itself should contribute 600*l*

960. In those grants there was no restriction with regard to the class of education that was to be given in the schools, was there?—I could answer that question more precisely, but I do not think there was much restriction

961. I think you stated that the teaching of the better classes in the schools of design had had this effect—that it had tended to damage the teaching of the artizan classes?—I think it has a tendency to do so. The latitude which is allowed in teaching the middle classes is unfavourable to the qualities which are required in teaching the artizan class

962. I think you stated that things were executed in some of those middle-class schools which would never be executed in a school of art?—Certainly. I have seen some abominable things

963. In fact, that system has led to the neglect of the artizan classes?—I think it has, it is more the interest of the masters to attend to the middle classes

964. Would it be a correct statement if we assumed that the master received four-fifths of his emoluments from teaching the better class of pupils?—I think you would not be far wrong.

965. I understand you to recommend that day instruction should be given to middle-class pupils?—To all pupils

966. But the day pupils would of course be the better class?—I can't conceive that a number of the artizan class should take the day instruction.

967. But is it not probable that the same results would follow as have followed in the art schools?—I think the cases are quite different.

968. In what respects do you think the cases differ?—The day instruction in the art schools is principally given to young ladies; there are a few gentlemen, but not so many as one could wish. Instruction in chemistry is not a mere plaything, like drawing a bad landscape or a bad flower, and therefore people will not come and learn chemistry unless they have an earnest intention of learning. You cannot have in science that kind of looseness that you can have in art. Whether a flower is well or ill drawn is a much more debateable point than a scientific fact, such as that two and two make four

969. I think you stated that the fees would come to 3*l* or 4*l* per annum?—Yes

970. Then would not that necessarily limit the instruction to a class above the artizan class?—That would not be beyond the reach of the superior artizan class, or of the children of small tradesmen

971. Have you any facts to show that the superior class of artizans do avail themselves of that kind of instruction to any extent?—I should certainly expect them to come to those schools in considerable numbers

972. You stated that we were a wasteful people, and you gave as an example of our neglect of scientific processes, that we allowed girders to be made in Belgium for South Kensington?—Yes

973. But was it really a want of science that led to that result?—Yes.

974. Want of science in making the girders?—Want of science in rolling the girders.

975. Were these girders better than those you could

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could get here?—It is really a case of very mixed considerations

976. Is it not purely a question of cost?—Exactly.

977 Not of science?—Yes, because a scientific economy in manufacture is worth something

978 Then how would you debit the science and the cost of production respectively?—I take it that a good thriftiness in manufacture depends very much on a knowledge of science.

979. Are not girders equally good made in this country?—Not at the same cost, or else they would have been supplied in this case

980 Can you state what is the total amount of the importation of girders into this country?—I cannot say, but in this case a large Staffordshire ironmaster got the contract, he neglected to fulfil it in time, and we found the reason was that instead of making the girders himself he got them, through a London merchant, from a manufacturer in Belgium Mr Whitworth told me, as a fact, that he was precisely in the same position now in Manchester itself.

981 Would not the element of wages enter into the question?—No doubt wages and strikes would have something to do with it.

982 You think it is want of scientific education in the middle classes which has led to a deficiency of good foremen in this country?—That is my impression.

983 In what class of manufactures should you say that deficiency exists?—I should say everywhere. I have heard the late Mr Minton say that he earnestly desired to obtain managers of a more instructed class than he could get here, he has now a Frenchman who is much concerned in his works. I have heard Mr. Whitworth say that the great object of his efforts in respect of those scholarships is to make good foremen and managers in regard to mechanical science

984 Do you think there is any machinery in the world equal to Mr. Whitworth's?—I believe none

985 Was there, in the French Exhibition, any machinery which was on the whole superior to the English?—I believe none

986 In fact, it is acknowledged in all the reports, that we hold our own in respect of all

kinds of machinery, is it not?—I believe so, but we are beaten in price.

987. You think that our want of education is subjecting us to great risk of losing certain trades?—That is my impression.

988. Can you refer to any important imports which we are now receiving from France, to show the want of scientific education in this country?—

989 I hold in my hand a list of the imports of French manufactures in 1866, and also of our own exports, our imports from France since the French treaty, that is, within the last four or five years, have very greatly increased?—Yes.

990 They have nearly quadrupled, standing now at 37,000,000 £; is not that so?—I have no doubt of it.

991 Would you not think that, if there was any risk of our failing in our manufactures for want of scientific knowledge, that those imports would be of a class of goods that we could not produce in this country?—I will look up the French imports, and give you an answer to the best of my ability.

992 Mr Akroyd.] I ask, do you mean that it is desirable to have in the country one central school of high grade, like Jermyn-street; are you of opinion that London is the most central point for it, and the one that would be most convenient for provincial students?—Certainly.

993 With regard to technical education for foremen, overlookers, and people of that class, you recommended secondary schools, now assuming (which I believe to be true) that employers of labour like myself select from their works young men of some scientific promise, are you not of opinion that the most convenient form of conveying technical instruction would be in connection with your local schools of science; in other words, that if these persons went to their ordinary work during the day, and attended the evening classes, it would be a far less costly and a far more convenient plan than that of sending them to secondary schools at some distance?—I think secondary schools should all be local, but secondary schools will not accomplish all that other nations are doing

994 But you think that plan would answer the purpose to which you allude?—No doubt.

Captain W. D. DONNELLY, re-called, and Examined

Capt. W. D.
Donnelly,

995 Lord Robert Montagu] I believe you wish to add something to your answer to Question 604?—Yes, in giving the answer to that question, I think there was a misunderstanding I took the liberty of writing this letter to the vice-president on the subject, which I believe the vice-president considers it will be advisable for me to put in.

996 You put in that letter as your additional answer?—Just so. It is as follows

" My Lord, " 30 April 1868.

" YOUR lordship will perhaps remember that when examined on Monday last, the Chairman of the Committee on Scientific Instruction, referring to the passages I had read from the report of the French Commission on Technical Instruction, asked me, Question 604, if I was not aware that since the report of this commission, a further inquiry has been made under the direction of the Minister of Public Instruction in France; that

one of the recommendations, since embodied in a law, was the establishment of training colleges for teachers of the applied sciences, and that such a training college had been opened at Cluny.

" I find that the Chairman referred to the law of the 21st June 1865, on the organization of special secondary instruction. I would submit that this refers to an entirely different matter, and in no way confutes or affects the recommendation of the commission on technical instruction, which relates to a different sphere of instruction, and refers to institutions such as the Arts et Métiers, Ecole Turgot, Ecole Chaptal, &c., not contemplated by this law on special secondary instruction. This law is for the purpose of organising a special development of the commercial schools or colleges to give, in the words of M. Duruy, 'cet enseignement intermédiaire qui, par en bas, confine à celui de l'école primaire, et par en haut se rapproche de celui des Lycées.' The schools

schools answer in fact to our commercial schools, such as those at Peckham, Rippenden, Pinner, &c. The course of education is arranged for five years, including a preparatory year, besides certain subjects of science, moral and religious instruction, French literature and language, history and geography, one or more living languages, drawing, music, &c. are included. This course is instituted as stated in the instruction of the minister to meet the wants of those who have not the means to pursue a course of seven or eight years' instruction at a lycée, without which full course, nearly all the advantages of a classical education would be lost.

"I was aware that such a system of non-classical education had been introduced, but I had no conception from the way the question was put, that the Chairman referred to it, or I might have pointed out the immense difference between it and the instruction contemplated by the Commission on Technical Instruction, and that there was no conflict between the two actions or recommendations. Indeed, Mr. Samuelson, in his letter to your Lordship of the 16th November 1867, page 20, after pointing out that the term 'special instruction,' appears to be ill-chosen for their schools, proceeds 'entirely distinct from the preceding are the technical schools proper,' and he then describes those which are referred to in the Report of the Commission of 1863.

"The corresponding class of schools to those contemplated by the law of 1865 has in England been considered by the Report on Middle Class Education. Possibly the Committee on Scientific Instruction may also consider this subject. All I would wish to point out is, that this is entirely removed from any existing action of the Science and Art Department, that the instruction in all the schools being alike, it is possible to train teachers for them, and that this possibility in no way affects the reasoning of the French Commission of 1863 on Technical Instruction, which is based on a consideration of the advantages of stimulating and encouraging local action, and points out the necessity for looking to local means alone to supply the different local wants, which, from their great variety, render especial training of teachers by the State inadvisable, if not impossible. The experience of the Science and Art Department has fully confirmed the justice of this reasoning.

"I have the honour to be, my Lord,
"Your Lordship's obedient servant,
"W D Donnelly,
"Captain, Royal Engineers

"The Right Hon the
Lord Robert Montagu, M P"

Capt W. D.
Donnelly.
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DR LYON PLAYFAIR, C B, called in, and Examined

997 *Chairman*] I BELIEVE you are Professor of Chemistry at the University of Edinburgh?—I am

998. You have had very considerable opportunities of becoming acquainted with the system of education and scientific instruction in this country?—I have, both as a professor, and for some time as one of the joint secretaries in the Department of Science and Art.

999. You have been engaged on all the exhibitions which have been held since 1851, have you not?—I have been engaged on all of them.

1000. Including the Industrial Exhibition which was held in Paris last year?—Yes.

1001. You were also engaged in the organisation of the Science and Art Department in 1853?—I was.

1002. You were connected with that department until 1858, I believe?—I was

1003. You were then appointed Professor of Chemistry at Edinburgh?—Yes

1004. That appointment gives you much experience as to the scholars of the university, does it not?—It does

1005. You have, I believe, formed the strongest opinion in favour of a more extended machinery for teaching science?—I have since 1849 repeatedly published my opinions on the subject.

1006. Will you be kind enough to give us briefly your views upon that subject?—My views are that with the improvement of locomotion throughout Europe, the value of raw material as an element of manufacture is decreasing, while the value of increased skill and intelligence is increasing: that increasing skill and intelligence in manufactures become more important than any advantage which this country may possess in the abundance of its raw material.

1007. That is speaking generally, of course?—

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—Yes, speaking generally, that is the basis of the argument.

1008. With regard to the manufacture of iron, for instance, in which we certainly possess very great advantages, and in which the raw material forms a large proportion of the cost, you would still say that superior skill, if it existed abroad, would, to a great extent, balance those natural advantages which we possess?—I do say so, particularly with regard to that manufacture. One condition in the production of iron is carried on with far more science abroad than it is by most manufacturers in this country. They analyse the ore, and the limestone, and ascertain the value of all the fuel which they employ, so that they combine them with such scientific skill, that they are able to produce iron cheaper than we can. In this country there are a number of manufacturers of iron at this moment who are not paying their way, and are asking advice of the chemist to aid them in their manufacture, on account of their ignorance of science.

1009. You think that abroad they are producing iron relatively cheaper than we are, but not absolutely cheaper, I suppose?—Relatively cheaper, and, I believe, in many cases absolutely cheaper, otherwise they would not compete with us in the iron manufacture as they do, not in an isolated way, but constantly. The case mentioned by Mr. Cole is far from isolated. There is, at this moment, a large house building in the centre of the iron district in Glasgow, which house is being supplied with girders from Belgium, and not from the iron districts in its immediate neighbourhood.

1010. Are you not aware that similar girders are made in this country?—Yes, and very good ones

1011. And that for years the manufacture of those girders was a monopoly of this country?—

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I have no doubt that a successful patent at one time gave us a monopoly. It is only recently that foreign countries have been competing

1012 Are you aware that, in consequence of its being a monopoly in this country, the same amount of capital could not be devoted to that manufacture as in other countries when there was no monopoly?—I think it is very probable

1013 Then would not you rather modify your opinion with regard to this being a proper instance to give of foreign competition successfully founded upon superior scientific knowledge?—It is only one out of numerous instances, but I am much struck with the fact that it is possible, under any conditions, to send over such rude substances as those large girders into the very centre of an iron district of our own kingdom. If it was a manufacture implying high mechanical skill with very much labour you could understand it better.

1014 In what way do you consider that the competing manufacture abroad of those girders proves that there is superior scientific skill there?—In the first place, I think the production is carried on in a more economical and skilful way, otherwise competition would be impossible. Although the great improvements in iron making have chiefly arisen in this country, we have far from exhausted the economy which science offers to the art. There is upwards of 75 per cent. of the fuel used in making iron which is absolutely lost in England. There is a vast economy still to be arrived at. And I believe there is cheaper production abroad in many cases, only from the science that is applied to it, while there is also a diminished cost of labour, which partly arises from the intelligence used in the application of that labour. That is only one instance out of many instances which I could mention.

1015 Without discussing the question with regard to superior skill abroad, you are of opinion that there should be a more extensive machinery for giving science education in England?—Very distinctly.

1016 And you believe that the result would be beneficial to our manufactures?—I do believe the result would be highly beneficial to our manufactures.

1017 Will you state what course you think might be taken in order to accomplish this?—I must commence by stating that I think we have no chance of putting ourselves into a good position until the whole educational organisation of this country is altered. It is, therefore, a large question. We have primary schools, but these primary schools are not in connection with the secondary schools, we have secondary schools which are not in connection with the higher schools or the universities of the kingdom, or the mechanical technical institutions which may be established, we have, in fact, no general school organisation, and, therefore, I think, until you take up the subject from the beginning, and follow it out you have no chance of arriving at a good result. I will begin with the primary schools. Our primary schools at the present moment aim at very little else than giving a man the implements they need, the knife, fork, and spoon of education, without giving him any of the substantial meat, for which they are alone useful. As soon as he has acquired those implements of education, your school system gives him no means of applying them to the purposes for which they are designed. There is no following out the objects of the

primary schools. I should therefore hope to see a system of half-time secondary schools for working men established, say from 8 to 15 years of age (indeed, I would myself at once go as far as 16 years of age, but probably public opinion would not yet accompany me that length), I would then give inducements for those secondary schools to pass their best pupils by means of exhibitions or scholarships into higher schools, in which science is taught, if they were capable of it. That taken along with what the department of science and art are now doing, would meet the case of working men; though it would not be adapted to foremen and managers of works. With regard to them, I think we must diffuse a knowledge of science more widely in schools, and in large schools in the great towns we must apply our endowments for more specific institutions bearing upon industrial instruction. Perhaps I may be allowed here to quote a case. In my own city of Edinburgh we spend between 50,000*l.* and 60,000*l.* annually in endowed schools, which give an ordinary education to 1,080 pupils, boys and girls. Those endowed schools rarely if ever produce a man above mediocrity, they can point to no distinguished man that I am aware of. They pauperise the middle classes in their education. If the State were to hold an inquiry upon all endowed schools, you might get out of such schools as those in Edinburgh a splendid system of graded schools, covering the whole country with institutions for secondary instruction.

1018 Mr. Bruce] Has no inquiry been held with regard to the endowed schools of Scotland?—No, I hope that a Royal Commission will be issued. They have recently been visited by the Scottish Educational Commissioners, who did not, however, attempt to inquire into their endowments.

1019 Chairman] Did I understand you to say in speaking of secondary education that you would have it commence at eight years of age?—There are two methods of producing compulsory education which already exist in this country, though unconnected; there is the principle of the Colliery Bill which requires that a boy shall have some educational knowledge before he is employed, up to the age of 12; but that is not connected with the Factory and Workshops Act, where he is employed on the half-time system up to the age of 13. I have a strong feeling that the principles of both Acts should be combined, and that you should not employ in labour any child who has not a small primary education; that he should then be taken into the secondary schools on the half-time system, which ought to have much more science in them; and that he should there acquire a knowledge of the science necessary to carry on his work as an intelligent man.

1020. Chairman.] You would allow no child to go to work until it had passed through the primary school?—I would make education the tool for labour, and he should not be allowed to go to work until he had got his education, wherever he chose, whether under the paternal roof or in a primary school. Though I think the most improvident and thrifless parent would urge education on his child, when it became a condition for employment, it would still be necessary to provide through industrial schools for the absolutely neglected child.

1021. Up to the point of the examination which would enable him to pass into this secondary

dary school?—Up to the point that would enable him to pass into that secondary school, that system is carried on in Scandinavia with great success, I have seen it at work myself

1022. In Switzerland and some other countries the instruction is carried on up to 16 years of age for the children employed in factories, is it not?—It is so, and with admirable success, the system of Switzerland is the most typical system that we could follow, they have the best elementary schools, and they have finishing schools besides, which go up to 16 years of age, on half-time work, then, after those finishing schools, they have special industrial schools where students may be educated in the sciences bearing on their profession, of course they have gymnasia and classical schools, which culminate in the universities, just as the industrial schools do in a great polytechnic school, which is, I believe, so successful that it is much more attended than the university

1023 Mr. Bruce] Are those schools so situated as to be fairly accessible?—Yes, they are all under one management, take the Canton of Zurich, for instance, which spends one-third of the whole taxation on their schools, just as we find from one-third to one-fifth of the local taxation used for like purposes in leading towns in America

1024 Charman] But with the exception of the polytechnic school at Zurich is it not the case that almost the entire cost of the education in Switzerland is provided from local sources?—Yes, the polytechnic school is a federal institution, but the others are local.

1025. Is it not your wish to illustrate what you would like to see done here by showing what is actually being done abroad?—Yes

1026 In this country do you think it would be necessary to establish those higher schools *de novo* entirely, or do you think there is already some provision which might be made available for the purpose?—I think it would be much the wisest policy to develop scientific instruction in its relation to industry through the institutions which you already possess, according to the demand for them, than to make a large number of central higher schools throughout the kingdom, (I am not now alluding to secondary, but to tertiary or higher schools) All over Ireland, England, and Scotland you have universities and institutions which, though they are not universities, have educational resources almost equal to them, these might exceedingly well be applied for the purpose of giving advanced scientific instruction as a supplement to secondary schools, both for artisans and for the middle classes, I think it would be well to develop existing establishments as much as possible before you found separate institutions, because you can do it in accordance with the demand as it arises, and by degrees.

1027. Are you aware that in France some of the decaying colleges have recently under a new law been converted into science schools?—I believe they have.

1028. Would you recommend the adoption of a similar course in this country?—With certain of the schools I would I do not think the Universities of Oxford and Cambridge are at all likely to be developed into industrial science schools, nor do I think it is advisable that they should be. It would be better for those universities to prosecute pure science rather than applied science We have in this country the

University of London, King's College, the institution at Jermyn-street, and Owen's College at Manchester, all of which could very well be developed into science schools, teaching applied science. We have in Ireland the Queen's Colleges and Trinity College in Dublin (if it were a little more open in its endowments than it is now), and the Dublin School of Science, while in Scotland we have four universities, all of them readily capable of being developed into scientific industrial schools of the higher class of polytechnics such as we find in other countries.

1029. Why have you not mentioned Durham?—I have not mentioned Durham for this reason: that though it does teach engineering just now, and does pay a nominal attention to science, it is so difficult, or at least it was so difficult, a few years ago to get them to comprehend science in any enlarged aspect, that I have not much hope of Durham That university had a splendid opportunity of becoming a people's university for the great manufacturing counties in the North of England, but being governed chiefly by clerical authorities, who perhaps naturally looked to the traditions of Oxford and Cambridge, the university has not taken root in the affections and sympathies of the population around it. I was once employed as a Government Commissioner to try and get Durham into a state favourable to scientific instruction, but I found the feeling so unfavourable there that I could do nothing.

1030 Can you inform the Committee what is being done in the way of applied science in Edinburgh?—The four Scotch universities for very many years have given much more science instruction than the universities in England, and the effect of that has been that they have got a great hold of the population; there are more university students in proportion to the population in Scotland than there are in any other part of the world, there is one university student for every 866 of the Scotch population, while there is only one university student for every 5,445 of the population in England; and one university student to every 2,894 of the population in Ireland, so that it will be seen that we have got in Scotland much more hold of the people on account, I believe, mainly of our teaching subjects which relate to their future vocations in life We have latterly in Edinburgh established a professorship of engineering, and one also of agriculture We had an old foundation of agriculture, and we have now put it on an efficient footing For the first time, I believe, in the history of British colleges, we have established degrees in technical science equal in rank to that of masters of arts or doctor of medicine, or bachelor in law; our new degrees being applicable to agriculture, engineering, and veterinary surgery

1031. Do you not think that the fact, that a very much greater proportion of the population attends the universities in Scotland, is due in a great measure to the cheapness of the universities?—I have no doubt that it is so, it is that cheapness which makes them the universities of the people, and it is also due to the intimate relations which have subsisted in practice in Scotland between the parish schools and the universities, it has always been the custom for the parish schools to send up lads to the universities, and that is very much promoted by the fact, that we chiefly make the schoolmasters of the

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the parish schools in the universities. We are the trainers of the schoolmasters, and they have naturally a love for their universities, and induce their pupils to go up; formerly a poor lad of promise would be sent up by subscription, or by collections made in the churches to enable him to pay his way in the university. Even now about 50 per cent. of the students pass at once from the parish school into the university, and in Glasgow 70 per cent., if the burgh school is also included as a second step.

1032. You state those degrees have only recently been established?—Yes.

1033. But the applied sciences had been taught for sometime before this, had they not?—Science has been taught, and largely, in its applications, but not with regard to any curriculum or system for industry until now.

1034. Then those degrees would be strictly degrees for technical instruction?—Yes, strictly degrees for technical instruction. We give the title of bachelor in engineering to a person who has acquired the scientific knowledge necessary to enable him to commence the study of practical operations with advantage. We then oblige him to go for two years into the office of a civil engineer, or into the shop of a mechanical engineer, and after those two years' practice, he may come back to us and get the title of (*Scientiæ Mechanicæ Magister*) master in engineering, showing that he has combined in that degree practice in his profession with intelligence in science. We compel him to get that practice in the workshop.

1035. I understand you to say that you thought it desirable to create those technical degrees, although you previously gave instruction, and, I suppose, conferred degrees in applied science?—Not hitherto in applied science. Two years ago we gave degrees in pure science, and we have just matured our scheme for giving degrees in applied science.

1036. Applied science has, however, been taught for sometime, has it not?—No, not methodically; but we have illustrated our lectures in pure science by industrial applications.

1037. Technical courses?—No, technical illustrations only.

1038. How many sons of manufacturers or sons of managers of manufactories, come up to you to receive instruction in pure and applied science?—I have been for 10 years at the University of Edinburgh, and I have never passed a year there without having four or five sons of manufacturers or of managers in my laboratory in addition to these attending my lectures.

1039. How many students have there been in your laboratory?—I have never taken more than 20, in fact, my laboratory will not contain more.

1040. The others would be persons qualifying themselves for medicine or other pursuits?—Yes, no doubt in my general class, which contains nearly two hundred students, many of them come to acquire a knowledge of science for manufacturing purposes, but do not go through a course of practical instruction in the laboratory.

1041. Comparing what is proposed to be done at Edinburgh with what is now being done in Jermyn-street, how should you distinguish between the two?—Jermyn-street professes to be a school of science, simply applied to mining, though it is not so in reality; it has a larger scope than than its profession implies. I do not think we

could make much analogy between the two institutions, because in the university our course of instruction is general and broad, and Jermyn-street is a special institution.

1042. You would have nothing analogous to Jermyn-street, except in the schools of engineering and mechanical science, then?—No; but, perhaps, you would allow me to explain a little here: we should probably have two other degrees, but I do not think it would be prudent at the present moment to propose them. There ought to be one degree in mining and engineering, but we cannot establish that until we have a professorship in geology. There ought also to be a degree for managers of chemical works, which is a very important industry in this country. I do not think it wise, however, to propose that until we get a larger laboratory, which we hope shortly to build; there are, therefore, two large industries at present unrepresented in this scheme of degrees.

1043. You intend them to complete the university of Edinburgh as a technical school?—Yes, having this great advantage, that in immediate physical connection by a bridge, we have the great industrial museum of Edinburgh, which the department of science and art freely put at our disposal, enabling us to use it with all the collections, in the most liberal way for our educational purposes. That is an advantage possessed by no other educational institution in this country.

1044. You have nothing resembling those complete collection of specimens illustrating geology and mineralogy which we have in Jermyn-street, I suppose?—We have, it is probably the most complete museum with regard to industry in this kingdom; it has not, of course, nearly so many fossils as Jermyn-street, not being at the head of the geological survey, but in its application to mining and all industrial purposes, it is singularly complete, and it is growing very fast. The Government have promised to double its size, and then it will be a splendid museum, it is the only museum which commences with pure science collections, and goes on with their applications to industry. Jermyn-street takes in only the applications.

1045. Lord Robert Montagu.] Was there not a condition attached to that promise of the Government?—Yes, there was a condition that the corporation should widen the street, which is a miserable one at present.

1046. That is the reason why the Vote has not appeared in the Estimates for this year, is it not?—Yes.

1047. Chairman.] But you are quite open to receive this Government grant?—Yes, we are now making a subscription to widen that street, and I have no doubt that the corporation will do its part in the work.

1048. Mr Bruce.] Government spent about 40,000 *l* upon that museum, did they not?—I believe so.

1049. Chairman.] Edinburgh will, in fact, afford a type of a polytechnic institution when all your wants are carried out?—I hope so, we are going to establish also an engineering workshop, not to teach a trade (which should never be taught in these institutions, I think), but merely to accustom the pupils to the use of tools.

1050. The amount of time to be spent in that workshop would be comparatively limited?—No; special engineering students will spend a considerable time in it, we have been able to

to do this, with regard to engineering, all through the liberality of one man, namely, Sir David Baxter, who has already given us 8,000*l.*, and seems to be inclined to give us anything we want for the purpose of improving engineering.

1051 We have nothing in London comparable with what you hope to have in Edinburgh, then?—Not anything so complete, you have got University College, which has a professorship of engineering, and King's College, having a professor of engineering, and also a workshop, both those might very advantageously be made as good as ours at Edinburgh, if the State offered them aid, and if they accepted the aid, at the present moment they are impoverished for want of funds, and do not go on so rapidly as they could wish.

1052 The education at King's College is rather expensive, is it not?—I am not sure; but I should think it was much more expensive than that of the Scotch Universities.

1053 With regard to Jermyn-street, do you see in Jermyn-street an institution at all resembling that which you propose to create in Edinburgh?—For its own speciality more complete I was at one time professor there, and I have therefore a strong feeling in favour of it, but I think there are some points in its organization which require considerable amendment before it receives the success which it deserves. The director of the geological survey is also the director of the school. Now the geological survey requires very great attention, as it is extended all over the kingdom, but the scientific education of an institution like that should have in its direction, whether that be done by the principal or by a council of professors, abundance of time and energy applied to it, otherwise it will not succeed. The professors, with one or two exceptions, have other duties, the professor of geology is the director of the geological survey of England, the professor of mining is mining engineer, I believe, to the Duchy of Cornwall, the professor of natural history is palæontologist to the survey, and so on. They have all of them other vocations besides their educational vocations, that has been a necessity owing to the small amount of salary which they receive as professors. They are obliged to supplement their salaries by taking other offices, and I think that all those matters have operated in preventing Jermyn-street being such a great educational success as the talent and eminence of its professors would seem to point to. Besides, when Sir Henry De La Beche, its former director, died, it lost a man of singular knowledge and foresight, who, from his acquaintance with the mining districts, would probably have forced it into success, although it was founded in advance of public opinion.

1054. But as far as the instruction given there is concerned, you would, I suppose, say that it was admirable?—The instruction is most admirable, and it has turned out first-rate men, but it has not got a large number of students.

1055 The partial non-success of Jermyn-street you would attribute then to the want of confidence on the part of the public, but not at all to any want of excellence in the teaching?—Certainly not to any want of excellence in the teaching, I attribute it chiefly to the want of one man's mind, or two or three men's minds among its council, constantly engaged in making it known, and thinking how to extend it; I never

saw an educational institution prosper, unless there were two or three persons constantly giving to it their energies, there are too many things carried on in that institution to secure the success of the educational section of it. That at least is my opinion, but I speak with diffidence, as I have been long separated from it.

1056 Without any one directing mind being given specially to the subject of tuition?—Just so, there is no directing mind to make the success of the school a special business. This is less required in a university when a *senatus* of professors is constantly engaged in watching its interests. It is more necessary in a Government institution where one man becomes the organ of communication with the Government.

1057 Do you think that the directing mind of an institution like that should be the mind of a scientific man?—The present director is a most eminent man, Sir Roderick Murchison, but he has the geological survey to attend to, and I do not think he has as much time to devote to the educational section as he would like.

1058 Are you aware what is the nature of the connection between the institution in Jermyn-street and the Science and Art Department?—Jermyn-street is under the Science and Art Department.

1059. Is it controlled in any way by the Science and Art Department?—Yes, it is controlled by the Science and Art Department.

1060 In what manner is that control exercised?—Through the president and the vice-president of the council, and of course through the secretary, as being an officer of the Privy Council.

1061. Through the president and the vice-president directly, and then indirectly through the Secretary of the Science and Art Department?—Yes.

1062. In order to control an institution of that kind, should you think it would be desirable that the director of the Science Department should himself be a scientific man, I mean the secretary of an institution of that kind?—No, I do not think that it is of so much consequence; but I think it is of consequence that there should be a change altogether in our higher management of the educational institutions of this country, and that they should all be brought into combination under one Minister of Education.

1063 You were once secretary for science in connection with the Science and Art Department, were you not?—Yes.

1064 Did you not consider it was an advantage that you were a scientific man?—I have no doubt it was both of advantage and disadvantage; when the Science and Art Department was first founded, a minute was passed making the secretary of the Science and Art Department vice-president of the School of Mines in Jermyn-street; I never acted upon that minute, and I do not know whether the Jermyn people know of it. I never acted upon it, because I saw that it was an anomalous thing; in one case was the official superior as representing the president and vice-president of the council, and, in the other case, I was the official inferior of the president of the School of Mines, and I saw that the two offices could not work well together.

1065. But do not you think it was an advantage in the organization of scientific instruction that you, as the secretary, were a scientific man?

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Dr. —I think that in the organization it was an advantage.

L. Playfair. 1066 Assuming that institutions similar to Jermyn-street were established in connection with the Science and Art Department, would you not consider it desirable that the executive officer of the department should be a scientific man?—Yes, if you have a scientific man, who is at the same time a man of administrative ability.

1067. Have you formed any opinion with regard to the system of scholarships which has recently been created by a minute of the Committee of Council?—I have, and in many respects they are exceedingly good. I think that in asking local efforts to come forward to the aid of the Government in establishing scholarships and to give the means of carrying on the pupils to the higher schools of the country, the plan will answer very well in colleges in Scotland, where for 50*l* a year a student may get a good education, how far it would be the case in England, I do not know, as in England education is dearer. There is one condition of these scholarships which I fear will not suit Scotland, namely, that the scholars shall attend the colleges or the schools, and pay no fees; now, there is no inducement to the professor in such a case to accept pupils, and it is creating a class of pauper students that we in Scotland should not wish, if I am right in my belief that the scheme involves non-payment of fees.

1068 Mr Bruce] The 50*l* in Scotland would be quite enough for both purposes, would it not?—Quite; it is as much as our students have on the average.

1069 Chairman.] It would be to give a premium on receiving scientific instruction in Scotland, would it not, the 50*l* and the remission of fees would be too much?—There would be no inducement to professors who depend for remuneration upon the fees almost entirely.

1070 With regard to the present organization of science classes, can you give the Committee any opinion?—I think the present plan of the Science and Art Department is a very good plan for securing to actual artisans that amount of science which is all that we need aim at in their case. I mean that it is sufficient for the great body of working men to offer them that knowledge which will enable them to carry on their work with intelligence and some understanding of what they are doing, but I do not think that the plan of the department is nearly sufficient to meet the wants of the country in getting skilled foremen and managers of our industries.

1071 Which would you consider the more important thing, getting skilled managers for our industries, or the instruction of the artisan?—I should say that they were both equally important; but the one which would most rapidly act upon the prosperity of the country, is the instruction of the foremen and managers of industries.

1072. In that case you may say, then, that we have begun at the wrong end?—I would say that both ends are right, but that beginning at one end, you will get along more quickly than beginning at the other.

1073 Mr Bruce] The two things, however, are not inconsistent?—No.

1074 Chairman.] But you think that the results might have been better if the process had been reversed?—Yes, the crying want of this country is a higher class of education for the foremen and managers of industries.

1075. Do you think the education of one such person would have a higher industrial value than the education of 20 workpeople?—Certainly; but the education of workpeople is a very important matter, because it will enable clever men among them to exercise their ingenuity much better than they could formerly do it, and we must remember that it is to such ingenuity among the masses that we owe many of our leading inventions.

1076. Mr Bruce.] Reverting for a moment to the first part of your scheme, you proposed the half-time system to be applied to children of the working classes from the age of eight up to the age of 15?—Yes.

1077. You presupposed attendance at a day school up to the age of eight?—I would not make it even absolutely conditional that it should be up to the age of eight, if before that they had the requisite elementary instruction.

1078. But you did assume that the range of subjects taught in those secondary schools would be larger than that used in primary schools?—Yes; what I meant to indicate was, that I think the higher instruction should be more in the half-time schools than in the primary schools. As a condition for this, you must truly make them secondary schools by an examination for entrance.

1079 When you spoke of them as half-time schools, did you mean half-time schools upon the precedent of the Factories Act?—Yes.

1080 And you also said that you would couple with the system of the Factories Act the system just adopted under the Colliery Act; that is to say, refusal of permission to work to those who did not show that they possessed a certain amount of education?—Yes, a small amount of education.

1081. At what age would you apply that refusal?—I am afraid my views are rather advanced upon that subject, at the present moment I would commence by saying that the principles of the Colliery Act in that respect should only be commenced a certain number of years hence, in order to give children time to get the knowledge; then at the end of a few years I would go further and advance in my age, and advance in my requirements; I would say, after a certain number of years, nobody under 15 years of age shall be taken into industrial employment without possessing such and such general knowledge, I would liberate the young person from that half-time system if he had acquired that knowledge; I would make it a condition that he should have a certain amount of information at 15 years of age under the half-time system, but if he had acquired it at 14 years of age, I would liberate him, and let him go into full work if he wished it, in order to induce him to study, but if he did not acquire the requisite amount of secondary knowledge even at 15, I would make it compulsory that he should have that instruction gradually going on, on the half-time system, till he was no longer a legal infant, and so continuing up to 21 years of age, he might go into full employment at 14 if he had the necessary knowledge; but if not, he must go on step by step up to 21 before you allow him to work full time.

1082. In all that you presuppose the existence of a national system of education supplying schools to the whole of the country?—Yes; I presuppose a new organisation of our whole educational system.

1083. Would

1083. Would you insist upon the attendance of the boy at school during his whole time unless he could pass a certain examination, and continue the half-time until he had made still further progress?—Not the attendance at school, I have a strong idea that where knowledge is a tool for work, a great deal more attention will be paid to it in the case of children; I should say, absolutely, that he should have a certain amount of elementary knowledge before he was allowed to work.

1084. Before he was allowed to work at all, even upon the half-time system?—Yes, before he was allowed to work at all, even upon the half-time system, I would insist upon a certain amount of elementary knowledge, wherever he got it, whether at school or at home.

1085. And you would cease to apply the half-time system to him when he had given proof that the secondary school had done its work for him?—Exactly, but the average time would be 15, and if he showed that he had got the requisite knowledge at 14, I would set him free for full work.

1086. What would you do with regard to a boy above 15 years of age, who presented himself for work, but who could neither read nor write?—At the present moment I would permit him to work, because rules of the kind we are now contemplating must be prospective, and a growing youth should have time allowed him in order that he may follow the course of the laws we make. I have been speaking of the principles of these Acts, but the Colliery Act especially, and the Workshop and Factories' Act, in a great measure are not effectually carried out, I do not think they are at all efficient in practice, but I am of opinion that when the Legislature passes an Act of Parliament it ought to take care that it is properly obeyed, it should do that by efficient Government superintendance. The Acts are, in fact, at the present time, in only partial operation.

1087. You think it would require a great deal more inspection than is now exercised to carry those Acts quite into effect?—Yes, a great deal more.

1088. Up to this point, you have applied the system of compulsion, wherever permission to work is sought?—Yes.

1089. Would you go further than that and apply the system of compulsion to those who were not seeking work, but who were at an age at which they ought to be at school?—I have no objection at all in the abstract to any system of compulsion as applied to schools, but I do not think you have a public opinion ripe enough to force the children into school by means of the policeman. I think such force is quite as respectable and humane as the threat of starvation, which is implied when we refuse permission to work if the lad has not a certain amount of knowledge. But you have got the Factories, and the Workshop Act, and the Collieries Act, in partial operation, and accepted by the people, and I think you will get your compulsion much more practically, and much more easily if you make education a condition of employment rather than by driving the children to school with the truncheon of the policeman.

1090. The school system of Scotland may be called a popular system, founded as it is on rates paid by the owners of property?—Yes, the parish schools.

1091. Is compulsion necessary in those districts in which this system exists?—Scarcely; we have nearly the average number of children that we should have.

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1092. The great failure has been in those parts of the country in which no popular public provision has been made for education?—Yes, the parish schools are far from sufficient for the wants of the population, but a great deal has been supplied by denominational efforts.

1093. I think I am right in saying that we have now reviewed your system as far as it applies to the working classes, with the exception of those superior spirits for whom provision may be made for carrying them on to the higher grades?—Yes, the main features of the plan have been gone through; but the general organisation has scarcely been touched. School unions to enable the schools of a district to employ masters on special subjects would require to be a part of the scheme.

1094. Coming now to the education which you suggest should be supplied for those who would be in the position of employers, or overlookers of labour, you suggest that provision should be made by endowments, and other means for teaching science in schools, embracing that particular class?—I do.

1095. You do not propose that Oxford and Cambridge should be opened to that class of students, except for the purpose of learning pure science?—Just so. Oxford and Cambridge might have an enormous influence in improving scientific education, and scientific discovery, in the country, if it opened its emoluments to pure science; but I do not think that Oxford and Cambridge have got the feeling or the faculties for teaching industrial science, nor do I care that they should do so, if they gave an impulse to the teaching of pure science, and spread it through the schools of the country, which they would do if their large endowments were open to scientific scholarships, on equal terms, and in equal number with their classical scholarships.

1096. You would relegate to other colleges than Oxford or Cambridge, and other superior schools, the task of teaching applied science to those classes of whom we are now speaking?—I would.

1097. In order to enable young men of superior talent, although of humble origin, to enter Oxford and Cambridge, would you make it a necessary part of the matriculation examination, and the subsequent examinations, that they should be acquainted with one or both of the classical languages?—I think a university is bound to see that all its students who aspire to a degree should have a liberal education. In the scheme for scientific degrees, which I have laid on the table, we require that all students who take our degrees in applied science, should be examined in the following subjects before they can take the degrees; they are the general subjects of a liberal education, Latin, Greek, or two modern languages as an alternative for Greek, then English, of course, to which we add logic, arithmetic, and the elements of mathematics and mechanics.

1098. When is that examination applied?—Before the applicants are allowed to count their years of attendance for the degree. All students may take the advantage of the clauses for the study of scientific subjects without this liberal education, it is only essential to the attainment of the university degree.

1099. You would be prepared to close the access to Oxford and Cambridge to any young man who should have qualified himself by superior knowledge of science, yet who should have neglected, or had not had the opportunity to

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learn, Latin or Greek, and those other branches or knowledge which are not usually taught at elementary schools?—As in the Scotch and German universities the want of a liberal education should not exclude students from attendance at classes, but only from university honours. These from their character are broad in their conception, and do not thereby indicate a certificate of proficiency in one or two subjects. An intending graduate would find himself at such a total disadvantage unless he had received a liberal education, that the universities would not suit him. Before he goes up to a university as an undergraduate, he should at least acquire the elements of a liberal education.

1100. At those secondary schools for the working classes, would you propose that Latin should be taught?—My own preference would be to have two classes of schools, in one of which, the secondary school, the Latin and Greek should form the predominating subjects, and the teaching of science the subordinate, and then another class of schools in which the classics should not be taught at all, but science should predominate; or perhaps Latin might be taught, but be made subordinate to scientific instruction.

1101. Do you think that in the former class of schools, namely, that in which classical knowledge was made predominant, a sufficient amount of knowledge could be conveyed on the half-time system?—I am not now speaking of working people, I am alluding to schools of the middle and upper classes.

1102. But, to return for a moment to the secondary schools for the working classes. Will you tell us how a young man of superior talents belonging to the working classes could enable himself to profit by the higher institutions of education?—I have more of a Scotchman's notion on that subject than coincides with English schools, perhaps. All our parish schools in Scotland teach Latin, and, therefore, no working man who has attended such schools, and who desires to go further and pass to the universities, would be kept back by want of knowledge of that subject. But that is not the case in England, because the English national schools do not attempt to teach Latin. If we exclude townbred youths, 70 per cent. of students from the country pass into our universities direct from the parish school without going through the secondary burgh school.

1103. Have you seen the recommendations of the School Commissioners just published?—Yes.

1104. Would you not look rather to the adoption of some system such as they recommend, for enabling young men of humble origin, but superior talents, to emerge and obtain the benefit of the best education, I mean a system which would turn the existing schools in the country into three grades of schools, supplying the means of advancing the students from one class to another, so as to carry them on at last to the highest class?—My own sympathies are entirely with that view. I would not myself make Latin a *sine quâ non* for the universities, as I would be content with other evidences of mutual culture; but I believe that the universities themselves are so thoroughly imbued with the notion of the necessity of it, that you would not get them to go into an educational system that did not include Latin.

1105. Would you then make two classes of schools, a class of schools for the education of the

poorer classes, at which education would practically cease at 14 or 15 years of age, and then another class of schools, at which education might be carried on by successive stages, by means of scholarships and endowments?—Yes, the utmost facilities should exist for enabling youths of promise to pass upwards through graded schools to the university. If you had these, the old traditions of our universities, that there is no human culture except by means of Latin and Greek, would sink into the errors of history.

1106. Lord Robert Montagu.] I think one of your objections to our Minutes of the 21st of December last year was, that we stipulated for the free admission of students to the institutions?—Yes, if I am right with regard to the fact that you do so, I know that it is included in the scheme now under consideration by Mr. Whitworth, for scholarships, and I have taken objection to it, in the draft which he was good enough to submit to me.

1107. Are you aware that the condition of the remission of the fees is only applicable to those cases where a local contribution is raised, in connection with an institution?—Yes; I know it requires a local contribution; but suppose Roxburgh raises 25 *l.*, and that you furnish the other 25 *l.* for the scholar, to send him to Edinburgh, I understand that the condition would apply in that case.

1108. If the locality chooses its own institution in which the exhibitioner is to be educated, it must remit the fees?—Yes.

1109. But if the boy selects the institution to which he is to go, the fees are not remitted; are you aware that that is the case?—I was not aware that that was the case.

1110. Chairman.] In the case of a boy being sent to the University of Edinburgh, he would have his 50 *l.*, but the University of Edinburgh would not remit his fees?—No, we should not care to accept him on that basis.

1111. The Government could not compel you to remit his fees, except in institutions connected with the Government?—I understand it this way, that suppose Roxburgh gave 25 *l.*, Roxburgh would have to pay the fees.

1112. Lord Robert Montagu.] Suppose Roxburgh has an institution of its own, if that institution had not to remit the fees, it would come to this, that the higher the fees Roxburgh imposed, the less need would there be for the local contribution?—Certainly.

1113. Are you aware that the Hartley Institution at Southampton asked of us if a remission of fees to the extent of 25 *l.* would be counted as a local subscription to that amount?—I was not aware of that.

1114. Nor also that the same institution asked whether the remission of 10 *l.* in fees would not also count as a 10 *l.* subscription?—No, that is clearly not what is meant by the Minute.

1115. You were only thinking of preventing that evil consequence, I suppose?—I am only anxious that while you protect the grant from abuse, you should not create a paper set of students who would be looked down upon by other students in the university, and be of little interest to the teachers.

1116. But if the case is as I have suggested by my questions, your objection would be removed, would it not?—It would; if you encourage the localities to contribute their quotas, and send up
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their students to other institutions totally unconnected with them.

1117. Then it would come to the same thing?—Yes.

1118. You have spoken of iron being produced cheaper abroad, and you said you thought it was due to the fact that there was less useless expenditure of forces in the foreign manufacture?—Yes, in the cases of which I was thinking, every day, or at all events every week, the minerals are analysed and put together exactly in the proportion in which they are requisite, without there being any waste. Now, I have examined into the manufacture of iron in this country, I was once on a commission for this purpose with Professor Bunsen, under the British Association, and we found in the course of our investigations the greatest amount of waste going on. There was no analysis made by the manufacturers, but by practical experience they threw a certain amount of material together, without examining whether the material altered day by day, or week by week, in fact, they did not possess the chemical knowledge requisite for the purpose. At one of the places where we made that investigation, and where they had carried on the iron manufacture with great success, they applied to me a few weeks ago to send a chemist, in order that the manufacture might be conducted with scientific economy.

1119. And you think this diminution of manufactured produce is due to the want of scientific education in the managers of manufacturing firms?—That is my opinion.

1120. But not to the want of technical education in the working people?—I think the word "technical" is a word very much misunderstood, what I mean by it is scientific education which can be applied to industry, but not the teaching of trades in any way.

1121. What I mean is this: that the difficulty exists in the managers of the works more than it does in the working people?—I think that if working people had more scientific intelligence, they could more readily be shown what were the causes of this waste, and they would use their processes with more economy.

1122. But the particular effect to which you allude is due to the want of scientific education in the middle classes?—It is so.

1123. When you said it was desirable to have a more extended scientific education in England in order to increase our manufactures, you meant, I suppose, that you would desire to give to the middle classes a more scientific education?—Yes.

1124. Do you think it would be right for the State to pay for the scientific education of the middle classes?—I think it would be perfectly right for the State to do as they are doing now, and have been doing for many years; namely, to pay in the way of endowments to the universities to enable them to educate the middle classes in the applied sciences which they require, the State has done so in a small way for the Scotch universities, and with great advantage. In such directions I think it would be quite just and proper for the State to take action; again, I think that if there were a strong local feeling for industrial education in a district, shown by local rates and contributions, it would be wise and just and economical for the State to come to the aid of that locality, even if it were the middle classes who were assisted by the State. The

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middle classes contribute largely to the taxation of the country, and are entitled to receive some paternal assistance from the Government.

1125. But in the case of the endowments of universities, and of the aid given to increase the sums raised by localities, the end would not be so much the increase of manufacturing produce as the improvement of the minds of the middle classes, I suppose?—It would be to teach the middle classes the sciences which they were afterwards to employ in the industry they had to pursue, but it would at the same time improve their minds, it would have that double effect, because those sciences are capable of being made useful in their occupations.

1126. Mr. Dixon] Have you any acquaintance with the primary schools of England?—Yes, a general acquaintance.

1127. Do you think that the certificated teachers in those schools might be so trained as to give the children a little elementary knowledge of science in addition to the three R's?—I think teachers might give their pupils sufficient to form their tastes, and to induce them to pursue the subject; for example, in chemistry, if they gave them sound knowledge of the physical and chemical properties of air and water, it would be a great gain to them, and would give them a taste which would induce them to follow out the subjects more thoroughly in secondary schools on the half-time system, or in the evening science schools of the department.

1128. You see no reason why the teachers who receive certificates from the State, and who have been trained up in training colleges, should not have given to them this necessary power to teach that elementary knowledge in addition to reading, writing, and arithmetic?—On the contrary, I have seen many teachers who have acquired such knowledge, and have used it with great effect in the schools.

1129. Do you think it would be desirable that the Government should direct special attention, and give special encouragement, to the acquisition of such knowledge by those teachers?—I think so, it would be much more useful than many subjects in which they are compelled to have a knowledge now, such as the extreme attention which is paid to mere descriptive geography, without connecting it intimately with physical geography, through which they might learn a good many of the elements of science.

1130. Chairman] Is not that done in the continental schools very much?—Largely.

1131. Mr. Dixon] You would recommend, in addition to the teaching in primary schools, that some elementary teaching should be given which would lead the children up to a taste for scientific instruction?—I would give inducements, but at the present moment the payment on results system, which I think contains within itself an admirable educational spring, may operate in favour of lower instruction, but detrimentally to higher instruction. I last week examined a school in Linnithgowshire, in which I found immense attention given to the three R's. On asking the reason, I found that the inspector was about to come round, but there were few boys in the school who could tell me whether the world was round or square, or what was the constitutional object of having a queen or king, and only a few boys who knew the name of the queen who now reigns over us.

1132. Mr. Bruce] Yet at that school the pay-

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ment was not made on results, and they would only have been refused if the results were gross failures?—Payment on results is not enforced in Scotland, but the examination is by results, and a favourable or unfavourable report depends upon their position under the revised code.

1133. Mr. Dixon.] Suppose this elementary teaching in science were given in primary schools, do you not think that those particular schools where that instruction was given would also be more successful in teaching the three R's?—I think that there is a great advantage in payment by results, but I think that some modification would make it advantageous to the higher instruction as well as to the lower instruction.

1134 You said, I think, that you thought that if scientific instruction were to be given to the middle classes, the result would be very beneficial with regard to the industrial prosperity of this country, and would therefore increase the national wealth?—That is my belief

1135 Do you not therefore think that if Government funds were judiciously spent in the promotion of the scientific education of the middle classes, a full return might be expected to the Government from the increased taxation of the country?—Yes, I think the investment would be an admirable investment in that sense

1136. And therefore, that even in those localities where there do not happen to be very benevolent and public-spirited individuals likely to come forward and to encourage science schools, the Government would not be spending unwisely if it were to do something towards the origination of schools in such places?—I am not so sure of that, because the Government has frequently aided education much in advance of public opinion. In the case of Jermyn-street, for instance, Government was far before the demands of the public. There is no doubt that a school of mines should be very important in this country, but going so much in advance of public opinion, that school has not been so successful as it might have been, in consequence of the want of public demand. Government sowing only on its own perception of right, will be a long time before it reaps any harvest.

1137 Why could not the Government do in any district what Sir David Baxter has done for Edinburgh?—Sir David Baxter acted upon the demand of the public; as a benevolent man he came forward and met the demand, and came to the State, who supplemented what he did. He gave a capital sum which produces annually 200*l.*, and the State 200*l.*, but that was in answer to a strong public demand expressed by the public will.

1138 Mr. Atrold.] You have been alluding to factory education, perhaps you are aware that where that education is carried to the greatest perfection, children are received in infant schools from three to eight, and taken as short-timers from eight to 15, and then coached on in evening classes?—Yes.

1139. You recommended the application of the half-time system to the system of examinations which is now taken in coal mines?—Yes. I recommended it as a supplement to the small amount of education required as a preliminary to employment under the Collieries Act.

1140 If you carry that out in connection with factory education, might you not have a pass examination for a short-timer at eight years of age, so that he would not be allowed to enter a mill unless he were able to read (putting it at a mini-

mum as a condition of work) after that, at thirteen years of age, you might again adopt a higher examination as a pass examination for full timers?—Yes, only I think if you had your examination in the primary school as a condition of work, your half-time schools might rise much in their instruction, and therefore you might be getting your secondary instruction in your half-time schools, instead of spending so much time in teaching the three R's, which is their chief vocation at present. My object is to convert half-time schools into efficient secondary schools for the working classes, who at present do not enjoy the advantages of a progressive education.

1141. Perhaps you are aware that in many of these factory schools English grammar and social economy are taught?—Yes, in some of them.

1142. You would not have primary and secondary instruction altogether distinct, but both carried on in the same building?—Just so

1143. In respect of the education and foremen and managers of works, I think you rather assumed that the character of the education should be of a higher grade than that of the artisan class?—Yes

1144 Having in view very large works, where the foremen and managers can receive a large salary, I suppose, but you are aware that in some smaller establishments the foremen or managers would hardly be able to afford that higher instruction?—They might get instruction in the half-time schools if these were made secondary, as I suggest

1145. Do you receive students from the provinces in connection with your laboratory?—Yes, I have sent several students to iron-works

1146 Lord Frederick Cavendish.] Do you find that there is an increasing demand in large manufactories for instructed managers?—Yes, I do. There are much larger salaries given than formerly. I have at this moment one of my pupils in London, who is in treaty for entering a manufactory here, commencing at 300*l.* a year, as a young chemist, with prospects of a considerable increase, and there are a great many such cases. Where salaries of only 100*l.*, or salaries like that, are given, the knowledge which is required must be of a very elementary character. I know numerous cases where young chemists get 300*l.* or 400*l.* to begin with.

1147. Chairman.] If you heard, then, that in large works a salary of 100*l.* was given, you would assume that there were some accessory advantages to the man who accepted that salary, for example, that chemistry would there be learnt in connection with the mysteries of the trade there carried on?—Partly that, or else that the manufacturer did not want the man for anything more than examining his soda ash or bleaching powder, or something of that kind

1148 But if a good man were to accept a low salary, it would be with a view of learning something, and then probably he would only stay a few months and go away?—Yes, certainly; if he were a good man, he would not accept a salary of 100*l.*, with the intention of remaining.

1149. Lord Frederick Cavendish.] Is there a demand for a greater number of such men than could now be educated in our existing institutions?—I would not say that, it is only the more intelligent and advanced manufacturers who make the demand, so that there is, perhaps, just as great a supply as there is a demand just now

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1150 If, then, in past years, the Government had educated, at the public expense, a large number of young men for this purpose, the probability is that they would not have found employment?—I think so

1151 Do you find that the number of young men wanting scientific education is increasing?—I do not find my classes increasing, but then they have always been large

1152 But perhaps you may have heard what are the facts in other places?—We have found sufficient demand to induce us to establish degrees in science, which shows that the demand does exist.

1153 *Chairman*] There is a very large increase in the number of students at Owen's College, Manchester, is there not?—There is a large number of chemical students

1154 An increasing number?—Yes

1155. Is it not the fact that there are more applicants than the laboratory can accommodate?—Probably, I have no doubt whatever that if in Edinburgh we had a tolerably respectable laboratory, there would be an increasing demand. Even though it is not a manufacturing town, like Manchester, I should like to see the Government give aid to the building of two or three good laboratories throughout the country. Prussia has lately built two, one in Berlin and another at Bonn, at a cost of about 50,000*l* each. Leipsic has also built one for herself on a like scale. In this country we have nothing at all to compare to these

1156 *Lord Frederick Cavendish*] Do you imagine that there are many young men who are seeking such an education, but who cannot get it for want of the necessary facilities?—I would not say there are many, but I sometimes receive letters from young men of merit desiring such an education, and saying that they cannot get it. There is one science teacher, whom I have in my mind just now, who wrote to me that he had got a great vocation for science, and I found that he had. He had no means of acquiring the necessary knowledge, but we managed to get the means, and he is now one of the best science teachers in this country.

1157 *Mr. Read*] Would you allow no boy to be employed in agriculture unless he could read and write?—I would.

1158 And after that you would say that he should go on the half-time system, but what would be the nature of his studies then?—That would be according to how he had passed in reading and writing, I suppose it would be carrying on his reading and writing further, and acquiring some knowledge of food in relation to agriculture, what he was growing, and so on, which would be learned in secondary schools

1159. Would you have him learn anything of the application of mechanics?—Certainly

1160. The University of Edinburgh has done something, and contemplates doing something for agriculture?—Yes.

1161 Is that the case with the other Scottish universities?—No, ours is the only Professorship of Agriculture in the kingdom in connection with an university. The professorships at the Queen's colleges did not succeed, and they were abolished.

1162. You have a good agricultural museum in Edinburgh, have you not?—A fair one, in connection with the Industrial Museum

1163. Do you think it is possible that institutions like the South Kensington Museum help

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agriculture at all?—I think that all industrial museums should have a section devoted to agriculture, for it is, without exception, the most important of all the industries, and therefore deserves encouragement

1164 *Mr. Aceland*.] Do you think it would be practicable to give scientific instruction generally to ordinary practical farmers, taking into account the fact that they must early in life make themselves well acquainted with the habits of animals?—In properly constituted secondary schools, farmers might learn a great deal of the sciences which bear more immediately on their avocations

1165. Do you think that if the standard of general education rises among agriculturists in England they will appreciate a direct scientific instruction?—I think they will; I have always in my own class a certain number of farmers who come to study chemistry, and they even study it practically in my laboratory.

1166 At what age do they generally come?—From 17 to 19 years of age

1167 With regard to towns, do you think it necessary, in order to help our large towns to derive the advantages from science which are necessary to enable them to make money, and to conduct their manufacture profitably, to subsidise them largely from the Imperial funds?—I do not think so, I think there is a great deal of wasted endowments in the country, and in a great many cases they would be sufficient.

1168. But suppose there were not endowments in a particular town, do you not think that the useful application of science, as a matter of general policy, ought to find its own reward in the gains of those who make money by it?—When you have given a taste for science in our public schools, and made it a part of public education for every boy, that state of things would arise, but under our present system of scholastic education there is no taste for it, and no demand from the boys.

1169 Assuming that we put our endowed and other public schools on a satisfactory footing, should you think it necessary to prolong, as a permanent arrangement, grants from the public treasury, for the purpose of teaching science?—Certainly, in our universities and higher schools of that kind. I would not ask for endowments for special schools in every town, such as Leeds or Bradford

1170 But why should Parliament be called upon to provide for the middle classes the money which is to pay for their instruction in a particular subject which is profitable to them?—Because under the method of education which it has adopted in this country, it has never given the encouragement to this kind of knowledge, which is so necessary. Hence our nation has fallen behind in the race of industry, and must rectify its errors, and give the necessary impulse to the minds of the people

1171 Your answer, then, goes only to this, that it is a temporary evil, which should be remedied by temporary measures, but you would not say that the teaching of science for profitable industries should be a permanent charge on the revenues of the country?—As soon as you have created the demand, I think that might cease.

1172 *Mr. M'Lagan*.] Are you aware of the attempt that was made to teach chemistry in the schools of Scotland?—No.

1173 Was that school in Linlithgowshire of which

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which you speak in an agricultural or in a town district?—It was in a manufacturing district; and had only been opened for a few months.

1174. Do you think that payment by results, and inspection by results, is a barrier to the introduction of chemistry into schools?—No, I think that if the system of payment by results was modified, and brought into harmony with higher kinds of instruction, it would give a great stimulus to all kinds of education; but the present limited method induces teachers to address themselves to the lower branches of instruction, to the neglect of the higher branches.

1175. Mr Bruce] You are aware that there is a Minute for giving direct payments for examinations passed in the higher subjects, are you not?—Yes; but I would make those much higher, and I would make the others the condition of winning them. I would not make the three R's the great means of paying schools, but rather make them the necessary conditions and first steps for winning rewards in the higher branches.

1176. But is chemistry a subject which could be taught in elementary schools?—I do not think that chemistry, as a science, could be taught in elementary schools, but certain ideas of it could very well be conveyed there.

1177. Chairman] The properties of bodies, in fact?—Yes, something very elementary.

1178. Mr McLogan] Have you given any evidence with regard to the Watt Institution in Edinburgh?—No, and I am glad the honourable Member has called my attention to it. The mechanics' institutions in this country have largely failed in teaching science to workmen, but the Watt Institution has been eminently successful. It has always six or seven hundred pupils attending it: they have systematic instruction in science for working men.

1179. Of what class are the pupils?—Working people, artizans, and attendants in shops.

1180. Mr Bruce] To what do you attribute the success of that institution?—To the fact that the managers, when they started, consulted together on what kind of instruction the working men mainly require, and fixed upon a few subjects; namely, Mechanics, Chemistry, Arithmetic, Mathematics, and Mechanical Drawing.

1181. Mr McLogan] With Physics?—Yes, including Physics; and again, the managers of

the institution were not themselves working men. Working men not having a strong faith in what is required for a particular district yield to pressure from without for every kind of education, so that you have them boasting, as at Huddersfield, that there are 20 or 30 classes, instead of making a much better boast, namely, that there are, perhaps, only four. The managers have since added French, but they refuse uselessly to augment the number of subjects; and the consequence is, that the institution has got on with great steadiness, and is a most important one. I believe one main cause of that is, that the management has limited the curriculum to the known requirements of the city.

1182. Mr Bruce] Is that institution mainly frequented by people of the working and artizan class, and attendants in shops?—Yes.

1183. Mr Read.] Is that institution endowed?—No, it is self-supporting, with the aid of a slight subscription from the townspeople.

1184. Chairman] Is that connected with South Kensington?—No.

1185. Mr McLogan.] Do the classes meet in the day, or in the night?—In the evening altogether.

1186. Mr Bruce.] Do you know why they do not avail themselves of the advantages offered by the Science and Art Department?—There has not been sufficient information in regard to it, but I hope that at the ensuing examination which begins in a few days, a number of students will come forward; the school has been proud of its independence, many of the men having obtained good positions in consequence of being educated there.

1187. Mr McLogan.] Do you know who founded the school?—The late Mr. Leonard Horner was the founder of it.

1188. There was once a Professorship of Technology in Edinburgh, was there not?—Formerly there was. It was abolished from two causes. First, because the Department of Science and Art applied its salary to the director of the Industrial Museum, whom they did not wish to act as professor in the university, and thus the latter had no funds to support the Chair, and, secondly, because the university had larger and broader views of technical instruction, and seen the absurdity of centring all technology into the duties of a single chair.

Monday, 4th May 1868.

MEMBERS PRESENT

Mr. Akroyd
Mr. Bagnall.
Mr. Bazley
Mr. Henry Austin Bruce
Lord Frederick Cavendish.
Mr Dixon

Sir Charles Lanyon
Mr. William Lowther
Lord Robert Montagu.
Mr Edmund Potter
Mr. Read
Mr Samuelson

BERNHARD SAMUELSON, Esq., IN THE CHAIR

TRENHAM REEKS, Esq., called in; and Examined

1189 *Chairman*] You are the Registrar of the Royal School of Mines in Jermyn-street, I believe?—Yes

1190 Can you state to the Committee what are the objects of that school?—The special object is, to teach science in its application to mining purposes

1191. But is that special object strictly adhered to?—I think so, the object is stated more precisely in the prospectus of the college “The chief aim of the Royal School of Mines is to become to Great Britain what the *Bergakademie* of Freiburg and the *Ecole des Mines* of Paris are to Germany and to France”

1192 Do most of the pupils educated at this school enter afterwards into the occupation of mining?—No, I think not

1193 I suppose you have pupils who intend afterwards to follow various industrial pursuits?—I think those who enter the School of Mines with the view of becoming chemists or manufacturers, generally enter specially for chemistry, if they wish to apply that knowledge They would not enter with a view of becoming associates, they would only enter for one course of lectures perhaps, and not go through all the curriculum

1194 You mean that those persons who intend to follow some special pursuit would enter themselves for the classes dealing with that subject, but that those who intend to follow the business of mining enter themselves for the entire course of study?—Yes.

1195 Is there any connection between the Royal School of Mines and the Royal College of Chemistry in Oxford-street?—The College of Chemistry is the Laboratory of the School of Mines.

1196. But otherwise they are independent institutions, are they not?—No, I should say that the college was dependent on the school, in fact, we had a laboratory in Jermyn-street, but it was found so inconvenient that the College of Chemistry was purchased instead

1197 You have matriculated students and occasional students?—Yes.

1198. Can you state what number of matriculated students there have been during the last three or four sessions?—Including the exhibitioners, who are students sent by the Government, in 1863-4 there were 20 associated 0.72.

students, in 1864-5 there were 13 associated students, in 1865-6 there were 13, and in 1866-7 there were 18 *T Rec Esq.*

1199 And during the present session how many have entered?—The account has not been made up yet, but I believe there will be fewer. *4 May 1*

1200 How many of these are exhibitioners?—Three in each year

1201 You have students who are sent up by the Inland Revenue Department?—Yes; they are sent solely to study chemistry, and to attend the lectures.

1202 They are not exhibitioners?—No, they are not.

1203. Are those students numerous?—There are six each year

1204 Are the exhibitioners generally young men who have been trained in any special institutions?—Generally in schools of science under the South Kensington Department, but I believe they are open to all.

1205 But you do not know, as a matter of fact, whence you have received the exhibitioners who have received a special training during the last three or four years?—No, not the Government exhibitioners, but I believe they are generally training masters, or pupils who have been trained under the supervision of the South Kensington Department. I simply enter or register them

1206. That does not concern you?—Not at all

1207 In addition to these exhibitioners and matriculated students, you have a number of occasional students?—Yes

1208 The number of those students is very much greater, I suppose?—Yes; in 1863-4 there were 88 of those students, in 1864-5 there were 72, in 1865-6 there were 73, and in 1866-7 there were 89.

1209. Does that include the students in the Royal College of Chemistry?—It includes only those who attend the lectures; not the laboratornes

1210. Have you any register of those who attend the laboratories?—Yes, it is published every year; but the laboratories are always full with the whole number that they can take.

1211 There is a metallurgical laboratory, is there not?—Yes, there is a metallurgical laboratory, and there are lectures also.

- T. Reeks, Esq.*
4 May 1868.
1212. Do the numbers which you have given include those students?—No; those are simply students who attend at the lectures; but some students attend both
1213. Have you any register of those students who attend the laboratory, are they increasing, or decreasing?—I believe they are very much the same, it is a very small place, holding only eight or ten.
1214. You speak now of the metallurgical laboratory?—Yes, Doctor Percy keeps a record of what the students do, and where they go to
1215. You have also lectures to working men?—Yes, we have lectures to working men in the evening.
1216. Are those lectures very numerous attended?—To the very utmost, many more come than we can accommodate.
1217. There are several hundred auditors, I believe?—The 600 tickets which we issue are all taken, and very many people are sent away.
1218. Is there any condition attached to the issue of those tickets?—None, except that the men must be artizans.
1219. And they must prove to your satisfaction that they are artizans?—They always leave a paper with their name, address, and occupation; they pay sixpence for a ticket for every course of lectures.
1220. And the demand for those lectures is beyond your power of accommodating the auditors?—Very much, especially in physics and other popular lectures
1221. The lectures are delivered by the same professors who teach in the Mining School?—Yes; they teach in the Mining School in the daytime.
1222. The courses consist of six lectures?—Yes; and there are seven subjects taught. Each professor gives that course every alternate year; so that in one year there will be three courses, in the next year there will be four courses; and three courses again in the following year
1223. There is no attempt at class instruction, I believe?—None
1224. It is lecturing illustrated by experiments?—Illustrated by experiments and diagrams, which of course are used also in the school
1225. What are the fees for matriculated students?—For the whole course, extending over three years, it is 30*l*, but laboratory fees vary according to what the student requires: he may go for three, six, or nine months, for each three months he pays 12*l* in the chemical laboratory, and 15*l* in the metallurgical laboratory.
1226. For a nine month's course the fees would be 36*l* in the chemical laboratory and 45*l* in the metallurgical laboratory?—Precisely.
1227. Thirty pounds are payable in advance for the entire course in the Mining School?—Thirty pounds in one sum in advance, or two annual payments of 20*l*
1228. The course is three years, is it not?—The course is three years; it is made optional to the student if he chooses to do the three years' subjects in two years if he can, but very few attempt it.
1229. Mr. *Lowther*] Do you not consider those fees rather high?—No, I think, compared with any other school, they are moderate; there is an objection to making them too low in case of our underselling other institutions.
1230. What are the class of people that come to Jermyn-street chiefly who pay those fees of 45*l* and 30*l* a year?—It is very difficult to say; physicians' sons sometimes. Professor Willis has sent his son Mr. Foster, of the Society of Arts, sent two sons. Then we used to have students from the Turkish Government also. A great many Spanish-Americans attend the school with the view of managing mines, they having property in Peru or the Brazils.
1231. Are those foreigners as well grounded in the knowledge they acquire as the English students?—We have generally found that the Turks are absolutely ignorant almost of the language, but with the Spanish-Americans it is very difficult to say, I think they get demoralised in London, they are not satisfactory students.
1232. Mr. *Bagnall*] How long have those working men's lectures been established?—Almost all of them commenced in 1853 or 1854.
1233. Do any examinations follow those lectures?—No.
1234. Can you trace the results of the lectures at all?—No, I think the men come there for amusement, they attend all the lectures, one is as attractive as another
1235. You think they come for amusement, rather than with any serious intention of learning science?—Yes, certainly.
1236. Mr. *Bazley*] Can you state what are the pursuits in life which the young men go to on leaving your establishment?—As far as I can ascertain, some are employed on the geological survey both here and abroad, one is at Cambridge as a professor
1237. Are there any sons of country gentlemen among the students?—No, I should think not, of the three students who came out as associates last year, one went to Cammell & Co.'s, of Sheffield.
1238. The greater number of those who attend the lectures are not able to attend the regular course of instruction, I suppose?—No, certainly not, they are generally men who are occupied in the daytime.
1239. Do you think that that class of men derive anything from those lectures that is useful to them in their pursuit in life?—No, I think they merely come for self-instruction.
1240. *Four passer le temps*?—No; I think they come with a desire of attaining knowledge. There is another class of lecture in the evening, which is to supply the wants of those who are not admitted to the working men's lectures. There are two courses in the year; anybody is admitted upon payment of 5*s*. for the 10 lectures, but they have not the attraction of the working men's lectures. At Professor Tyndall's lectures, where, on account of the magnificence of the illustrations, besides the celebrity of the lecturer, you would expect a full attendance, we never have more than 250, though we could accommodate 500 or 600.
1241. *Chairman.*] Are ladies admitted as occasional students?—Yes, there are three ladies; one is an occasional student, and the other two ladies are personal friends of Dr. Tyndall; ladies, however, would be admitted, and are admitted as students.
1242. Mr. *Bazley.*] Of all those who have attended your lectures, are you aware of any instances in which young men have received benefit

benefit which could be traced in their subsequent pursuit of their occupations in life?—I should say so in a great many cases

1243 Can you quote any instances of the kind?—Yes; there is one who is now working the Hematite mines at Whitehaven, he attributes his entire success (and he is making 10,000*l.* or 20,000*l.* a year) to the education which he received at the School of Mines

1244 Would the same kind of answer apply to attendance at the evening lectures?—No I should say most of the attendants at the evening lectures come with a view to get general information, or to amuse themselves; lectures on natural history, for example, are not likely to produce much practical result with respect to a man's future pursuits There may, of course, be instances in which attendance at the lectures on chemistry might produce beneficial results in the future, but I am not acquainted with them.

1245 Mr *Akroyd*] In the return of the department, I see, at page 243, a tabular statement of the students entered for the years 1864-5 and 1865-6, and from those statistics it appears that for the year 1864-5 there were only two students who entered for the mining schools, and in the next year 15 students, does that embrace the whole number?—The two are occasional students, in addition to the matriculated students.

1246 What is the total number of students in mining at present on the books?—For the present session I cannot state what it is, probably not more than four or five.

1247. Mr. *Buzley*.] Are the proprietors of mines generally throughout the country aware of the advantages that might be obtained for a young man if he were sent to this institution as a student?—I should say certainly not I think our school sustained a great loss by the death of Sir Henry De la Beche, who had visited all the mines of Cornwall and Devon, and was acquainted with their captans. We were originally established as a School of Mines, but in 1852 our name was altered, and we were called the Metropolitan School of Science, which was of course to the mining world generally a relinquishment of our object. Then, in 1854, Sir Henry De la Beche died, which was a great misfortune for us.

1248 Mr *Akroyd*] I find, in page 19 of your return, the following "Royal School of Mines The number of students entering for one, two, or three years, with a view to become associates, including the eight Royal Exhibitors, has been 13." May I take that as the total number of students, or would you have to add the four or five occasional students?—In the session of 1865-6 there were four students only that passed the examination in mining, including the associates and the occasionals

1249 I find the attendance also under the other departments seems very slight; for instance, in the same page, 243, the number in mineralogy is only six for the year 1864-5, and five only for the following year, 1865-6?—That is so.

1250. In metallurgy there is only one for the year 1864-5, whereas there are five for the following year, 1865-6?—That is so.

1251 Mechanical drawing, there is only one for each year?—In mechanical drawing; our rooms will only hold a certain number, and we are obliged to limit them; in fact we consider it a favour to admit occasional students at all in mechanical drawing.

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1252 In applied mechanics, there are four students for the year 1864-5, and in the following year six students?—Yes

1253. So that, notwithstanding the completeness of your machinery, the classes for whose benefit this institution is founded do not appear to avail themselves of it to the extent which is desired?—That is so

1254 Can you account for that?—I should attribute that to the general indifference of the public to scientific instruction

1255. Have you any idea of the number of students that come from the provinces?—Yes; they come nearly all from the provinces

1256 Have you among them many science masters?—Only those who, I believe, are sent by the Government, the three exhibitors

1257 Suppose it was desirable to increase materially the number of science teachers throughout the country, would not your institution be available for that purpose?—Certainly

1258 *Chairman*.] But Jermyn-street is not a complete science school?—It is not nearly so complete as the recently established college in Dublin.

1259. You give no instruction, for instance, in mathematics?—We give no instruction in mathematics, botany, or agriculture.

1260 You have no chair of civil engineering?—No, and we have no chair for mining machinery.

1261. And no chair for mechanism of any kind?—We have applied mechanics, but not mechanism, there is no chair of surveying.

1262. Mr *Akroyd*.] Seven branches of science are taught in your institution, chemistry, natural history, physics, geology, mining, mineralogy, metallurgy, and, moreover, applied mechanics and mechanical drawing. Now for the various classes for those different purposes, you have, of course, abundant appliances for teaching?—Very ample appliances, indeed, no institution in the country can be more amply supplied

1263 *Chairman*] Except that your space for the purposes of mechanical drawing is very limited?—Yes; we have no class room, and we are obliged to use the library

1264 So that if the number of matriculated students were to increase very much, you would require to increase the accommodation in the class-rooms, or to find rooms for the purpose elsewhere?—Precisely, and if there were one additional professor, we should have no room for him.

1265 Even with regard to the present number of professors, the accommodation for the auditory is very limited except with regard to the theatre, is it not?—Yes, the theatre is large enough, but we are obliged to use it for all purposes Suppose a lecture on natural history is followed by a lecture on geology, the whole of the apparatus and diagrams have to be removed I have no doubt that each professor would like to have a room to himself, for the purpose of chemical lectures, indeed, it is absolutely necessary we have a lecture room at the college for that.

1266 How many will that room hold?—Speaking roughly, I should say that with crowding, it would hold 180 to 200

1267. In the chemical laboratory, how many can work at one time?—Thirty-six to 40, and they frequently press in a few more

1268 In Dr Percy's metallurgical laboratory, how many students are there on an average; I 4 how

T Reeks,
Esq

4 May 1868

- T. Reeks, Esq.*
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- how many would it hold?—About eight or 10 at the very utmost.
- 1269 Are you acquainted with any other laboratories in England?—Yes, generally.
- 1270 Do you know the laboratory at Owen's College, at Manchester?—No; I think there is no other metallurgical laboratory in the country.
- 1271 Do you know the laboratory of the Midland Institution, at Birmingham?—I have been in it.
- 1272 How should you compare that, in point of accommodation, with the one in Oxford-street?—I should say that the one at Birmingham is better than ours.
- 1273 You think the laboratory of the Midland Institution at Birmingham is superior to that in Oxford-street?—That is my impression.
- 1274 Are you acquainted with any of the continental laboratories?—No, I remember the School of Mines Laboratory in Paris. But I believe those are all vastly improved, in fact, Dr Hofmann has left us to superintend the laboratories at Bonn and Berlin. The department have published reports thereon, and those laboratories are really magnificent, they are spending from 50,000 *l* to 80,000 *l* on each.
- 1275 Those are Government laboratories?—Yes, Government laboratories.
- 1276 Can you give us the total cost of maintaining the Mining School in Jermyn-street?—The cost is about 2,400 *l* a year; I am not now speaking of the rent of the building, but merely of the pay to the directors, professors, and teachers, and the cost of illustrations and attendance, it amounts to under 2,400 *l*.
- 1277 Does that include any portion of the staff?—I am not paid as registrar, I am paid by a per-centage on the fees, the professors themselves receive, as a kind of retaining fee, 200 *l* a year, except the teacher of mechanical drawing, who receives 100 *l* a year; there are 400 *l* granted for illustrations for the lectures, and there are two constant attendants who receive 80 *l* a year each.
1278. The school has no receipts from the public then, the fees paid are taken by the professors, are they?—One-eighth of the fees is retained as a repayment for the illustrations, and one-tenth I receive as registrar.
- 1279 What do those figures amount to?—The total in 1866-7 was comparatively large, being 972 *l* 15 *s*, while in the previous year it was 771 *l* 15 *s*.
- 1280 Those were the total sums received?—Yes, fees of all kinds, including the evening lectures to working men, and the associates' fees.
1281. What portion of that would go to the credit of the school?—One-eighth.
- 1282 Mr. *Potter*] What becomes of the rest of the money?—I get one-tenth, and the professors divide the remainder, the fees from the associated students are equally divided—each professor takes that portion of his fees which his students paid in consideration of attendance at his lectures.
- 1283 *Chairman*] Are the laboratory fees included?—No, those are the property of the professors.
- 1284 In both instances, chemistry and metallurgy?—Yes.
1285. Dr Hofmann has resigned the professorship of chemistry, has he not?—Yes.
- 1286 And Dr. Frankland has succeeded him, has he not?—He is not yet officially appointed; Dr. Hofmann had three years' leave of absence granted him to organise those schools in Germany, and in the meanwhile, Dr. Frankland occupied his place, but Dr Hofmann has now resigned, and Dr Frankland will no doubt be appointed to the post.
1287. I see in the Estimates a sum of seven thousand odd pounds for the Royal School of Mines, while you have only accounted for 2,400 *l*. What items make up the remainder?—I was not aware of that sum being in the Estimates.
1288. Would the remainder be the cost of the Geological Museum?—I suppose it might be the rent of the building in which the survey has offices as well as the School of Mines, I believe the sum I give you is the precise cost of the School of Mines.
- 1289 What is the rent of the building?—The ground rent is 800 *l*.
- 1290 But a very small portion of the building only is occupied by this mining school?—A very small portion, the larger proportion is for the museum, and for the offices of the geological survey and the Mining Record Office.
- 1291 The building in Oxford-street is property of the Government, is it not?—They pay the rent for it, the ground is theirs, and I believe it is rented by the Government.
1292. Mr. *Akroyd*] I think some part of the staff at Jermyn-street are engaged in the geological survey, are they not?—The director of the survey is the professor of geology; that is the only one.
1293. Taking those lectures to working men do you think they are of much value beyond that of showing them entertaining chemical experiments?—I think lectures given by men like Dr Frankland and Dr. Tyndall must have some value.
1294. But the value would not be very great unless the subject were pursued by subsequent study?—No.
1295. The evening lectures on natural history, geology, chemistry, and physics are conveyed in courses, and those you perhaps conceive would have more educational value than the others?—There are 10 lectures in a course.
- 1296 Mr. *Lowther*.] Do you consider London is the best place for this college?—It is a great advantage having those professors who are resident in London.
1297. Do you not think it might be better to have this mining school in a mining district?—I do not think so, for you would then lose the advantage of having those first-rate professors.
- 1298 Do you consider that one such college is enough for England?—From the results we have at present, I think it is more than enough, the mining proprietors have not taken advantage of it.
1299. Do you know why that is so?—I can only refer again to the general indifference of the public to the value of science.
- 1300 Do you think it is sufficiently known that the institution exists?—No, I think not. We have one great disadvantage: if a gentleman comes and asks if he sends his son, what it would lead to, we cannot point to any certain results, as they can at the School of Mines in Paris. We cannot assure him that a successful course of study in our school would be likely to lead his son to any good appointment.
1301. You cannot point, in fact, to cases where the education given to anyone at your college, has aided him in his subsequent career?—Yes, we can.

1302. Then would not that be an inducement?
—Yes; but there is no guarantee that we can offer of any such results.

1303. Do you know the mining school at St. Petersburg?—I know that there is one

1304. Do you think that that is prosperous?—I think the miners of Russia are a very distinguished body. There are two colleges of mines established in America, which seem to have taken the prospectus of this institution as a guide.

1305. They have been modelled, you think, after the Institution in Jermyn-street?—I think so.

1306. *Chairman.*] Where are those colleges in America?—One is Yale College, New Haven, and the other is Columbia College, New York.

1307. *Mr. Lowther.*] Do you think the Jermyn-street Institution was formed on a French model?—I should say it was formed on the model of the Ecole des Mines, but at the time our school was established, most of the professors were belonging to the institution in other capacities. Of course it was not established in a perfect condition, the Government were asked for a certain sum, and the best was made of that sum.

1308. *Chairman.*] Has any correspondence taken place between any provincial bodies and the Mining School, on the subject of the establishment of such schools in the provinces?—I do not know of any. Professors have granted scholarships, or exhibitions, to two or three mining schools, one at Cheltenham, one at Truro, and one at Bristol; but not more than three or four institutions have taken advantage of that.

1309. But have you been consulted with regard to the establishment of mining schools in the provinces?—No.

1310. You have had no communication with the North of England Mining Institute of Engineers?—No, Mr Smyth may have had private communications, of course.

1311. With regard to mining, I think you have stated that the most able and successful students in your school have obtained employment abroad?—A great many have.

1312. Has that been the case with regard to other subjects also, besides mining, can you trace the pupils of the laboratory in Oxford-street, and Dr. Percy's Metallurgical Laboratory?—I have no doubt Dr. Frankland, or Dr. Percy, could trace them. A great industry, namely, that of the coal tar colours, originated entirely in Oxford street; three of our assistants are great manufacturers. Mr Perkins was a pupil; but he sold his patent to Messrs. Simpson, Maule, & Nicholson, who were all educated at the college, and they have all made their fortunes.

1313. Does the same thing hold good with regard to some of the paraffin inventions?—No, I think it is Mr. Young who is the great manufacturer in that case, and that it dates before the establishment of the College; but I am not aware.

1314. Has it ever occurred to you that this school might advantageously be converted into a complete school of science?—I think that might be done with very little difficulty, it only requires the addition of one or two professors.

1315. Have you personally any opinion on the subject?—I have only seen the scheme of the college in Dublin; the great difficulty appears to be in catching the students; there is ample machinery

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1316. You are not of opinion, that even if the school in Jermyn-street were made more complete, you would have a much greater number of students?—I have no data to go upon, but I fancy the increase of students has not been very great in Dublin.

1317. But that is quite a recent institution, is it not?—Yes, I believe the students are few, and I do not see that there would be anything to attract a greater number of students in making Jermyn-street a college of science. There is one great want with us, namely, a house in which the students should reside and be taken care of.

1318. You mean a house in the nature of a boarding-house?—Yes; a person will ask now, "If I send my son up to town, who is to take care of him, or look after him?" and we have no answer to give.

1319. You are at a disadvantage in that respect, as compared with King's College, then?—Yes, King's College and University College.

1320. In which the masters receive pupils in their houses?—Yes, there is a hall at University College.

1321. *Mr. Lowther.*] How is that managed in Paris, do you know?—I do not, but I think that the evil might be remedied. At this moment we have an application from the mathematical master at Woolwich, who would be happy to receive students into his house, and give them a general superintendence, but he lives some little distance off, and he would not like to go to the expense of removing to London, though he would, of course, do so if the plan succeeded. The teacher of mechanical drawing, Mr. Edgar, who was an artillery officer, and who now belongs to the church, and is head master of a very large school at Sheen, has given the whole of this subject a great deal of thought, I believe.

1322. *Mr. Akroyd.*] Would it not be possible for him to receive as boarders some of the pupils from Jermyn-street?—It was, in fact, the suggestion of his brother-in-law, who is the professor at Woolwich, whom I have just named.

1323. *Chairman.*] In fact, there is only one of your teachers who is likely to receive pupils?—There is not one who is in a position to receive them.

1324. *Mr. Read.*] With regard to the geological survey, do you now simply map the minerals, or do you take any account of the superficial deposits?—We used simply to map the formations, but last year the Duke of Buckingham ordered the superficial beds to be mapped, and it is now being done, of course that makes the work very much longer and much more difficult.

1325. But how do you do that, do you have a series of maps, or are the superficial beds and the primary strata shown on one map?—That is at present under discussion, we have not got the means yet of distinguishing both on one map; it is very difficult, especially where the maps are very much printed over, or shaded, in mountainous places, at present we have only published one map of the kind.

1326. A map of what district?—I think it is Buckinghamshire, the district in which the Duke of Buckingham lives.

1327. Are you going on with this survey in that way?—We are ordered to continue it.

1328. And you will take notice of those superficial deposits in future maps?—Yes, in fact, the survey is now progressing on that ground.

1329. Of course these geological surveys will

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T. Reek
Esq
4 May 186

T. Reek, Esq.,
May 1868. be of some service to agriculture?—It is precisely with the view of making them agricultural maps that this is done.

1330 Do you analyse the soil?—No.

1331. *Chairman.*] Are many of your pupils employed on the survey?—A great many are on the survey, and in India or Australia.

1332. Then, so far as that goes, students are prepared for their work in this mining school?—The mining school has been of great advantage to the survey

1333. Can you trace the persons who have

been sent up to you from the Inland Revenue Department?—They are sent with the special view of becoming analysts to the department, with a view of detecting adulterations both chemically and microscopically.

1334. And you have six of those officers always in your school?—The department send six every year; they used to send 10.

1335. Is there a sufficient demand for so many as that?—They have a large laboratory with a great number of assistants in the Revenue Department.

JOHN FREDERICK ISELIN, Esq., called in, and Examined.

J. F. Iselin, Esq.
— 1336 *Chairman*] You are one of the Assistant Inspectors of the Science and Art Department, I believe?—I am an Inspector of Local Schools.

1337. Your duties, I believe, are to go and inspect the schools *in situ* in the country?—Yes.

1338 Do you visit those schools at the periods when the examinations are being held?—The examinations are held during the month of May. I am in the habit of going to inspect them when the examinations are being conducted.

1339 During the remainder of the year how do you employ your time?—I employ my time during the remainder of the year as inspector of schools besides

1340 That is to say, you attend during the time when instruction is being given?—Yes

1341. Does your inspection extend over the whole of the United Kingdom?—It has done so, over the whole of the United Kingdom.

1342 But there is another inspector, is there not?—There was another inspector, Dr. Sidney of Dublin; we divided the work between us, but now Dr. Sidney is made Secretary to the College of Science

1343. The whole of the schools in the country are subjected to your visits?—Yes, but the new arrangements are not quite perfect yet.

1344. But, in practice, has any line been drawn between the district visited by you and the district visited by Dr. Sidney?—None.

1345 You visit Lancashire, I believe?—Yes.

1346 Yorkshire, also?—Yes.

1347 And also the London districts?—Yes, all the London districts, and every district except, perhaps, Ireland, which I have not visited so much as Dr. Sidney

1348 Scotland?—Yes.

1349. Speaking broadly, can you say in what parts of England you have found that there has been the greatest sympathy with the instruction given in connection with the Science and Art Department?—I think the two principal districts where our science instruction is most appreciated are those in the neighbourhood of Woolwich, the classes being chiefly attended by artizans from the Arsenal, and the South Lancashire districts, of which Manchester is the centre.

1350 East Lancashire too, I suppose?—Yes; taking in Liverpool.

1351. The whole of South Lancashire and the North of Cheshire?—The whole of South Lancashire and the North of Cheshire

1352 Have you paid any attention to what is being done in elementary science instruction to adults in other districts? I mean do you know whether there are any districts which had not

put themselves in communication with South Kensington, but which are giving science instruction apart from such connection, referring, now, chiefly to artizan instruction?—No; none have come across me at all

1353. But do you believe that any such instruction of importance is being given, apart from South Kensington?—I cannot call anything to mind, except that I believe in Owen's College some few artizans are admitted, but it is an exceptional case

1354 Are they admitted in addition to their usual students?—Yes, in addition to their usual students

1355 We have been told that, in Yorkshire, very much less is being done than in Lancashire?—I am not aware that any instruction in science is given in Yorkshire at all, apart from our schools.

1356. And it is, therefore, in connection with your schools?—It is in connection with our schools up to this moment

1357 Except Halifax, you could not speak of any other town in Yorkshire where much is being done?—Halifax and Huddersfield, but they all come under one teacher, who lives at Huddersfield, Mr Jarman.

1358. What has been his previous career?—I believe he was originally a national school teacher, but, at the time the revised code was established, he did not find it suit his convenience to carry on his profession as a national school teacher, and he took up science teaching. Since then he has established himself as a chemical manufacturer in Huddersfield

1359. Had he any special preparation for science teaching?—I believe that he was entirely self-trained.

1360 You know most of the science teachers, I suppose?—Nearly all of them.

1361. Have many of those received a special training for the teaching of science?—No, very few of them, except those who as exhibitioners are now attending the School of Mines

1362. Do you know how many of those there are, speaking approximately?—I can hardly tell you; but I should say about half a dozen

1363. Out of nearly 200 who are teaching at those schools?—Yes; that is to say, those who have received trained instruction in science; a great many of the 200 were teachers before. Of course, some of them have an aptitude for teaching

1364 But they have not received any special teaching in science in any institution, except the small number you have named?—Except just a few. The number of institutions where they could receive a special training is indeed very small.

1365 Unless

1365. Unless they have been in Jermyn-street, you may almost presume that they have not been anywhere?—Yes, I think so. Some of them may have taken degrees in science, at the University of London.

1366 Are there many of those?—Five or six, perhaps

1367 Bachelors in science, perhaps?—Some of them are doctors. Dr. Burkenhead was, for instance, who is dead.

1368 Are there any other Doctors of Science who are teaching at this moment?—No, but last year Dr Bithell was teaching at Hackney.

1369 Had he any other occupation?—Yes, I think he was in a house of business in the City.

1370 Who is the teacher of science at the Midland Institute in Birmingham?—Mr. Woodward

1371 He was a Bachelor of Science of the University of London?—Yes, I believe so.

1372 Have you found in general that those gentlemen who have had this special training in science in the University or in Jermyn-street are superior teachers of science to those who have not been so instructed?—No, I do not think so

1373 They may know more science, I suppose?—They may know more science, but that does not necessarily give them an aptitude for teaching. One of the most successful teachers we have had been a common mechanic, he had had no experience in instruction at all until he took this up.

1374 But he had not taught before?—He had not taught before

1375 He had not even been trained as a teacher?—He had not been trained as a teacher

1376 Then if any special instruction were to be given, you would think it ought to include instruction in teaching?—I should not like to go so far as that. There is no doubt, I think, as a general rule, that the best teachers we have are those who have been national schoolmasters, and have had experience in giving instruction, but I would not shut out others who have not had such experience on that account.

1377 But, if men were to be specially trained for science teaching, you would think it desirable that they should receive instruction in teaching, would you not?—Yes, I think upon the whole I should consider it desirable

1378 You would consider that almost of more importance than any very great scientific acquirements, perhaps?—Yes, I think almost the first thing that I should like for a teacher would be the power of teaching

1379 In point of fact, if the science instruction in one of the training colleges, such as that at Chelsea, for instance, were tolerably advanced, you would prefer such an institution for training masters to such a school as Jermyn-street, instruction in teaching being given in one and not in the other?—There is one thing more to be said about the teaching of science as applied to industrial manufactures. If we rely on training colleges and trained teachers, we do not get those who have sufficient knowledge in manufactures to apply the science which they know; that is why I think it is advisable to get as teachers those who are themselves employed in manufactures or have a practical knowledge of them.

1380 Then what would you say to Owen's College in the heart of a great manufacturing district where the pupil under training would have an opportunity at the same time of coming

into contact with practical men and visiting their works?—That would be one of the best preparations that he could have for becoming a good and efficient teacher.

1381. So far, you would say that Owen's College would be a better school for a teacher than Jermyn-street, or any existing institution in London?—Yes, I should give it the preference, because of its more immediate connection with manufacture.

1382. With regard to the pupils who are not intended to be teachers, would it also be of advantage to them to be taught in an institution situated in a manufacturing district?—As far as applied science goes, undoubtedly it would.

1383. Have you inquired at all into the facilities which now exist in connection with science schools, for establishing day-classes where they do not exist at present. I mean where evening instruction only is now given, how far do you think it would be possible to attach systematic day schools to the existing science schools?—That would depend in a great measure on the class of pupils you wish to get.

1384 Boys of 15 to 18 years of age?—If they were artizans or employed in manufactures in any way, it would be almost impossible to get them to attend day schools.

1385. But I am thinking of laboratories and cabinets of instruments for teaching natural science; are there many laboratories for experimental instruction in existence which might be made useful during the day time, as well as at night?—A great many could be made useful in the day time, if you could get the proper class to attend, but it is only pupils of the middle class who would be able to attend.

1386. But there are many schools possessing apparatus and laboratories, which are now only used for artizans in the evening, but which might also be used by the middle classes in the day time, are there not?—There are not many connected with South Kensington

1387. Can you mention any?—The Midland Institute at Birmingham has a very good laboratory, and that is open on Saturday afternoons for practical instruction in analysis

1388 They give instruction for six or eight hours?—About six hours.

1389 Can you give any other example?—I do not think that I know any other

1390. Is there none at Oldham?—Yes, but the laboratory is small, and not much used, in fact, I do not think they make use of it at all, and there are only three or four pupils who attend the class in chemistry, that subject does not bear at all on the manufactures of the district.

1391. And at Manchester, except at Owen's College, there is nothing of the kind, is there?—There are some small classes in chemistry in the neighbourhood, there is a school at the Mechanics' Institute, but that has no laboratory.

1392 There is, in fact, no other in existence except that of Owen's College?—There is a laboratory at Halifax, in the Working Men's College and one at the British Trade School

1393 Is instruction given there during the day to the middle class of students?—I think not, but in the evening there is instruction given to an artizan class.

1394. Comparing the laboratory of the Midland Institute with other chemical laboratories which you know, would you say that that was a good laboratory?—Yes, I should say it was a fair laboratory; it is situated quite at the top of

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- J. F. Iselin, Esq.*
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1395. But sufficient instruction in analysis could be given there?—No doubt
1396. And is given there on Saturday afternoons?—No doubt.
1397. Comparing that laboratory with the laboratory of the Royal College of Chemistry in Oxford-street, which is the best?—I do not know the laboratory of the Royal College of Chemistry in Oxford street.
1398. You know, perhaps, the laboratory attached to the Trade School at Bristol?—That is a very good one.
1399. Do the middle class of students avail themselves of that laboratory?—No, not at present; they have started a mining school there in connection with the Trade School, which must, from the fees they charge, be attended by students of a higher social position; they will, of course, use the laboratory in connection with mining studies.
1400. Is there any metallurgical laboratory in the country?—None, except in Jernyn-street, that I know of.
1401. Have you visited the north and the north-east of England at all?—Yes, Newcastle and Gateshead
1402. What instruction in science is given there?—Very little indeed, until last year. We have only got two classes in that district now, one at Gateshead and the other at Alnwick. We used to have one at Newcastle; but the teacher left, and it was not revived again.
1403. Have you had any communication with the North of England Institute of Mining Engineers on the subject of science instruction?—Not that I am aware of.
1404. There was a mining school at Wigan, was there not?—Yes.
1405. Can you tell us anything about that?—It was originally started, I think, in 1858 or 1859; but it did not seem to meet the wants of the population. The inhabitants of Wigan are generally colliers, and the amount of elementary education they possess, is very small; I was of opinion when I first saw it that the school itself would never be a successful one, although the teacher was an uncommonly good one.
1406. Who was the teacher?—Dr. Durkenhead.
1407. Then one of the obstacles to the success of that school was want of primary education in the classes for whom it was designed?—Yes
1408. Is that a serious obstacle elsewhere?—In a great many instances.
1409. You find that there are certain subjects which it is almost useless to attempt to teach, because the people are not sufficiently advanced in primary education?—Yes, to a certain class of pupils, for example, mathematics would be out of the question to the majority of working men; they are not in a position to comprehend a rigid mathematical proof, or even to understand the meaning of a mathematical formula.
1410. In fact, but very few of them can work an ordinary sum in arithmetic, can they?—I dare say it is so; but I do not come across subjects of that order.
1411. Then with regard to the pupils who are taught in those schools, does any great portion of those consist of *bona fide* artisans?—Yes, in some cases, undoubtedly a large portion of them, especially in those places where the drawing subjects are taught, descriptive geometry, and mechanical drawing, which are, of course, a great benefit to a man employed in a machine factory; in fact, practical geometry, to a considerable extent, is to a working man what mathematics is to a more educated man, but we are very far behind the French in practical geometry.
1412. Is that from the want of good technical books?—Yes, partially, no doubt, the subject never having been until lately thoroughly investigated in England so as to be made available in teaching.

DR. JOHN PERCY called in; and Examined

- Dr. J. Percy.*
— 1413. *Chairman* | You are Professor of Metallurgy at the Royal School of Mines, are you not?—Yes
1414. How long has your class been in existence?—Since 1851.
1415. The instruction in metallurgy is given in connection with the general course of the Mining School, is it not?—Yes, some students come expressly for that alone; but still I can state that it is given in connection with that general course
1416. Have you many students who come to you for instruction in metallurgy who do not attend the general courses?—Yes.
1417. That instruction of yours, I believe, is given chiefly in the laboratory?—Partly by lectures, and partly in the laboratory.
1418. The instruction given by lectures I suppose they would have in common with the other students?—Exactly.
1419. Is the laboratory practically confined to special students, or have you also many matriculated students who attend the laboratory?—That section which follows the metallurgical division attend at the laboratory practice, but we have many others who do not belong to that section, and who are only occasional students
1420. With regard to those who are matriculated students, and attend your regular course, do they pay separate fees for the regular course?—Yes, but it must be clearly understood that the Government is not at the sole expense of that laboratory; they find the place, and they find the fuel; but all the working expenses, even the attendant, are paid out of the fees of the students
1421. Then, even with regard to the exhibitioners, if they attend the laboratory course, they would not be free of that course unless they paid the fees?—Certainly not, otherwise I should have to pay the expenses myself.
1422. Would a poor student be compelled to pay the fees then?—In special cases I have remitted what excess or surplus there is in the way of net profit.
1423. But that would be in your discretion?—entirely
1424. In fact, a poor student, although free of the School of Mines, would not be free of your laboratory; and, I presume, not free of the laboratory of the College of Chemistry, in Oxford street?—Certainly not of mine; and, I believe not of the other.
1425. Will you inform the Committee what is your

your course of instruction in and out of the laboratory?—My function is to deliver a certain number of lectures, which must not be fewer than 60, and they generally amount to between 60 and 70. Then the other part is the laboratory instruction, for which I am responsible, and that is the only part in which we really can teach a practical art, that of assaying. Assaying can be taught, and is taught, in that laboratory as practically, I believe, as in any other place in the kingdom.

1426 I suppose the lectures cover the theory of metallurgy, that is to say, you give lectures on the principles upon which the extraction of metals is founded?—Yes

1427 But do you also profess the mode in which the operations are carried on in manufactories?—Certainly, I describe them with as much detail as I can, or, as I consider necessary.

1428. You teach the technology of metals, in fact?—As far as it can be taught; assaying, I maintain, can be taught practically, and it is taught there

1429. Taking, for example, the smelting of iron, you would instruct your pupils in the methods which are pursued in various localities, in order to obtain the desired results?—Yes; I must give the student who came to that course credit for possessing a considerable amount of chemical knowledge, the first thing I have to do, is to establish the data to be applied in elucidation of the phenomena, I have then to describe the special processes and apply the data, which I endeavour to lay down in the first instance.

1430. And you do that, both historically and practically?—Both.

1431 You consider it necessary that your pupils should be taught what has been done, and what has been attempted, and proved impracticable, and also what is being done in the best manufacturing establishments?—Certainly, it is one of the most important parts of my function to show what has been attempted, but without success, in order that the teaching may serve as a warning for the future

1432. You do not think it would be sufficient to teach the principles upon which the processes are founded, but you also teach the processes as they exist?—Yes; that is to say, I describe them as best I can I need not tell the Chairman of this Committee that the processes of metallurgy can only be learnt in the proper sense of the term by actual inspection at the works.

1433 But the instruction which you give is sufficient to enable the students at once to comprehend the process when they see it in actual operation?—Yes; the phenomena which take place in any one process, or in any series of operations which constitute that one process

1434. If you were to confine yourself to principles without illustrating them by the details of what is being done in practice, your pupils would find themselves at fault when they went into any metallurgical work?—Yes, it would be impossible without giving that kind of detailed instruction to conduct such a course with anything like satisfaction—it is not only the metals that we are concerned with—we have first to deal with the general principles of metallurgy, and then to treat pretty extensively of the fuel which is used, which at the present day is one of the most important parts of the whole course, I mean with regard to its economy then we

go into furnace and other materials which are used in metallurgical constructions; then I take metal after metal, describing, first, the so-called metallurgical chemistry of it, and afterwards the mode of treatment in other parts of the world as well as in this country

1435. With regard to the chemistry of metals, do you teach that yourself, or is it the province of a separate professor?—To a certain extent I do teach it, but it ought to be, and it is, the province of a separate professor, if I were to attempt to teach it thoroughly, the course would be extended to three or four times its length

1436 You assume, in fact, that a certain amount of chemical knowledge is possessed by your pupils?—Yes, metallurgy is, to a large extent, a branch of applied chemistry.

1437 When your pupils come to you, do you find that they are tolerably well prepared?—Pretty well; but they vary very much in that respect.

1438. Have you yourself a preparatory course?—No, I have not, they are not compelled to take chemistry at our institution, they may get it where they like

1439 With regard to your formulae, do you find that your pupils with an adequate knowledge of mathematics come to understand them?—Yes, but I wish to say that I decidedly object to the variety of formulae which exists in the present day among chemists, for it is a source of great confusion. Chemists have three or four sets of formulae, and the effect is very much like that of having several different coinages existing in a country at the same time, one of the greatest wants of the present day in chemistry is a general concurrence as to formulae.

1440. With regard to machinery as applied to metallurgy, do you profess that also?—To a limited extent, but that is almost special, and it is a thing that we ought to have taught in a much more systematic way—not only in reference to metallurgy, but to mining, with special descriptions of those machines that are used in mining and metallurgy; that, in fact, is very much wanted.

1441. In Jermyn street there is no professorship of that, is there?—No

1442 You would find it impossible, even if you possessed the knowledge, to combine that with your own course of instruction, I suppose?—I do not think that, but I do not possess the knowledge.

1443. But would it not increase your labour to such a degree, that you would be physically unable to carry out the course?—No, there would be no physical hindrance

1444. But it is not to be expected that a man who is a thorough metallurgist should know that too, is it?—He is perhaps supposed to know all that, but I do not know it myself; in metallurgical works you are aware that mechanical engineering is included.

1445. You do not consider that specially your subject, however?—No, I do not.

1446 But you think it is desirable that there should be a professor of mechanical engineering?—Yes; with special reference to mining and metallurgical machinery, both. I lay great stress upon that. I think you should have such a man as they have got at Freiberg.

1447. Because mining and metallurgy are the special subjects of your institution?—Just so

1448. Besides your matriculated students, have you some students visiting your laboratory?—

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Dr J. Percy We are generally full, and we have frequently had applications which we were unable to receive.
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1449. How many students will your laboratory take?—Ten, at the most.

1450. Do they generally stay with you for a considerable time?—One will remain a month, another three months, another six months, some of them want special knowledge, it may be in assaying iron, or assaying copper, or assaying silver ore, and then we adapt the instruction as far as we can to the special requirement.

1451 I suppose those students are ordinarily adults?—Some are adults, but some are not, I may add, that the list which I have handed in to the Chairman will give an accurate account of the kind of men that we have had at our school, their destinations, and so on.

1452. I find in this list, that some of the students are put down as visiting the laboratory for a very short time only?—Yes, some of them visited it for a short time only; they are going out, perhaps to the colonies, or on some foreign tour, and they want to obtain some special knowledge in a short space of time.

1453 Do you find that those men receive any material benefit from the instruction they get from you?—It depends very much upon the man himself and his previous habits, if you get a man trained in chemical manipulation and dexterous at it, it requires a comparatively small amount of practice in the metallurgical laboratory to enable him to succeed perfectly, but sometimes you will get a man who will devote a long period of time to the study, and he will do nothing after all, while others pick it up with great rapidity.

1454 Of course it is impossible for you to impart any systematic instruction to those who remain with you less than a year?—If they take the whole course, we devote our time in the laboratory specially to the art of assaying, for that is what we find students most require; they obtain in that way information which they can apply to their own pecuniary advantage, and the advantage of their employers, so that the laboratory is to a large extent an assay laboratory; and if the students stay long enough they are taught the modes of assaying all metallic ores and all necessary metallic alloys.

1455 Do you recommend those students to attend your lecture courses?—No; some of them who come up well instructed in chemistry do not require it, we find the state of preparation extremely different.

1456 But for the matriculated students, or such as intend to be matriculated students, would it not be desirable that there should be some preparatory course which should put the students nearly all on a level as far as possible?—I must assume that they have that preparatory information, they are instructed in chemistry by lectures or oral teaching, as well as laboratory teaching, before they come to me.

1457. That instruction is given in the College of Chemistry, of course?—It may be given there or elsewhere, there is no limitation, students may go and get those subjects up elsewhere.

1458. You find that many of them come up who are very well prepared to receive your instruction, do you?—Very well prepared indeed.

1459. Do you in practice know the localities where your students have received that previous instruction?—No, I have not gone into that.

1460. Without going through the list which you have handed in, are you able to say that

there is much demand for men trained in this way for employment in the country, or more demand than there was formerly?—I remember there was a time, say in 1850, when I was continually in metallurgical works in South Staffordshire, and scarcely an iron work in the kingdom had the assistance of an experienced chemist; while now I think I may say that almost every large iron work in the different parts of the country has its own chemist—a well-instructed man, capable of making assays, and so forth. I remember a time when an iron-master would have ridiculed the notion of assaying iron ore, and have been quite ignorant of the term "analysis," now you find that investigations are made at all our large works, and in many cases with the best results.

1461. The late Mr. Samuel Blackwell gave a great impulse to that subject, did he not?—Yes.

1462 Taking lead and copper smelting works, does the same hold good?—Yes, one of the largest works in the kingdom have now a manager at their works who is a most able man, and who was formerly engaged in my laboratory.

1463. You think, on the whole, that scientific knowledge is much more appreciated in metallurgical establishments than it was a few years ago?—Unmistakably so, sometimes we have received applications that we could not respond to, all our really good men have found situations, and some in point of money are doing much better than their teachers.

1464 Formerly, you found that your best men were compelled to go abroad to find situations, did you not?—Since the establishment of the school, the demand for such men has been growing, but I think you will find from the list that many of the men are abroad.

1465. Have you any experience of the French Ecoles Centrales des Arts et Manufactures?—No personal experience. I know the men by correspondence, there is an American Technological Institute, formed about two years ago.

1466. Where is that?—I forget where.

1467. Is it in a district where metallurgical works are extensively carried on?—I do not remember

1468. Do you think it would be any great advantage if a school of the description of the Jermyn-street school were established in a mining district, or smelting district instead of London?—Decidedly, but it depends upon what you want to achieve by so-called science instruction. Is it working men pure and simple you want to teach, or is it foremen and leading men in such establishments.

1469. For the moment, we will confine our attention to what you might call the officers of large works, managers and foremen?—There are many of those men who cannot afford to come to London to obtain the instruction they could get here, we have had many men of that class from different works; some have come twice at intervals of a year or two, they have come from the works direct and remained with us three months, four months, or six months, coming from lead works or copper or other works.

1470. Would you recommend Birmingham or Merthyr, as a better locality for such a school than Jermyn-street?—Birmingham requires, I should say, much more special knowledge of chemistry than is supposed; the trades of Birmingham which depend on chemistry are numerous and very important; it is not so much

the strictly metallurgical work which is carried on in Birmingham, for their manufactures are various, I may mention the manufacture of glass, of soda, of tartaric acid, &c. The trades there are chiefly dependent on mechanical appliances, still we have silver refineries there, and other metallurgical works.

1471. When I said Birmingham, I was thinking chiefly of South Staffordshire?—When you have got an old iron district with old furnaces, where fuel is becoming exhausted, and the iron ore too, it is very difficult to induce men to lay out money in accordance with new ideas; but it has been done, and in the case of the Earl of Dudley's works especially.

1472. Then let us take the Cleveland district, which is comparatively a new one, do you think that a school of metallurgy would be a very great advantage to that district?—I think that a school of that kind would be a great advantage in every great metallurgical district.

1473. But, still speaking of foremen and managers, do you think that a school of that kind would be more available in such a district as I have been speaking of than the school in London?—I do not know that it would, it depends entirely on the class of men and the means of those men. If you allude to foremen, and people of that kind, then, of course, it would be more useful in such a district than in London.

1474. Then, with regard to foremen and people of that class, you consider it important that they also should receive instruction of a similar kind?—It is very important that those men should have the means of acquiring the elementary knowledge which relates to their particular vocation—chemistry, physics, and so on, but I would not attempt to teach them too much; above all things, I should consider the diffusion of a number of cheap and thoroughly good text books on the sciences of their various arts of the utmost importance. That term, science of art, is very much misunderstood, and I will, with the permission of the Committee, explain what I mean when I use it. If we take, for example, any ore, say an ore of copper; copper pyrites, which is compounded of iron, copper and sulphur, we will suppose that there is a certain quantity of silica in it; the problem is to extract the copper from that complex body by the agency of heat and air alone, which is done most effectually. That is done by many operations, not fewer than six. Now, many an experienced copper smelter would be able to conduct the operation perfectly from traditional knowledge and his own experience without knowing a single phenomenon that occurs in the course of the operation. A man who conducts a metallurgical process in that way possesses simply what I call empirical knowledge; but another man may possess that practical knowledge, and at the same time be able to explain exactly what takes place in every one of those operations. That man has what I call a scientific knowledge of the art of copper smelting, while the other has simply an empirical knowledge. It may be abundantly shown that a man who is charged with the conduct of important works and has that scientific knowledge is certain to find it highly advantageous in guarding him from mistakes, and sometimes enabling him, perhaps, to project important improvements.

1475. To the advantage of his art?—Undoubtedly to the advantage of his art.

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1476. You think it is desirable that foremen, and people of that class, should possess elementary scientific knowledge of this description?—Yes, I think they should have the means of getting it. I think it should be accessible to them. It is only a few who are raised out of the many that we can depend upon after all.

1477. And that kind of scientific knowledge you think these men could readily obtain only in case the schools were placed in the districts where they live and practice their calling?—Certainly.

1478. Now, the classes in connexion with the Science and Art Department are intended for teaching of that description to persons of that class, are they not?—Yes.

1479. What is your opinion with regard to the utility of those classes as they exist at the present time?—I think they are doing good work, I have had to examine the examination papers for some years, and I find many of the papers are very satisfactory, while others show very imperfect knowledge; but on the whole I think it is a good and substantial work that is being done. It is very odd to see the variety of trades of the persons who submit themselves to be examined.

1480. You are speaking now of the examination in metallurgy?—Yes, of course, I examine only in the Metallurgical Department.

1481. Mr. Bruce] What do you include under that head?—General metallurgy, the art of extracting metals from ores, adapting them to the various processes of manufacture. Metallurgy is a misapplied word, it does not mean the working of metals, as its etymology will indicate.

1482. Chairman] You mean the conversion of the metals after they have been extracted from the earth?—Yes, metallurgy has nothing whatever to do with raising of metals from the earth. The ore is prepared by the miner, and then he extracts the useful metal and produces it in a form commercially valuable.

1483. Then what classes of instruction would you include under the term "metallurgy," you would, of course, include the chemistry of metallurgy?—Yes, certainly, metallurgy is, in fact, a part of chemistry.

1484. And you would include the mechanics of metallurgy?—Yes; certainly I do to a certain extent include it.

1485. In your papers, do you mean?—Yes.

1486. Do you set the papers?—Yes.

1487. And you examine them after they come up?—Yes.

1488. I suppose the number of persons receiving instruction in metallurgy in those classes throughout the country is only small?—About 70, but that, considering all things, is a large number.

1489. Do you know whether there are many classes?—I do not know.

1490. Is there any large proportion of failures?—Yes, a good many, but there are some very good papers, and from trades that would astonish you, it would be curious to have a return of those trades, it is all known to the Department, so that the Return could be easily given; every person who is examined is known to the Registrar at South Kensington, and such a Return would be a very valuable, or at all events a very interesting story.

1491. Mr. Bruce] Do you mean that the Committee would be astonished to find the number of persons acquiring the knowledge of metallurgy whose trades would not appear to have any im-

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Dr. J. Percy. mediate connection with it?—Yes, especially that

4 May 1868 1492 Do you suppose that many of those persons acquire the knowledge simply from love of the subject, or that some of them think in one way or the other it may be made to bear on their peculiar vocation?—I should say both.

1493. *Chairman*] And the classes which already exist you consider are doing good work?—I do I do not think numbers alone are to be taken as decisive proof of failure I should like to have the term failure properly defined, if you have skilled men scattered throughout the country, as you have now had during the last few years, thoroughly well-informed men scattered about at our great metallurgical works, those men become so many *foci* of light in the district, and they are all doing good work. Take a museum, I deny the fact that the numerical attendance is any proof that a museum is of use or not of use; it is the few who go to observe and get solid instruction that are the test of the use of such an institution.

1494. You mean that one good and capable man finding his way to North Staffordshire would exercise an influence over the whole of the trade of the district?—Yes, we might say that he is a metallurgical apostle. I have known great good to be done by such men

1495. Then with regard to artizans, properly so called, that is to say, those engaged in manual labour, would you consider it important that they should possess some knowledge of metallurgy?—I think that it is infinitely more important that they should be able to read and write and cypher I do not know that a Sheffield saw-grinder would do his work any better from knowing the exact composition of the steel he worked upon.

1496. Mr. Bruce] But supposing he were a man of ability, a little special knowledge might help him to develop into something else?—Yes

1497. *Chairman*] Have you had no communication from the North of England Institute of Mining Engineers on the subject of the establishment of a school of metallurgy or engineering?—No, not recently

1498 I have been requested to ask you whether you can state the comparative quantity of fuel expended in getting iron out of its ore as between this country and Belgium?—I should like to know what is meant by the term "fuel."

1499. Probably you would say that that would depend on a variety of conditions?—The term "coal" is properly supposed to have a very definite meaning, but in reality nothing can be more indefinite

1500 The result would depend, in fact, upon the richness of the ore and the calorific effect of the fuel?—I will maintain that there is no country on the earth where fuel is more economically used than it is used in many places in England. A gentleman from France, who is a very experienced man, went to Mr Vivian's zinc works and expressed his amazement to me at the great economy of fuel which he saw there effected.

1501. Mr. Bruce] Mr. Vivian is a man possessed of great scientific knowledge, is he not?—Yes; there is a great mistake with regard to the use of the word "fuel," and I am anxious to guard the public against the mistake If you talk about the quantity of coal consumed in South Staffordshire for making a ton of iron, and compare that with the quantity of coal con-

sumed in South Wales, you get an erroneous result, because in South Staffordshire the coal possesses far less heat-giving power than the coal in South Wales. The letters that appeared in the "Times," by Mr. Plimsoll, were utterly fallacious, and, in some respects, absurd

1502. *Chairman*] You would say that the quantity of fuel consumed, without taking other considerations into account, would be no guide at all?—None whatever You have to consider whether the iron is white iron or grey iron, for instance; what is the size of your furnace, whether it is cold blast or hot blast; and various other circumstances.

1503 But, apart from that, the richness of the ore is a very important element in the case, is it not?—Yes, and the degree of compactness of the ore.

1504. Its mechanical condition, in fact?—Yes; its mechanical condition is a very important thing

1505. Do I understand you to say that you believe that smelting is carried on more economically at certain works in South Wales than anywhere on the Continent?—I believe it is carried on as economically, if not more economically.

1506. Would you say the same with regard to the manufacture of iron in the Cleveland works?—Most undoubtedly I should, and I am sure I should be saying what is correct

1507. You are acquainted with the operations carried on at Creuzot?—Yes, I have not been there.

1508. And with what is being done in Westphalia you are acquainted, I suppose?—Yes.

1509. And I understand you to say that you are of opinion that, in the north of England, the work is carried on as economically, with regard to the quantity of fuel consumed, as it is at those works?—I have not the least doubt of it, I speak now of the best of the recent works.

1510. A great deal has been said about the importation of iron from Belgium; do you attribute that to any superior knowledge of science possessed by the Belgians with regard to the manufacture of iron?—Certainly not. Every great improvement with regard to the manufacture of iron, almost without exception, has arisen in this country; the utilisation of the waste heat of the blast furnace is due to the French; but we must not be surprised at our not having hitherto attended so much to the economy of fuel as we might have done, seeing the great abundance of fuel in this country It is a general rule that wherever there is great abundance there is some waste. I repeat that I do not think any great improvement besides the one which I have just mentioned, has arisen out of this country.

1511. Now with regard to iron girders, we have seen repeated accounts of iron girders of peculiar form being imported from Belgium, do you consider that the manufacture of those girders is due to the Belgians possessing any scientific knowledge we do not possess ourselves?—No, certainly not; only let there be a demand for such girders, and you will very soon see the thing done for you to any extent, but you can not expect a manufacturer to alter his mill all at once for a special kind of girders, unless there is a sufficient demand for it.

1512 Those girders were first brought in use in Paris, were they not?—Yes; they are very much more used there than they are here

Look at the question of iron plates, and see what the energy of our manufacturers has done in that respect, those enormous masses of iron can now be manipulated with certainty and facility, whereas, a few years ago, if you had suggested such a thing to an ironmaster, he would have thought you a deluded man

1513 Would you say the same thing with regard to steel that you now say with regard to iron?—Yes, we are ahead of all the rest of the world with regard to certain departments of steel, I imagine that, in putting the question, you are referring to Mr Krupp

1514 Yes, to Mr Krupp's works, and other works?—Mr. Krupp has done nothing in the way of invention with regard to steel, but he deserves the highest praise for what he has done by dint of wonderful organization, he has brought that to such a pitch that he has 1,000 pots or more of steel, all ready melted at the right moment, to be poured into a common reservoir and then cast; but there is a gentleman in the room who has done much more difficult work in the casting of steel than Mr Krupp has done [Alluding to Mr Whitworth.]

1515 But you are aware that there are other works on the Continent, both in France and Germany, which have achieved most remarkable results in steel castings?—Yes, that is a particular kind of steel, but not cutlery steel, there is no cutlery steel made in any part of the Continent to surpass ours

1516. With regard to metallurgy, in fact, you think we still stand at the head of the world?—No, not in all departments, with regard to those enormous masses of steel made by Krupp, we do not stand at the head of the world, but that is simply a matter of want of organization

1517. But you think there is no want of technical knowledge?—There is no special invention in this matter on the Continent. An artillery officer, who is a friend of mine, went over and saw a 16-ton casting made at Krupp's, and there is now no doubt whatever as to the mode of proceeding in Mr Krupp's works

1518. Lord *Frederick Cavendish*] When you spoke of the advantage of affording scientific instruction to those who were to become foremen or managers of works, you were speaking of a class who could only obtain a scientific education at night, because they would be at work in the day-time, were you not?—No, that did not occur to me

1519 But would it be possible for those who are to become foremen and managers of works to attend school in the day-time?—I cannot say.

1520. What class are those persons for the most part, who attend your lectures in Jermyn-street?—A superior class of men, above the rank of foremen

1521. Do manufacturers ever send up managers or assistants to Jermyn-street for instruction?—Several times they have done so.

1522. Paying their expenses?—Yes, I could mention several cases of that kind.

1523. Do you think that a great many more people would attend Jermyn-street, if there were greater facilities for boarding them?—Yes; but I never anticipate a very large number in my department.

1524. You think there is not a great demand for any very great number of scientifically taught

men in metallurgy?—No, I cannot see how there should be.

1525. Sir *Charles Lanyon*.] With regard to the class of students that come to Jermyn-street, are they principally from London, or do any of them come from the country?—They come from the country chiefly

1526 How many of those students return to the country as chemists or assayers to the manufactures in the Midland Counties, should you say?—I should say a very great many of them have got tolerably well placed.

1527 The manufacturers have taken men from your establishment?—Yes, I have handed in a list of the men, and the places where they now are, I will complete that list up to the present date, and lay it before the Committee

1528 What description of girders were those which you speak of?—Little light H girders

1529 You are aware, I suppose, that they are very much used in this country?—Very much more than they used to be, and if our manufacturers were once to see a little demand, you would very soon have them made in large quantities here. The Belgians have no ore of particularly good quality, and we could produce them quite fast enough

1530 Mr *Dixon*] Do you think that the method you adopt of teaching the practical application of the science of metallurgy to the smelting of metals, and so on, ought to be followed out, by teaching those sciences, a knowledge of which is required for use in other manufacturing processes. You stated that you thought it was not sufficient to teach merely the principles of the science of metallurgy, but also its application to the smelting of metals?—Yes.

1531. You would describe to your pupils the processes of smelting that are now, and had been formerly in use?—Certainly

1532. If other teachers were called upon to instruct science classes, would you recommend them to do the same when they were teaching pupils, who were destined to find employment in other manufacturing processes?—Decidedly I should

1533 You would not think it right that they should restrict their teaching merely to the abstract principles of science?—In teaching chemistry, for example, with special reference to metallurgy, you could not limit them in that way, you must teach the science as a whole; then having taught them the science, it is possible to specialize that knowledge, and turn it in one particular direction.

1534. You would in all cases teach the principles of the science of chemistry, for example; and in addition to that, you would teach its application to the particular industry of the district in which the teacher taught?—Most undoubtedly; I might mention a most remarkable case, which shows that we are not so far behind as some people suppose. One of the most interesting, difficult, important, and novel processes in metallurgy arose in Birmingham, about the year 1840, hitherto the Swedes and Germans thought they had that process entirely to themselves, but it was taken up by a friend of mine who is now dead, I mean the manufacture of nickel, and it has been carried on upon the foundation that was then laid, and developed completely in Birmingham, the whole trade in nickel and cobalt has been completely revolutionised.

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Dr. J. Percy. 1535. You include, in your definition of the word metallurgy, the mixing of metals?—Yes; to such an extent, for instance, as the composition of brass, and how to adapt brass for different purposes, a matter which is very important in Birmingham; many of those things are considered as trade secrets, but they are very well known nevertheless.

1536. *Chairman.*] What you stated with regard to metallurgy, you consider would hold good of other chemical applications?—Yes, I think so. As far as my knowledge goes, I can speak quite definitely upon the subject, for example, with regard to the manufacture of glass.

1537. You would say that chemistry should be taught in its principles, and elucidated both historically and otherwise with regard to its practice?—Decidedly.

1538. *Mr. Dixon.*] Did I understand you to say, that you would not approve of any elementary instruction in science being given in primary schools?—No, I never intended to say that, but I think the best thing to be done is to teach many of those men to read, and write, and cast accounts. You will see numbers of those poor fellows who are unable to do either.

1539. You would advocate giving to them some elementary science, if it could be done in addition to the knowledge of the three R's?—Certainly; every man should be taught something of the world on which he treads, and the air he breathes.

1540. Do you think it would be possible to give that instruction in our primary schools?—Decidedly; by way of simple illustrations, which always interest people.

1541. You do not think a teacher would be overcharged, if an attempt were to be made to educate him up to being able to give scientific instruction as well as the three R's?—You had better, at all events, have a good man, for you would not get the thing properly done by a mere smatterer.

1542. But in an elementary school, where the scholars pay 2d per week, would it be possible to have a separate teacher of science?—Why not? Surely it would be possible to have a weekly lecture by a competent man.

1543. *Chairman.*] You would assume, I suppose, that the man who gave this instruction in the primary school, would also be teaching in a middle class school, or teaching adult classes, or employing himself in some other way?—So much depends on the man himself, that I should not like to commit myself to any general statement in answer to that question.

1544. *Mr. Dixon.*] But you think it would be difficult to possess those elementary teachers with that knowledge?—I think it would, as a general rule.

1545. But might it not be advisable to give them a special training for that in our training colleges?—I cannot give an opinion off-hand upon that subject.

1546. *Mr. Akroyd.*] With regard to the number of metallurgical students, I observe in the 14th Report of the Science and Art Department, that there are 23 students entered, and at the metallurgical laboratory, one student; I suppose that is a casual student; I note that there is one such student for 1865, while there are five for 1866?—The class contained more than those, but that was for an associateship I suppose.

1547. Out of the number of your students,

I suppose the bulk are from the provinces?—Yes.

1548. Can you state how many of them are from the provinces, and how many are from London?—I cannot tell you that off-hand, but it would be easy to give a return of that.

1549. You were speaking also of the deficiency of teaching mechanical engineering in the mining school?—Yes.

1550. Has your attention been called to the lithographic drawings sent out by the French Government?—Yes, they are very good.

1551. Are they not very superior to anything we have in this country?—The French are very good draughtsmen, but I do not know that they are superior to what we could produce. I cannot say who is responsible for some of the things exhibited at South Kensington, but they certainly ought not to be there; I mean drawings of blast furnaces and so on, of the worst possible construction.

1552. I think you say that you would never anticipate a large number of students in metallurgy?—No.

1553. Would you say that there might be 50 or 100?—I should call that a very large number. A few years ago, at the *Ecole des Mines*, I think the total number of students was not more than 80, notwithstanding all the numerous Government appointments there, I may be wrong, but that is my impression.

1554. I may assume from your answer then, that the students are not likely to increase in number beyond 100?—Certainly not.

1555. Do you not think that one central school to supply the wants of Wales and Cornwall, and the Midland Counties, would be better situated in London than in any other place?—I think there should be other schools in other parts of the kingdom.

1556. But if the number of students were only 100, that would be a very expensive thing, would it not?—You would then catch a much larger class of men who could not possibly come up here.

1557. You think that if you had more mining schools elsewhere than in London, you would have a greater number of students than 100?—Yes.

1558. *Chairman.*] Adding the whole of the numbers together?—That is my opinion.

1559. *Mr. Akroyd.*] I think you stated that there is a great economy now practised in the use of fuel for blast furnaces?—Yes.

1560. Has your attention been called to the construction of furnaces for steam engines?—To some extent, incidentally.

1561. You are hardly prepared to say, I suppose, that the same economy in the use of fuel is applied there as in the other case?—I think I could venture to say that and prove it too.

1562. You are aware, however, that the Belgians and French consider themselves very much before us in such matters?—They may consider themselves very much before us, but the question is, what is the real fact.

1563. *Chairman.*] Are you acquainted with the trials of steam engines that have taken place at the Royal Agricultural Society's meetings?—Not specially.

1564. *Mr. Bruce.*] I understood you to say that, in addition to the pupils whom you, yourself, trained, and who were trained at Jermyn-street, you examined annually about 70 papers?—Yes.

1565. Have

1565. Have you perceived in those papers traces of the writers of them having studied those various sciences which are connected with metallurgy?—Yes, certainly; in the whole of the metallurgical papers

1566. Are you able to say whether those students were persons who had received their education at the science schools?—That is my impression. Some of them are very illiterate persons who cannot write well, but they think properly, nevertheless, which is a thing that may very commonly be observed

1567. You would say that, they were persons who were likely to have availed themselves of the evening schools for the purpose of getting this scientific knowledge?—Certainly; you have the fact that they do so

1568. Considering the great demand in England for schools for science as applied to manufactures, do you think that the amount of instruction already provided is sufficient?—I think the more a man knows of his own special department, the better it is for him

1569. Do you not think there must be in England an enormous amount of dormant talent, which would be evoked by schools conveniently situated?—I think so.

1570. Do you know whether many foreigners come to England for scientific instruction in mining or chemistry?—Not many; we have a good many from South America.

1571. Do many Englishmen go abroad for such instruction?—I believe not anything like so many as formerly did.

1572. I was informed the other day by an Englishman of science that a French school, the Ecole Centrale, out of 300 of what he called agents of manufacturers who were there, 50 were Englishmen; are you aware of any facts of the kind?—I am not.

1573. Are you aware whether Englishmen go abroad to get their training in metallurgy, and the mining studies connected with them?—I do not think many do that.

1574. Has the school at Freiberg been much frequented by Englishmen?—It has been; but that is not the case so much now as it formerly was. I have strongly urged many of our men to go everywhere and see as much as they could.

1575. You mentioned with great approbation the economies conducted in Mr H Vivian's zinc works in Swansea?—Yes.

1576. Are you aware whether he received his education in England, or abroad?—I believe he was at Freiberg

1577. You also said that at those zinc works at Swansea, great economies had been effected which struck with surprise some foreigner who had visited them?—Yes

1578. Are you aware where Mr. Vivian gets his scientific superintendent from?—I believe he is a German.

1579. Mr. Vivian has lately been, with great success, neutralising the copper smoke, and converting it into an efficient manure has he not?—I do not know about the success; it is a very pretty process, but it is only a partial condensation.

1580. Is that experiment conducted by a German or an Englishman?—It is under the superintendence of Mr. Morgan, who is an Englishman, and a very intelligent man, thoroughly well up to the chemistry of copper smelting

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1581. But was not the idea on which Mr Vivian conducted an experiment of very great national importance, an idea imported from Germany, and carried on by a German?—Do you mean the method for utilising copper smoke recently introduced

1582. Yes?—Yes, that is a process of which Mr. Vivian spoke very highly, it is a calcination process of great interest.

1583. I understood you to say you thought that Englishmen on the whole, in spite of the great abundance of fuel, are as economical in the use of fuel as foreigners?—When they are obliged to be so, they are more so than they used to be.

1584. Would you apply that to South Wales?—Immensely more so.

1585. But do you consider that they are more economical now in the use of their fuel than, for example, the French?—I think they are quite as economical in some works in South Wales; but that depends very much on the price of fuel in the two cases.

1586. You are very well aware, I dare say, of very considerable works which were remarkable for their great waste of fuel?—Yes.

1587. Under the management of unscientific men?—Yes

1588. And that immense economies have been effected under the management of scientific men?—I think so.

1589. Could you state to what extent per ton a reduction in finished iron has been effected?—Not exactly.

1590. Should you be surprised to hear that the quantity of waste had been reduced from 20 to 4½ tons?—At the Calder Iron Works, with a hot blast, it was reduced from eight to three tons per ton of pig iron.

1591. I understand you to say that you are of opinion that mining schools might advantageously be extended to all our large mining districts?—Yes.

1592. Has the experiment been tried in the Cornwall district?—Yes, a good many years ago, by Sir Charles Lemon.

1593. Did not Mr. Fox exert himself very much for that purpose?—I know nothing of the details.

1594. From your knowledge of the mining districts, which is very great, do you think that if mining schools were founded there, and professors of scientific knowledge procured, that they would flourish sufficiently to justify the expense of founding them?—I cannot speak of the mining districts specially, but only of the metallurgical ones

1595. But you think the schools would flourish in the metallurgical districts?—I think they would, I have always found men glad to get what information they possibly could.

1596. And ready to pay for it?—Sometimes.

1597. *Chairman*] Is it not the case that there are great varieties of practice which are not accounted for by local circumstances in metallurgical operations?—Yes, in a great many cases; there is tradition, for example.

1598. So that a process which is entirely abandoned in one district we find religiously maintained in another?—Yes

1599. If managers and directors of such works were better educated, do you think there would be a greater equation in that respect?—No doubt.

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- Dr. J. Percy. 1600. So that old processes would not be entirely superseded in another district?—Just so; what we want is to diffuse information as far as possible on those special branches, information concerning what is done on the Continent as well as in England, and to present that in a cheap and easily accessible form to all persons practically engaged in metallurgical operations.
- 4 May 1868. 1601. Mr Bruce] You specially recommended the compilation of useful scientific text-books?—Yes.
1602. You think that is a great desideratum?—Yes.
1603. Do you think they would be much studied outside the schools?—I think they would.
1604. Have you observed a progress, not only in the number of those who avail themselves of the science teaching provided by the Government, but also in the amount of knowledge which their papers give proof of?—Decidedly.
1605. You would not expect a system of education which involved rather severe study to spread very rapidly, I suppose, or among a great number of people?—I really do not know why in these days it should not.
1606. Should you expect that the progress of science schools would have been more rapid than it is?—No.
1607. On the whole, you are satisfied with the progress that has been made?—Quite.
1608. Chairman.] That means in your special department?—Yes.
1609. Mr. Bruce] But from such observations as you have been able to make on the teaching of science, are you generally satisfied with the rate of progress that has been maintained?—I think considerable progress has been made of late.
1610. Chairman] Would these publications which you have spoken of, be of much service to persons who had not received some amount of scientific training?—No, they must have received instruction by lectures, with illustrations.
1611. Unless they had received that, they would naturally be prejudiced against any process which the book described?—They would, in any case, want a description of the process such require a book at home, and to ponder over it. There are other departments, where I have an opportunity of lecturing on the same subjects, namely, the Royal Artillery Institution, for the special training of artillery officers; that has been going on for three or four years, with very great success indeed, and the School of Naval Architecture, which also goes on very well.
1612. Mr Bruce] Do you find that the artillery officers take much interest in these subjects?—Yes, they are capital men.
1613. Your lectures at the Admiralty are attended, not only by those who are compelled to attend, but by a considerable number of outsiders, are they not?—I have got 34 examination papers this year, and there is a very marked progress in them.
1614. Chairman] In both those schools the training is strictly technical, is it not, not only with regard to your own subject, but with regard to others, they are taught the construction of guns, are they not?—I simply deal in metallurgy, but chemistry is taught there. They have got a capital laboratory, and a most able mathematician, and then they have an opportunity of going to the Arsenal and visiting metallurgical works in different parts of the country under my guidance.
1615. I see that the mechanism of the steam engine is professed at the Artillery Institution?—Yes.
1616. That is all strictly technical instruction?—Yes, it is as special as it can be made.
1617. With regard to provincial schools, do you not think that the more special they can be made the more likely they are to attract pupils?—Yes, I think that would be one of the main elements in their success. Take chemistry: suppose a man were devoted to glass-making, he ought to learn something of chemistry; only he must first learn the whole thing, more or less, and then, after that, he can specialise.
1618. But you would not say that, having taught this man the theory of chemistry, you would have him to apply it to his own department of the arts without any guidance whatever?—No, a great deal can be done in respect of such special guidance.

Thursday, 7th May 1868

MEMBERS PRESENT.

Mr Acland
Mr Akroyd
Mr Bazley
Mr Henry Austin Bruce
Lord Frederick Cavendish.
Mr. Dixon

Mr. Graves
Mr William Lowther.
Mr M'Lagan
Mr Edmund Potter
Mr Read
Mr. Samuelson

BERNHARD SAMUELSON, Esq., IN THE CHAIR

JOSEPH WHITWORTH, Esq., called in, and Examined.

1619 You are a Mechanical Engineer at Manchester?—I am

1620 And you have been established at Manchester in that capacity for a great number of years, have you not?—I have been established there since 1833

1621 You are well acquainted consequently with the profession of mechanical engineering and its wants?—Yes

1622. And having in view the deficiency felt by that profession, you have proposed to found what in your presence I am bound to call a most munificent endowment. Will you kindly state to the Committee what are those wants which you wish by that endowment to provide for?—In a memorandum that I have given in this morning you will notice that on the second page, at paragraph 6, I state thus "My object in devising the foregoing scheme has been, while requiring a practical acquaintance with a few simple tools as a *sine qua non*, to render the competition accessible on fairly equal terms to the student who combines some practice with his theory, and to the artisan who combines some theoretical knowledge with perfection of workmanship." My object principally was to enable us to have better foremen and managers for our works, we always had to take our foremen from the working class, and very frequently we found, although the man was fully capable as far as practical experience of the work of the hand goes, he had no scientific knowledge, sometimes it has happened that he was deficient even in reading, writing, and arithmetic, and he had to give up his foremanship, and go back to the work of a common workman, that has frequently happened.

1623. You found skilled workmen whom you were desirous of employing as foremen entirely deficient in the theoretical knowledge, and even in elementary instruction?—Yes.

1624 And consequently your endeavour is to obtain a combination of practical skill and theoretical knowledge in those persons who are to be employed as foremen and managers in the works of mechanical engineers?—That is so.

1625. Now, have you considered at all where that instruction can be given to persons who are to qualify in that way?—I believe at present there are not many professors of engineering, indeed, I may say there are not any, there has been one just appointed at Owen's College, at Manchester, previously to that there were not any.

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1626 You are aware that an appointment has recently been made at Edinburgh?—Yes

1627 Instruction in civil engineering is given at King's College, is it not?—Yes

1628. Have you satisfied yourself at all with regard to the efficiency of that instruction with respect to its bearing on mechanical engineering?—I cannot say that I have

1629 What would be your opinion of the introduction of workshops into schools for technical instruction?—I think it would be very desirable for youths to learn the use of the simple tools which are enumerated here under paragraph 5, such as the axe, the saw and plane, the hammer and chisel, the file and the forge, but not to attempt the construction of machinery, but simply to be able to handle such tools as those.

1630 They might learn either in the school, or you suppose they would have opportunities of learning it elsewhere?—Yes, I think in every village where there is a boy intended to work as a mechanic, he may go to the carpenter or the blacksmith, and learn the use of such tools

1631. I believe you have considered the question in respect to how far it might be desirable to instruct very young children in the use of tools?—I think they can hardly begin too young

1632. You would not give that instruction in school?—No, you might have a competition in the school in the use of simple tools

1633 But you would allow them to learn the use of those wherever they had an opportunity of doing so?—Yes.

1634 Will you illustrate what you say about competition in the use of tools with regard to very young children?—First of all, I should propose learning the use of the knife I would give notice that there would be competition of half-a-dozen boys in the use of the knife, and I would have a carpenter prepare half-a-dozen cylindrical pieces of wood eight inches long, and one inch in diameter, and I would ask those boys to make it square by the use of the knife In the first trial I would have a piece of white deal Those trials might be, perhaps, once a week On the second trial I would have red deal, and, on the third trial, beech, or ash, or oak. That would be teaching those little boys the different natures of woods, at the same time that they would be learning to sharpen the knife according to the wood they would be operating upon You would want a very different edge for oak and for white deal. Then, if you found a boy with a very good intel-

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lect, he might, perhaps, be a surgeon, while a boy with less brain might be a butcher or a shoemaker, but this knowledge of the use of the knife must do good to all of them. In another trial you might prepare the wood square, and ask the boy to make it round, or to make it octagonal, or hexagonal.

1635 With regard to working in metals, you would be glad to see similar trials, I suppose?—Yes, for instance, with respect to the use of the hammer, it would be a very nice experiment to take a piece of lead (with, perhaps, a small quantity of tin in it, to make it hard)—say a sphere of two inches in diameter—and then ask the boy, with the hammer and anvil, to square it up under the hammer, and the same with regard to other tools. Parents very often say they do not know what a boy is fit for; but the school-master, at all events, ought to know what every boy he has under his charge is best fitted for, and he would know if the use of the hand as well as that of the brain was encouraged.

1636 You have thought over this subject very seriously, and the conclusion at which you have definitely arrived is, that those exercises would be extremely useful to children in the primary schools, but that the instruction itself should not be given in schools; that is, you would have the competition in the school, but instruction of that kind should not be given in school hours?—Certainly not; they would get the instruction wherever they could.

1637 Now, in your higher schools, in schools which might be more properly called colleges—Owen's College, for instance—you would teach mechanical engineering, in addition to teaching theoretical and applied mechanics, and mechanical drawing. You would not confine yourself to instruction in mathematics and mechanical drawing, but you would teach mechanical engineering and the construction of machinery?—As far as it could be done from drawings.

1638 You would wish your teachers to explain the construction of various machines?—Yes.

1639 And you would ask them to state why certain principles and modes of construction are adopted, and why others are not adopted?—Yes.

1640 I suppose you would have them state historically what attempts at modification of construction have been made, and which have succeeded, and which have failed?—Certainly.

1641 For instance, you would take a steam engine, and go into the history of the steam engine?—Yes.

1642 You would trace that back to its rude elementary form, I presume?—Yes. I would have models of the different kinds of steam engines that had been in use at different times, showing the progressive improvements which had been made.

1643 Of course, you would distinguish between locomotives and stationary steam engines?—Certainly.

1644 And hydraulic machines you would treat in the same way?—Yes.

1645 And machinery for textile manufactures?—Yes. I have thought it would be very desirable in a place like Manchester to have a professor who was acquainted with the cotton branch of machine making; an engineer who had been brought up simply as an engineer in a workshop would understand the construction of steam engines, but if his attention had not been pre-

viously called to the construction of cotton machinery, he would know nothing about it. In a place like Manchester, where there are so many thousands employed in the cotton manufacture, it would, in my opinion, be desirable to have a professor who understood the cotton machinery as well as a professor of general engineering.

1646 Because, as you have observed, a man might be a very good engineer, and yet be entirely at a loss if he were to enter a cotton manufactory for the first time only to see the cotton machinery in motion?—Exactly.

1667. But you would not think instruction of that kind would supersede the necessity of becoming acquainted with the practical uses of machinery in a factory?—Certainly not.

1648 You would wish to combine the two things?—Certainly.

1649 In view of that, do you think there would be a great advantage in having a college for teaching mechanical engineering in any district where such engineering was practised?—Yes.

1650. You would look upon Manchester, for instance, as a good centre for a college in which the technology of mechanical engineering should be taught?—I should, there could be no doubt that it is the best place in this country for a college for teaching mechanical engineering.

1651. You are, of course, acquainted with the science classes of the Science and Art Department; can you tell, from your own experience, what has been the bearing of those classes on the instruction of our industrial population, say at Manchester, for instance, and among your own men?—I cannot say that I am in a position to do that.

1652. Do you not know whether any of your workmen or foremen attend the science classes at Manchester?—The foremen, I think, do not. In consequence of the number of years we have been engaged in business, the majority of them are not very young men.

1653. But with regard to your apprentices, or those young men who stand in the place of apprentices, I mean of the age of 18 or 19 years; do you think they attend those classes, in order to obtain a knowledge of mechanical geometry, or elementary geometry?—I am not aware that they do.

1654. Then you would say that the science schools at Manchester, so far as you are aware, have made no great impression on the men in your works?—Not at present; but the number of students are gradually increasing at Owen's College.

1655 At Owen's College there are evening lectures for working men, are there not?—Yes.

1656. With regard to the endowments which you propose to found, will you kindly explain to the Committee what the principal features of those endowments are?—In February last there was a meeting held at the fifteenth anniversary of the foremen engineers, and I was requested to act as president, and perhaps I might read a few remarks which I then made, which would show what I said to those foremen. Speaking of the foremen engineers as a body, I said: "As a body they have risen by their own merit and talents. Therefore, though this is a moment of great depression, the prospect for foremen engineers is full of promise. It is necessary, however, that they should qualify themselves carefully for the more intimate relation with their employers to which

which the circumstances of the times invite them. To do this the education of the workshop alone is not enough. I have an immense appreciation of the education and training of the workshop, it is more important and indispensable than any other, and gives a mastery over men and things otherwise not obtainable, but to it must be added sound technical and scientific education, and I hope each trade and industrial occupation in this country will provide its own system for imparting it. Without the training of the workshop the highest Continental plan of technical instruction is comparatively useless as regards valuable results upon national industry. In this respect I think we are yielding to a good deal of unnecessary panic as to what is doing on the Continent. The thorough knowledge of first principles, and the steady pursuit of them, lies at the root of every branch of human production, but especially of mechanics. To make things as simple as possible, to make things as true and good as possible, and then to introduce *system* so as to get the immense economical advantages of repetition in manufacture, are the grand objects to which our efforts should be directed. The patient and steady pursuit of these objects I am desirous to impress upon this society of foremen engineers as the most valuable advice I can offer them. Much has been said about foreign competition, and it cannot be denied that the foreigner copies fast and well, but if you qualify yourselves by supplementing the training of the workshop with a thorough sense of the objects to which workshop labour should be directed, the mechanical supremacy of this country is not likely to be seriously disturbed. The present depression cannot last, the work of the world has to be carried forward, and a boundless future lies before us if we bring to bear upon it practical skill, directed by scientific knowledge, and hearty co-operation between employers and employed."

1657. Now, in order to carry out the object of combining theory with practice, you propose to found 30 scholarships of the annual value of 100 l.?—Yes.

1658. And to place those scholarships at the disposal of the Lord President of the Council or the Minister for Education, if such a minister should be appointed?—Yes.

1659. And you propose that the student who should be successful in gaining one of those scholarships, should devote it to the pursuing of his studies in any way which may appear to himself most desirable, subject to the approval of the highest educational authority for the time being?—Yes.

1660. With regard to the competition itself, you intend that it shall be partly in science, and partly in practical skill?—Yes.

1661. With regard to the practical part, I believe you have not yet quite completed your scheme?—No.

1662. Then do you think it would be desirable that we should adjourn any questions that the Committee might wish to ask you upon that portion of your scheme?—I think so, we are now going on in the preparation of the practical development of the scheme.

1663. But with regard to the theoretical subjects, those are fully stated in the paper which you have handed in, I believe?—Yes.

1664. I think you propose that the examinations for the theoretical portion shall be conducted

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at the same time as the examinations of the Science and Art Department in the month of May, but that your competitors shall be specially examined in papers set for the purpose?—Yes.

1665. A certain number of marks would be assigned to those papers?—A certain number of marks would be assigned to those papers, and a certain number of marks would be assigned as a maximum to proficiency in practical work. I propose that the number of marks should be equal in both cases, that is to say, that if 500 marks were the maximum for scientific work, I would give 500 also as the maximum for the most skilled hand workman.

1666. And the aggregate number of marks for practical skill and scientific instruction is to decide who are to be the recipients of the scholarships?—Precisely. I have a letter here that I addressed to Mr. Henry Cole on the 4th of May, which I think perhaps you would like to hear read: "Referring to your letter of March 28th, by which you transmit to me a copy of the Minute which the Lords of the Committee of Council on Education have passed in acknowledgment of my endowment of scholarships for promoting mechanical science, and the concluding sentence of the Minute which invites further suggestions, and offers to render assistance in carrying out the intentions of the endowment, I beg leave to enclose, for the information of the Lords of the Committee of Council on Education, a memorandum on the subject of the endowment, which I trust will meet with the approval of their Lordships, and that they will cause it to be circulated, and the necessary correspondence arising out of it to be conducted by the Science and Art Department. I would beg leave to ask the Lords of the Committee of Council on Education to undertake the examinations for these scholarships. As respects the preparation of the necessary details for the examinations in the use of tools, I am willing to be responsible myself with the aid of friends, and I propose to obtain the consent of a few gentlemen to advise with me from time to time in whatever may arise in the future for my consideration. In reply to the invitation of their Lordships to submit any suggestions, I venture to submit for consideration, whether honours in the nature of degrees might not be conferred by some competent authority on successful students each year."

1667. Do you there mean students competing in the examination, or that the degree should be conferred subsequently to the examination while the students were pursuing their further studies?—I mean, that the degrees should be conferred on those who had received the 100 l. scholarships subsequently.

1668. That is to say, in the years of study succeeding the receipt of the scholarship?—Yes, where a scholarship was given to a student for three years, for instance, I mean that some degree might be conferred on him at the end of the three years, "Thus creating a faculty of Industry analogous to the existing faculties of Divinity, Law, and Medicine; I am of opinion that such honours would be a great incentive to exertion, and would tend greatly to promote the object in view. I venture further to express a hope that the Government will provide the necessary funds for endowing a sufficient number of Professors of Mechanics throughout the United Kingdom."

1669. By "professors," you would understand Professors of Engineering, as well as Mechanics?

—Yes,

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—Yes; “In conclusion I inform you that the necessary arrangements for securing the endowments have been made, and I have given instructions for the preparation of the draft of a deed of trust, which will be sent for the approval of the Lord President.”

1670 To that letter you have received a reply in the form of a Minute?—Yes.

1671 Will you kindly read the Minute of the 5th of May?—“My Lords read Mr Whitworth’s letter of 4th May 1868, transmitting a memorandum on his scholarships, and on the establishment of 60 exhibitions, of 25*L*, for the present year, preparatory to the competition for his scholarships, and requesting that the Science and Art Department may conduct the necessary examinations and correspondence. Their Lordships have great pleasure in acceding to Mr. Whitworth’s request, and giving every assistance in their power.”

1672 I think we must finish that sentence for you, “Every assistance in their power in carrying out his patriotic munificence.” In this Minute the scholarships of 25*L* each are for one year only, I believe, and that for the present year?—Yes

1673 Your object in creating 60 exhibitions of 25*L* each for this year only, is in order to draw out young men for that competition for the higher scholarships which is to take place in the year 1869?—Yes, precisely

1674 And you place those exhibitions at the disposal of various institutions?—Yes

1675 You allot eight to Owen’s College, Manchester, three to the University of Oxford, three to the University of Cambridge, and three to the University of London, and you distribute the remainder among the institutions of the second class?—Yes

1676 I believe you intend that the institution named shall have the absolute control of those exhibitions?—Yes, the absolute disposal of them.

1677 They may use them in any way for the encouragement of students in training in those institutions?—Yes

1678 Mr Acland.] Is there not this condition attached, that the students must undertake to compete for the scholarships in May 1869?—Yes; but they may be given to any promising student without any special examination.

1679 Charman.] I believe the Committee of Council on Education have acceded to your request, that the Science and Art Department shall conduct the correspondence with those various institutions in regard to those scholarships?—Yes

1680 Perhaps Mr. Cole, who is present, will have the kindness to read the letter?—(Mr. Cole) This is the form of the letter which is now going out to those various institutions, being addressed to the universities and other institutions to which the scholarships of 25*L* each have been offered by Mr Whitworth.—“I am directed by the Lords of the Committee of Council on Education to transmit a copy of a Minute, dated 5th May 1868, which their Lordships have passed, on a communication made to them by Mr Whitworth, expressing his intention, with the view of preparing for carrying into effect his liberal endowment for 30 scholarships of 100*L* each, to create at once 60 exhibitions of the value of 25*L*, to be held for the ensuing year. It is Mr Whitworth’s desire that one of these exhibitions should be placed at the free and absolute disposal of the

University of Durham. The exhibition may be given with or without competition, as the university sees fit, either to a student at the university, or to a youth who has obtained a certificate of competency at the local class examinations. The only condition attached to the acceptance of these exhibitions is, that the holder proceeds to qualify himself for the competition for the scholarships of 100*L*, to be conducted in May 1869, and satisfies the university that he will present himself as a candidate at that competition. The use of one or more of the tools specified, namely, the axe, saw and plane, hammer, chisel and file, and the forge, may be acquired in almost every village in the United Kingdom. I also enclose specimens of the examination papers, showing the nature of the examination to be held by the Science and Art Department for the competition for the scholarships of 100*L* in 1869. In the event of the University’s accepting the 25*L* exhibition, further information respecting the competition for the 100*L* scholarships in 1869 will be sent. It is Mr. Whitworth’s earnest wish, in which the Lords of the Committee of Council on Education join, that you will give your hearty co-operation in promoting his desire to benefit the engineering and mechanical industry of this country.”

1681 With what views are those examination papers set?—In order to convey an impression of the nature of the examination which is to be held by the department.

1682 And they are papers similar to those which are ordinarily set for the May examination?—Yes

1683 Mr. Acland.] The competition for those 100*L* scholarships is not based upon special papers, but on the ordinary papers set by the department?—In one sense there is nothing special in them, but it may possibly seem to be right to prepare a higher sort of paper. That, however, is a matter for consideration.

1684 So that if a student presented himself, and said that he would come up for a more honourable examination, he should have the opportunity of doing so if he pleased. Mr Whitworth has specified the subjects: “Mathematics (elementary and higher); mechanics (theoretical and applied); practical plain and descriptive geometry, and mechanical and freehand drawing, physics, chemistry, including metallurgy.” Now, we have going on during this very month of May, in the evening, at perhaps 300 places throughout the kingdom, examinations worked by papers in each of those subjects

1685 Your ordinary machinery supplies you with the means of fulfilling the conditions in question?—Perfectly.

1686 Charman.] Those papers would be at about the same standard of difficulty as those in your May examination?—Yes, with possibly one standard higher. We have two standards now; and it has been considered possible that there may be a third

1687 Mr Acland.] The case is quite parallel to what the Royal Agricultural Society did a few years ago, when, instead of instituting a special agricultural examination, they decided to give honours to selected candidates, having certain agricultural qualifications, who passed in certain local examinations?—Yes.

1688 Charman.] You say you believe that the exhibitions to artisans may, perhaps, be increased to 50*L* for the year by connecting them with

with the Science and Art Department, under the Minute of the 21st of December 1867?—(Mr. Whitworth)—Yes

1689 (To Mr Cole) Is that impression of Mr Witworth's shared by the Science and Art Department?—(Mr Cole) I apprehend that the Lord President will give that interpretation. It comes quite within the spirit of the Minute for the 25*l* scholarships. If, for example any one of those towns, say Halifax, finds a youth competent to take the 25*l* scholarship, and if he be an artizan, it is only to ask the department whether Mr Whitworth's scholarship would be accepted under the terms of the Minute, as a contribution

1690. You believe that, with regard to artizans, and to artizans only, those scholarships would probably be accepted?—I believe so with regard to artizans only.

1691 But the institutions named here are so-called institutions for the instruction of artizans, are they, so that that would then apply only to the three for the Society of Arts, and the seven towns mentioned?—Yes, and Owen's College, perhaps, may select artizans. There is nothing to prevent the University of Oxford selecting an artizan, but I venture to think that the intention was, that it should encourage its own youths

1692 Mr Bruce (to Mr Whitworth)] I should like to have your opinion as to whether you think that, under the conditions you have made, the greater number of these scholarships would be earned by the men of theory who had learned practice, or by the men of practice who had learned theory?—I think that the men who had learned practice would, perhaps, have the best chance. But we have been in the habit, and our engineers are also now in the habit, of taking youths with a premium. For instance, we have been paid 100*l*. per annum by gentlemen to receive youths for three, four, or five years, and those youths are permitted to go right through the different branches that are named here—"Smiths' work, Turning, Filing and Fitting, Pattern-making, and Moulding." Now, those youths would, I think, be the most likely to be the successful competitors, namely, youths who had parents determined to give them all the benefit of a good education, and prepared to pay those premiums with them

1693 You think that these youths would have special advantages for acquiring the manual skill?—Yes, as well as for receiving instruction at school; I think ultimately those would be the persons most likely to be successful

1694 But, apart from that selected class, would it not seem more probable that the man who had got manual skill should acquire the additional quantity of theoretical knowledge which would enable him to get one of those scholarships, than that the man who had the theoretical knowledge should acquire the manual skill?—I think so; it is very difficult to acquire manual dexterity unless you begin very young. Mr Stubbs, of Warrington, told me 25 years ago that in the manufacture of delicate files, such as dentists use, a boy never did any good unless he was put to it at about eight years of age. He said it was no use putting a boy to it at 12 years of age, because the delicacy of touch required so much practice; and I suppose young ladies if they go to the piano very early find it is better than if they go later. I have known a few instances, but very few, where parties who have been brought up to something else have, nevertheless,

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distinguished themselves as mechanicians. The most conspicuous case I ever knew was the late Mr Cleiment, who assisted Mr Babbage in making his calculating machine. He was brought up as a slater, and became, perhaps, the best mechanician in his time, but even he was not able to acquire skill in manipulation so much, though he was a man of great mechanical instinct

1695. In those cases where it is necessary that the practice of manual labour should begin at so early an age, it is all the more expedient that the means of giving a good education in the technical branches of the work should be provided?

—Yes

1696 In your establishment, at what age do children commence working?—In one establishment we have three distinct branches. We have the ordinary labourers, and then we have a class which I have contributed a good deal towards forming, what we call machine men. We generally get young men who have been brought up in the cotton factories, and who have acquired the manipulation, and they soon learn to work those machines, they are not skilled mechanics

1697 They get their early education elsewhere?—Yes, in the cotton factories, and from their acquaintance with machinery they soon learn to work the planing machine, and the shaping machine, and, in fact, every machine in our establishment is manned by those young men, except the turning lathe. We have not a mechanician employed in that department. The third class is that of skilled mechanics

1698 You stated that if our workmen paid due attention to scientific instruction you see no reason to apprehend that we should lose the mechanical supremacy which we, in your opinion, at this moment possess?—Yes.

1699. Do you consider that there is danger of our losing that mechanical supremacy unless great attention be paid to scientific instruction?—There is no doubt that they have in Prussia and Belgium, and France been making great strides, so that we are not so far ahead of them as we were

1700 They have been making very ample provision for the superior instruction of the working classes, have they not?—Yes

1701. Such as is not widely diffused in this country?—Yes

1702 *Chairman*] Do you mean there by working classes, the working classes strictly speaking, or foremen and managers of works?—I mean the foremen and managers of works, there has been more attention paid abroad to their education

1703 Mr Bruce] But my question was directed to working men, surely in Prussia, where the education of working men is continued in excellent schools up to 14 or 15 years of age, provision is made for the education of the working classes which is not made in this country?—Yes

1704 *Chairman*] Their primary education is better?—Yes, I may mention this, with regard to those men whom we call our machine men, their wages are between those of a labourer and those of a skilled mechanic; now by great care and strict attention to those men we are able to finish all our work by means of those men. In our machinery which was exhibited in Paris, there was not a single thing but what was finished by machine men; the skilled mechanic never put his hand upon it except to put it together, and

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there was no example from any other country of work finished in that way

1705. At what age do your mechanics come in?—From 14 to 16

1706. And your mechanics are exclusively employed in erecting the machinery of which the parts have been prepared by the class of men whom you call machine men, and who are not mechanics?—Precisely.

1707. Mr. Akroyd.] With regard to the Association of Foremen Engineers, is that an association for mutual instruction or education, or is it an association formed solely with a view of protecting their own interests?—They assist each other in time of sickness, and also, I believe, when they are out of employment, they meet together and read papers for mutual instruction.

1708. And among those foremen are there any of the middle classes, such as you get premiums with, or are they chiefly from the artizan class?—They are chiefly from the artizan class.

1709. Then what becomes of those apprentices who pay the premiums you have referred to, do you make foremen of them?—I think they more generally, perhaps, become draughtsmen; those that we have had have done so.

1710. That is to say, draughtsmen of machinery, and so on?—Yes

1711. Your works are chiefly employed in the making of machinery and tools for use abroad as well as at home, are they not?—They are machinery for making machines, which for want of a better term are called tools.

1712. Do you find, in fact, that any foreign machines are sent over to this country which come into competition with your own?—Very rarely, not machines in general, the Americans have sent some special machinery for rifle making

1713. You are very much employed in the making of the fine screws, which divide the inch infinitesimally, and I believe you were the first to introduce them, were you not?—With regard to screws, before I took the thing up, every separate engineer had his own particular screw, they all varied, and there were very often fractions which nobody knew much about, so that when a locomotive establishment ordered locomotives from different engineers, they had all those different screws in them, and there was in consequence great complication. It was just the same in the Royal Navy, every engineer had a different size, and in fact a different screw. After some years, I got the Admiralty to adopt a given screw, and by degrees we have now got it everywhere. I believe there is now not a marine engine in the kingdom which has not got the same screw, and the same size, so that what is an inch in one place is an inch in the other, but formerly there was the small inch and the big inch, and at one place you found one, and at another place the other.

1714. I suppose you find the use of those fine screws an immense advantage in the manufacture of rifles and small arms of all kinds?—Yes.

1715. Do you find any material competition in regard to those small arms, from parts such as Liège, in Belgium?—I believe they can make small arms in Birmingham as cheap as at any place in the world.

1716. I understand the conditions of examination for these scholarships are, that the candidates must be under 26 years of age, and that the condition of the candidature for the exhibitions are,

that they must be under 22 years of age, but neither of those competitions do you fix a minimum age?—No

1717. So that even as to a boy of 12 or 13 years of age, it would be quite open to him to enter the competition?—Yes.

1718. The competition, in fact, is for the scholarships only, and not for the exhibitions?—Yes.

1719. I observe, moreover, that the maximum number of marks obtainable in theoretical subjects, and those obtainable by the most skilled workmen, must be about equal?—Yes.

1720. But you do not fix a minimum?—No

1721. Then a competition for the scholarship might have a full quantity of marks for theoretical knowledge, with but a very small number of marks for the practical part of the examination?—Just so.

1722. Mr. Dixon.] Do you think those who have received the education to be given by means of your scholarships, will be afterwards content with the position of workmen?—That would depend entirely on the man's capabilities. For instance, in our establishment, I should say that we have 800 people, while we have about 20 foremen, so that there is one foreman for every 40 men. Then we have two managers, and of course we try to select the very best men for the position of manager. The foreman should also, of course, be superior to the workman. Out of 40 workmen, we only find perhaps one foreman.

1723. The object of my inquiry was to ascertain whether you do not think that after having received this education, which will be of a high class, the students will feel themselves to be above the condition of foremen, and aspire to that of masters?—There is no doubt they will. The masters will select the best of them for foremen, they will not be any the worse as workmen from having received a good education.

1724. I dare say you are aware that there are a great many gentlemen who think that the scientific education of the middle classes should be carried on at the expense of those classes, and I notice here that you say, "I venture further to express a hope that the Government will provide the necessary funds for endowing a sufficient number of professors of mechanics throughout the United Kingdom," now I want to ask you, whether you are of opinion that the scientific education of the middle classes should be aided by the Government, or left entirely to the voluntary efforts of the middle classes?—I think the Government ought to assist.

1725. Has your attention been drawn to the benefit to be derived from museums?—Yes.

1726. Would you advocate the establishment of museums in the manufacturing centres as conducive to the scientific education of the industrial classes?—Yes.

1727. In what way do you think museums might be made instrumental to the teaching of science?—I think museums, especially when they exhibit the gradations that have taken place in machinery (showing the various improvements that have taken place) are very instructive indeed.

1728. That kind of museum would be what we might call our historical museum?—Yes.

1729. You do not think it would be advisable to have the most improved machines of each class in actual work in those museums?—No, I think not;

not; that would be an expense which it would not be necessary to incur.

1730 But still you would have machinery in the museums?—Yes.

1731 To what extent and in what manner do you think the Government might be called upon to assist in the establishment and management of such museums?—I think that every locality would, to a certain extent, furnish the models and machinery for its own museum, I do not think the Government should be called upon to do that

1732 Would you think the Government might contribute in some other way; for example, towards the erection of the building?—I think the locality ought to do something. Perhaps if the locality did half the Government might do the other half

1733. Mr *Potter*] I think you referred to certain working-class apprentices that you take at 14 years of age?—Yes

1734 And those apprentices you keep to distinct departments only?—Yes. I must explain that, when a youth comes to us, say, at 14 or 16 years of age, without paying a premium (there is no indenture, and we have, strictly speaking, no apprentices,) we put the young man to that which suits him best, and the result depends entirely on himself and the progress that he makes. We do not consider that we are bound to teach him a trade

1735. It is beneficial to yourself, of course, to keep him in one division only?—Yes; but if he is a clever youth, we find it to our interest to push him on

1736. But the majority are educated in the separate departments?—Yes, certainly

1737 Do you think youths of that class would have any chance of taking these scholarships under the different handicraft heads?—Generally speaking, they would not. It is only where you find a strong mechanical instinct, and a man with brains, that he would have a chance

1738 It would be an exceptional case?—Yes

1739 You admit that they would not stand much chance in the competition against that class of pupils who go through the whole of your establishment?—Yes

1740. Have you any educational test before you take those lads?—None

1741. Do you not find, then, that a young man goes up, under those circumstances, without any knowledge except that of his speciality?—Yes.

1742. Would you not think that it would be desirable that some educational test should be come to for the lads before they go into such establishments as yours?—It would be very desirable

1743 They would not come under educational clauses of the Factory Act, of course?—No

1744 I think you have been a supporter of the Manchester School of Arts since its establishment in 1838?—Yes.

1745 You have watched the progress of that institution from that date to the present time, have you not?—Yes.

1746. Have your hands ever availed themselves to any great extent of the education given there in mechanical drawing?—Not to any great extent

1747. You did, in the first instance, bring that mechanical drawing under the cognisance of the directors, did you not?—Yes.

1748. Do any of your apprentices avail them-

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selves of the evening classes at Owen's College?

—Some of them do

1749 To any great extent?—No, I think not.

1750 Or of the Mechanics' Institution schools?—Not to any great extent

1751 All these three institutions are within half a mile from your own establishment, are they not?—About that

1752 Have you any idea that if that class of education which is given in the School of Arts, the Mechanics' Institution, and Owen's College were reduced in cost it would still be more largely diffused?—I daresay that it would

1753 You think that that would multiply sensibly the number of attendants?—Yes

1754. Have you ever heard any objection made to the rate of fees at Owen's College in the evening classes?—No

1755 With regard to the foremen and proprietors of large establishments like your own, you would say that they sprung very mainly from the working classes, who have been employed, I suppose?—Yes.

1756 Mr *Bazley*] You have a great practical knowledge of the manufacture of steel?—Yes.

1757 Are you acquainted with the state of the manufacture of steel in Prussia as well as in this country?—Yes

1758 What may be the comparative merits at this time of the steel manufactured in Prussia and the steel manufactured in this country?—

With regard to the quality of the steel made in Prussia as compared with what is now made at Sheffield, I do not think there is much difference, there are larger masses of steel made in Prussia than have been made in this country; and I think that about five years ago in the manufacture of what we call homogeneous metal, that is to say, mild steel, Mr Krupp was very much ahead of everybody else, but now, and for the last year or two, according to my own experience, I do not think there is any difference

1759 If I am correctly informed your own manufactured steel is very superior to that which is produced generally in Sheffield?—I have added a new process; that of giving compression to steel in a fluid state, so getting rid of all air bubbles and gases

1760 By that process in all probability your own steel is made greatly superior to that of Prussia?—Yes, no doubt

1761 *Chairman*] But that process is still only in course of development, is it not?—Yes.

1762 Mr *Bazley*] You have had it in operation for two or three years, I believe?—I have been prosecuting it for the last two or three years.

1763 *Chairman*] You are not bringing forth commercial products by that process are you?—Yes.

1764 Mr *Bazley*] Are you making any large guns for the public service or for the foreign service of that superior metal?—Yes, we have just sent in to our own Government two 9-inch guns

1765. And they prove to be vastly superior pieces of ordnance, do they not?—Yes.

1766. Nothing that you know of has eclipsed them in any way?—No, they are much superior to anything that has been hitherto produced

1767. And in that respect you have no competitor at all, have you?—No; it is in process of development now; it requires very powerful machinery for the large guns.

1768. Have foreign Governments sometimes applied

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applied to you for your guns or your tools?—Yes, very frequently; not so much for the guns, we have supplied the Brazilians with the whole of their guns for their ships; our own Government refusing to take our own guns of course has had an influence with other Governments,

1769. Did the Emperor of the French on one occasion send an emissary to make observations respecting your guns?—We had in Paris an exhibition of guns, and the Emperor was desirous of having the mountain gun tried at Versailles, and we had a trial, which was very satisfactory.

1770. And that gun was perfectly successful?—Yes, it was.

1771. In your opinion, is it possible to make a perfectly plane surface by any mechanical agency, or is not art more successful for that purpose than any skilled mechanism that has yet been applied?—In order to produce a true plane you require the hand, no mechanism can produce a true plane

1772. No planing machinery that you are acquainted with can do so?—No, it is quite impossible.

1773. By the method which you pursue in your own establishment you can make surfaces of so true a plane that when they are put together they adhere with great tenacity, and it is only by the application of great force that they are sundered?—Just so.

1774. You think, in fact, that we have accomplished work in this country which is not surpassed by any of our foreign competitors?—Just so

1775. Mr. *M'Lagan*] Is it the fact that in the Exhibition at Paris last year the machinery and tools from foreign countries were superior to those from this country?—No, certainly not.

1776. Was there a more extensive exhibition of those tools from foreign countries than there was from this country?—Yes

1777. But the tools themselves were not superior, you think?—They did me the honour of giving me the grand prize

1778. But I am taking the average?—The average of the English tools was superior to the average of those from foreign countries.

1779. Has there been a greater improvement in the manufacture of foreign tools during the last 10 years than there has been in this country?—There has been a greater improvement in the general manufacture of tools in foreign countries during the last 10 years than there has been in this country, because 10 years ago they were so far behind us

1780. Do you think from your own knowledge of the subject that this improvement in the foreign manufacture of tools can be attributed to the means of education afforded to workmen in other countries being superior to the means of education for workmen in this country?—I have already stated that I think the greater improvement which has taken place in foreign countries is in consequence of their being so far behind us 10 years ago; I think the average of the tools made in this country are at this moment superior to those of any other country.

1781. You say there has not been so much progress in the manufacture of tools in this country as there has been in foreign countries, owing to the fact that the manufacture in foreign countries 10 years ago was very much behind the manufacture in this country?—Yes

1782. But do you think that if workmen in

foreign countries had not had the means of educating themselves for the manufacture of those tools there would have been as much progress there in the manufacture as there has been during the last 10 years?—I think the improvement that has taken place in the manufacture of tools in foreign countries has been very much owing to their having obtained tools from this country and made copies

1783. In what country did you observe the greatest improvement in the manufacture of tools at the Exhibition in Paris last year?—I should think Prussia.

1784. Did you observe any great improvement in America?—Yes, in America also.

1785. Are not the means of education in those two countries much greater than in almost any other country in the world?—Yes, I believe so.

1786. Then may we not infer from that that the means of education for workmen has probably something to do with the improvement in the manufacture of tools?—Yes, I should say so.

1787. Mr. *Lowther*] Have you visited Mr. Krupp's works?—Never. I have been in the habit of using his material

1788. But you have not seen his men at work, have you?—No.

1789. Mr. *Acland*] I think you said you thought it desirable that the middle classes should be able to have the means of obtaining scientific instruction, will you be so good as to give your reason for that, because it would seem at first sight that, as scientific instruction for the purposes of this Committee, is supposed to be the means of spending capital advantageously, persons having capital should find the means of getting the education for themselves?—I confined myself to the providing of professors, and I think that probably in any locality that would raise a certain amount for a college or school, it might be desirable for the Government to give a similar sum for the purpose.

1790. Is your reason for that, that you think it desirable at the present time, and under the existing circumstances of this country, that the Government should give a stimulus to that object, or do you think that the different localities engaged in industry ought permanently to lean on the central Government for the purpose of getting that education?—I think the different localities should do, in fact they ought to do it, but they have not done it, and I think it is so important for the interests of this country that it should be done, that I should be very glad if the Government would step in.

1791. Do you think that if the subject is fairly put before the country, persons having capital will be found indisposed to pay reasonable fees for scientific instruction for their children, with a view to their getting on in business in after life?—I do not know that you can say that the middle classes are backward in that respect.

1792. I understood you to say that persons frequently paid about 100L a year for the purpose of enabling their sons to acquire technical knowledge and experience in manufacture?—Yes.

1793. Do you think that when once the importance of scientific instruction is recognised in this country, that the same motive will not induce people to pay reasonable fees for competent scientific instruction?—No doubt many would; but it is desirable to educate the working classes as well. My object is to make good foremen

men and good managers. Then in order to get those, you must educate a great number, because it is only where the man has got the requisite intellect that he can become a foreman or manager, he must have the brains for the work. Take our own establishment, we have one foreman to 40 workmen, but we would like to have the 40 workmen educated, and take out the best of them for foremen

1794 Do you then think it is for the public and national interest that those 40 workmen should be educated at the public expense?—To a certain extent, I would have the Government provide professors, so that the public could attend lectures, for the purpose of getting the desired instruction.

1795. Do you think that those workmen, having, as I suppose they have, pretty high wages, would not be able to pay moderate fees for such lectures?—Practically, we find that we do not get sufficiently educated workmen

1796 If the Government were to confine itself to the organisation and inspection of these public institutions, should you say that would meet the case, leaving the parties directly and personally interested to pay the current expenses of the education conferred?—I cannot say

1797 What is your opinion with regard to the institution of model workshops attached to universities or schools, such as King's College, or Owen's College, for the purpose of giving a training in practical skill, do you think that practical skill can be given in a model workshop which is not established for business, but simply for teaching?—I think that, as has been stated in the letter, youths may learn the simple use of tools in almost every village from the carpenter or smith. I would not have a youth make machinery in a school or college

1798 Admitting fully that, as you say that knowledge may be acquired anywhere, and under real workmen in that way, the Committee would be glad to have your opinion of the real value and utility of what are called model workshops, do you think they teach much, or is it better to leave the people to pick up the knowledge where they can in places of real business?—Decidedly

1799 Your opinion is not favourable to model workshops?—Certainly not

1800 In reference to this memorandum signed by yourself, dated the 4th of May, may we understand that the subjects here laid down have been matter of consultation between yourself and the department, or are they purely your own views?—I have been in consultation with regard to the whole of those with Mr Cole, and have received the greatest assistance from him, but the whole of the scheme with regard to the combination of handicraft with theoretical knowledge is my own suggestion

1801 Referring to the syllabus issued by the department in which elementary mathematics are included, I think there are certain specifications of the requirements for the fifth class and the fourth class?—Yes

1802. Would you kindly state, if you conveniently can, what you require under class five of your own memorandum for elementary mathematics as a qualifying examination for your

scholarships?—That I should leave entirely to the Science and Art Department, and to professors

1803. For a student of the fifth class which requires one book of Euclid, would that be sufficient as qualifying him, in your opinion, or would you go higher?—I would go as high as I found in practice could really be got

1804 I am speaking of the qualifying examination named in No 5, not the competitive examination named in No 4?—Whether they might be considered to have a satisfactory knowledge of the subjects named would be ascertained when the examination took place

1805 You were asked just now whether there was any minimum required in your view of theoretical knowledge, and I understood that the question rather suggested that on your plan a mere workman would beat the others, but do you not, in fact, require a reasonable standard of theoretical knowledge from all of them?—Yes, certainly

1806 Lord *Frederic Cavendish*] Do you propose that the Government should also appoint those professors whom you recommend that they should endow?—I think it would be well for the Government to take the recommendations of the locality, I think the locality ought to be appealed to. For instance, in the case which I mentioned with regard to Manchester, considering the great extent of the cotton manufacture, it would be desirable there to have a professor who was specially acquainted with the cotton machinery. I think the Government should take the recommendation from Manchester

1807 The recommendations of individuals, not of a consultative body?—Just so.

1808 Do you propose that they should teach not only the first principles of mechanics, but also how to apply those principles to particular departments of industry?—Yes, to a particular manufacture, in fact, that the professor should be practically acquainted with the cotton manufacture.

1809 Do you not think that there would be a danger of a Government professor exciting ridicule if he were to go down to a manufacturing town and teach manufacturers how to improve their machinery?—It would much improve a youth who wanted to be a manufacturer, the son of a manufacturer perhaps who would have to continue his father's business may get a great deal of knowledge with a competent professor to teach him.

1810 Do you not think it would be better that they should be instructed in the general principles of mechanics, and learn the details in manufactories?—I would do that also, but if a youth's education had been with reference to mill work from a professor who had studied it, it would certainly benefit him very much.

1811 *Chairman*] With regard to the appointment of professors, I suppose you would look to the interest of the working class as well as the middle class, you would wish that men highly qualified should reside in different manufacturing districts, in order that both those classes should be able alike to receive instruction from them?—Certainly.

J.
Whitworth,
Esq.
7 May 1868

ROBERT HUNT, Esq., F.R.S., called in; and Examined

E. Hunt, 1812 *Chairman*] You are the Keeper of the
Esq., F.R.S. Mining Records?—I am

7 May 1868 1813. As such, I believe you pay periodical
visits to the different mining and metallurgical
districts of the kingdom?—To all of them through-
out the United Kingdom

1814 And I believe that those establishments
have been freely and courteously thrown open
to you?—Quite so

1815 You are, therefore, well acquainted with
the methods and processes carried on in various
localities?—In all cases connected with mining
and metallurgy, and also with some other manu-
factures

1816. You are also acquainted, I suppose, with
the facilities for scientific instruction in the
various localities?—For about 28 years my atten-
tion has been specially turned to that subject in
relation to mining.

1817. But not so specially as to metallurgy?
—Not so directly.

1818 Did you find that there is amongst the
proprietors and the workmen in mines, and
amongst the analogous classes in reference to
metallurgy, an increased desire for scientific
knowledge of the art which they practice?—
Amongst the working miners I think it is un-
doubtedly so. There is an increasing desire for
such scientific knowledge as is directly applicable
to their bread getting. I am sorry that I cannot
say the same with regard to the proprietors.
With few exceptions, I find there is rather oppo-
sition than otherwise

1819 *Mr Bruce*] Do you mean an opposition
on the part of the mine owners to the education
of the miners, or a reluctance to increase their
own scientific knowledge?—Rather that there is
a reluctance on the part of the owners of mines
to the workmen increasing their knowledge. I
believe it to be a fear that they would be spoiled
as hewers of wood and drawers of water

1820 *Chairman.*] But, with regard to the
owners and managers, are they more disposed
than they were to instruct themselves or their
relatives, or to get them instructed?—I do not
think there is a very general desire for an increase
of scientific knowledge among that class

1821. That is with regard to mining?—Yes,
and also metallurgy.

1822 Is it not the case, then, that in many of
the large metallurgical establishments there is
now what I may call a chemical or metallurgical
laboratory; a scientific department, in fact?—In
many of those it is so; or I should rather say,
instead of many, in some of them. For example,
at the Dowlas Works they have there a regular
chemist, who is employed in the analysis of ore;
the same in Brown and Company's Works at
Sheffield. In large works of that class they have
their chemist, but that seems to be the only
scientific department. If we look at the dye
works and chemical manufactures there, we shall
find that they have generally a superior chemist
to direct their works; but the value which is set
upon that department must be measured to a
certain extent by the salaries which are given to
those men, and those salaries are really very
small for the kind of education which the men
possess.

1823 You are speaking now of chemists?—
Yes.

1824. But have you not found, that chemists
have been in many instances promoted to the
management of works, having begun by entering
into the laboratory?—I only know one or two
cases of that kind.

1825 Do you know many instances where
educated mechanical engineers are now employed
as managers, whereas formerly men who merely
possessed the routine of metallurgical operations,
held those appointments?—I do not know that I
can speak of that in connection with metallurgy;
but certainly, in some of our mining operations, I
know of such people.

1826. But on the whole you would say, per-
haps, that there is an increasing demand for
theoretical knowledge among the managers but
not a rapidly increasing demand?—There ap-
pears to be an increasing desire, certainly; but
there appears to be also an exceeding amount of
uncertainty with regard to the proprietors them-
selves, as to the value of the advantages they
might expect to derive from such knowledge.
Again and again I hear a remark like this "We
do not desire our workmen to come here in kid
gloves." With regard to the Miners' Association,
which I organised nine years ago in Cornwall, I
have been met, again and again, by some of our
largest mine proprietors with the statement, that
they believe I have been doing great mischief;
and when I ask why, they say, because you will
make these men so vain that we shall not be able
to get them to do their work. The result, how-
ever, as far as I can see it, has been just the
contrary, these working miners, young men who
have been educated by the Miners' Association—
many of them still remaining as working men—
have not shown anything like that vanity which
has been expected, and certainly their self-
conceit has not been increased. I might men-
tion a striking instance of a young man working
under ground at the present time, in Botallack
Mine, near the Land's End, who has carried off
the gold medal in Mineralogy, in the examina-
tion of the Department of Science and Art, but
that young man, still in the mine, is well content
to use the pick and gad. There are several other
cases of the kind to which I might point

1827. Do you think any great advance has
taken place in our mining and metallurgical
operations?—Certainly

1828 And so far as you are acquainted with
similar industries abroad, do you think that the
proportionate advance abroad has been much
greater than the advance which has been made
in this country?—I have no actual knowledge of
the condition of either mining or metallurgy
abroad, so that I cannot fairly answer that ques-
tion

1829. With regard to this mining school in
Cornwall, it is, I believe, a school in connection
with the Department of Science and Art?—It is
in connection with the Department of Science
and Art to the extent that the teachers have
been certified by the Science and Art Depart-
ment, and therefore they are entitled to the
money on the passed students. Also the prizes
held out by the Science and Art Department
are an inducement to the students of the classes
in their studies, but beyond that there is no con-
nection between the Miners' Association and the
Science and Art Department.

1830. The

1830. The young men who attend the classes of those certificated teachers are the ordinary working men, I presume?—They are, with very few exceptions, working miners.—the exceptions being young clerks in the counting-houses on the mines, or in one or two cases, perhaps, the sons of the managers of the mines. But speaking generally, those students are working men.

1831. Setting aside those exceptional instances of which you have spoken, do you think that the instruction given in those science classes is making an impression on the working men?—Yes.

1832. You think it is tending to increase their scientific knowledge to an appreciable extent?—Yes.

1833. And to a useful extent?—No doubt, two students, who had been connected with the Miners' Association, are now managers of departments in the large smelting works at Swansea. Several have taken very excellent positions in connection with mining operations abroad, and there are some others who are advancing to take the position of managers at home.

1834. In fact, in those classes, working men are being trained to hold superior situations?—Exactly.

1835. Mr *Bruce*] And so far the fears of the masters are realised?—Yes, so far.

1836. *Chairman*] You are in fact doing the work successfully?—With fair success, the number of students desiring instruction is large, the difficulty we have to contend with is the want of money to carry on the classes in the different districts. Perhaps it would be satisfactory if I were here to explain the history and operations of the Mining Association. The late Sir Charles Lemon, 25 years ago, being impressed with the advantages of scientific education, offered to the county of Cornwall a piece of ground on which to build a mining school, 500*l* towards the building, and to endow that school with 20,000*l*, provided the County would submit to a tax of a farthing on the ton of copper ore raised in the county, but that farthing a ton decided the question against Sir Charles Lemon's effort. Sir Charles Lemon, notwithstanding, commenced a school at Truro, in which he had three professors, the Rev Mr. Moseley was one, then teaching mechanics, Mr. Prudeaux of Plymouth, a well known chemist, taught chemistry, and Mr. Dickson, the present Inspector of Mines for Lancashire, was the teacher of Mine Engineering. That school was carried on at Sir Charles Lemon's expense for three years, and several of the young men so educated, who are now alive, are in the position of managers. Subsequently, Sir Charles Lemon, having abandoned the scheme, Dr. Barham of Truro endeavoured to continue it, and by the aid of subscriptions from Mr. Robarts, Sir Charles Lemon, and some other gentlemen in the county, the school was for some years carried on at Truro, but it was found that there was as much difficulty in getting the miners to go to Truro as if the school had been in London, and it was abandoned. I then thought I would make an effort to take the school to the miners, instead of placing the school in a centre, which the miner must be at some cost to reach. With the assistance of the present Members for the county, Mr. St. Aubyn, Mr. Kendall, Mr. Robarts, and Mr. Davy, I succeeded in arranging the Miners' Association, so called; and the plan to be adopted was, that to every mining centre

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where we could get a class of 10, we should send a teacher. At one time our subscriptions were in better condition than they are now, we had eight classes in operation, whereas now we have only three. the subscriptions have fallen off mainly on account of the severe depression which has fallen on Cornish mining within the last two or three years. We have now a class at St. Just, which contains 12 students, a class at St. Breage, near Helstone, which contains 20 students, and one at Camborne, which contains 18 students.

1837. Mr *Bruce*] What is the rank in life of those students?—They are all of them either miners, working underground, or in some way young men connected with mines; the sons of mechanics in all cases.

1838. *Chairman*] Do they pay any fee?—They pay 5*s* a year, but if any of the young men are under 16 we admit them for 2*s* 6*d* a year to a course of lectures, varying from 20 to 40, according to the arrangements of the teachers.

1839. What is the cost per head?—The cost of the working of the Association at the present time is about 200*l* a year.

1840. With regard to all those classes?—Yes, the only payment we have to make is to the teacher, to whom we give 100*l* a year. We pay his travelling expenses, as well as the expenses connected with the classes, namely, the apparatus and the chemicals that are used; we purchase the books for the students which we sell to them at half the cost.

1841. What is the entire number of your students?—It is about 40 at this time. Of course if each individual class had been large the teacher could manage them, but we cannot work more than three classes at a time, the teacher goes from one place to another taking the three within the week.

1842. I suppose a very slight increase of the subscriptions would enable you to provide instruction for a greater number of pupils?—Four years ago we had two teachers, and then we kept from six to eight classes in operation; we are now teaching Chemistry and the use of the blowpipe, and the ordinary processes of Metallurgy, and Mineralogy. We desire also to teach Mechanics, but we are not now doing it, though a few years since we were doing so. We had a teacher of mechanics who taught mechanical engineering, the principles of applied mechanics and mechanical drawing, but for want of funds, that is now suspended.

1843. Is there in the county of Cornwall a good chemical or metallurgical laboratory, or have you both?—There is neither, when Sir Charles Lemon established his school at Truro he then had a laboratory fitted up in connection with the Royal Institution, where there is an excellent museum, and the Committee of the Royal Institution allow the Mines Association the use of that laboratory, but it is not open for any purpose beyond the mere use of the laboratory.

1844. Not for instruction in analysis or assaying?—In each of the classes we have assaying furnaces and a small collection of apparatus just sufficient for the young men to repeat the experiments which the lecturer may have been explaining to them, we have a small laboratory at each place where a class is established.

1845. The instruction given is actual individual instruction in the elements of chemistry and assaying?—It is by lectures once a week to each class, between that lecture and the lecture next

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week, it is expected that the students will themselves work out some of the problems which the lecturer has been dealing with, and that they shall be prepared to meet him on the following week; I might here state that those young men take the greatest possible interest in doing the work themselves, especially in testing the ores of copper, either by the ordinary wet process or by assaying.

1846 Are you aware whether there is any institution of a similar kind in any other part of England?—I think not.

1847 Or in Scotland?—I believe not, there was a mining school in Glasgow which was given up for want of funds; there was also a mining school at Bristol which was for some time supported from the purse of Mr. Handel Cossham, but I believe that also died out, though I am not quite sure of that.

1848 You are not aware that that school has been re-established lately?—No.

1849 Have you had any communication with persons in the North of England with regard to the establishment of a similar school in Northumberland?—I have been recently in Newcastle lecturing at the Philosophical Institution there, and I had some talk with the council; they were expressing an earnest desire that some such establishment should be carried out in connection with the Philosophical Institution at Newcastle.

1850 Are you of opinion that a similar school to that of which you have given us the detail in Cornwall, would *mutatis mutandis* be of great use in the colliery districts?—I think such schools would be of the utmost value in the colliery districts.

1851 Will you be so kind as to state in what particulars you think they would be of use?—With regard to the operation of such teaching on the colliers as a body, there might be some difficulty in expressing an opinion, but such classes being established, I am quite sure, would bring out from among them the most intelligent, and the most industrious, and they would become acquainted with things which it is very desirable for them to know, such as the laws regulating the flow of fluids—air or water—and the conditions which are involved in the development of gases from coal, and generally, the principles, by the application of which they may protect themselves from the influence of those destructive gases. It appears to me that a large number of those men are now absolutely ignorant of the principles of the safety lamp, if they once became well acquainted with the principles of the safety lamp, they would be able to use it more judiciously. They should know the principles of ventilation, and instead of doing, as they now do, things to interfere with the ventilating arrangements of the mine, they would endeavour to carry out those arrangements, and perhaps improve them.

1852 Apart from all other considerations, you think that the safety of fiery coal mines would be very much increased by the establishment of mining schools in those districts?—Decidedly I think there would be a most important improvement in the course of a few years.

1853 Are you aware that there was a mining school at Wigan?—I was aware of it; but I had forgotten it for the moment.

1854 Is that mining school in existence?—I am told that it is not, but I do not personally know the fact.

1855 Then an attempt was made at Wigan to establish a school which, for some reason, has ceased to exist?—It was in operation for many years.

1856. Mr. Bruce.] I suppose there are some special reasons why those schools should flourish in Cornwall, one of which may be the fact that the miners generally have a larger personal interest in the working of the mines than they have in other places?—I do not fancy that that has any special operation. I think it is the circumstance that some few of the mine owners, and others, proprietors of the land, gentlemen of the county,—seeing that the schools would be advantageous, have subscribed to support the schools.

1857 You are well acquainted with the mining population in various parts of the country?—Yes.

1858. Should you consider the Cornish miners to be especially intelligent, and, speaking with regard to their opportunities, a well-educated class of men?—The Cornish miners are essentially a religious body. They are a thinking body of men, and generally industrious, and their perceptive powers are exceedingly good, but their reflective powers require training. They are men of impulse, and, consequently, our great idea for many years with regard to these schools has been, that, rather of cultivating good mental habits than the mere acquirement of scientific knowledge.

1859. I suppose the real security against any large number of the men being diverted by education from manual labour is, that the number of men who can rise above the necessity of manual labour, is limited, by nature, by the want of intellectual power?—Yes, certainly.

1860 But, as a matter of fact, I suppose the masters are right in thinking that those men who avail themselves of those opportunities, do emerge from the class of manual labourers?—If a man shows that he possesses a large amount of knowledge or intelligence, he is naturally seized upon by some proprietor or manager, to the mutual profit of both the parties.

1861 And on the whole there is no class that profits more by such education being given to such men than the employing class?—Just so.

1862. Chairman.] Should you not say that the true remedy against any alleged evil supposed to arise from education in raising any particular man above his class would be raising the whole class; levelling upwards?—Beyond all doubt that is so.

1863. Mr. Bruce.] Do you see your way to supply that want of local individual effort which has prevented the foundation of schools such as you have described in other mining districts?—I think so.

1864. Then how would you do it?—In the first instance it would be done by interesting a certain number of the proprietors of mines or owners of metallurgical works, who in all cases should raise a certain sum to support the teachers; and then I think it is really desirable that the Government should be persuaded to give encouragement to such efforts.

1865. But you complain of the apathy of the employers, as a class, and their indifference to the instruction of their workmen?—Yes, but there are splendid exceptions.

1866. It seems to me that you would still depend upon their taking the initiative?—Yes; I should depend on their taking the initiative; I am afraid the attempt would not otherwise be a success.

1867. Ther

1867. Then I understand you to say that you would rather look to the general progress of education and the diffusion of sounder opinions on this subject, than to any immediate effort that might be made?—I should. I fear that there is at the present time a very imperfect knowledge of the value of science among the employing class, and certainly there is a large amount of doubt in their minds as to the value of that which we call technical education.

1868. There is an enormous sacrifice of health if not of life, in the mining districts in Cornwall from the absence of due attention to ventilation, is there not?—Not so much as to ventilation as from the absence of attention to the means of descending to and ascending from the mines.

1869. But is it not the fact that the miners work in very bad air, in excessive heat, and in air which is filled with dust?—The only deficiency of ventilation in the Cornish mines is in what are called the close ends, that is to say, when they are driving onwards, before they have made a connection with the level above or below them. But taking all the main parts of the mine, a natural ventilation exists, and the air in almost all cases is good.

1870. I believe it has been established that the life of the miner is considerably shorter than the life of those who are employed above ground and even of the colliers?—The average duration of the Cornish miner's life is 35 years. From a very long experience (more than half my life) my own impression is, that their bad health is due to the operation of climbing, and to the bad character of their food, which latter may be referred to the circumstance that their wives are employed in the mines, and consequently that they have none of that instruction which would fit them for being good housekeepers. The men live on a weak broth or an indigestible paste, and have an amount of nourishment which is insufficient to enable them to support the enormous labours which they have to endure in climbing the ladders from the deep mines.

1871. I suppose that even where science classes are established, they are but little frequented by the colliers in the colliery districts?—I can only speak with certainty of Glasgow; there I found on two or three occasions a school of 18 or 20 intelligent young scholars who were receiving instruction very readily, and showing great industry, as I learned from their teachers.

1872. Instruction in the branches of science bearing on their trade?—Yes, either mine-surveying or the laws of motion with regard to the passage of currents of air and water, a knowledge of the ordinary principles of mechanics and the like.

1873. Then you are already of opinion that the multiplication of men having that knowledge would tend greatly to diminish the number of deplorable accidents in mining and colliery districts?—I think it is the only thing to which you can look for the purpose of diminishing the number of such accidents.

1874. *Chairman.*] With regard to what you stated about the health of the miners being injured by the climbing in some of the Cornish mines, there are engines called man-engines for carrying the men to their work and bringing them up to the surface again; is it found that in the mines where those engines are established the average of life is higher than in the mines where such engines are not in use?—Our experience

in that respect is so little that an expression of opinion would perhaps be premature. The man engine was introduced at the Tresavean mine, some 25 years ago, but it only continued in operation a few years. There was an impression that the miners had been greatly improved by its use. There are six mines in the county in which those engines are established, and the impression in all those cases is that the men are greatly relieved by it, and exhibit better health. I think there is no doubt of the fact, but a longer time is required before we can pronounce upon it.

1875. *Mr Akroyd.*] The total number of students which you now have in Cornwall under teaching in your association is about 40, you say?—Yes.

1876. That appears a small number in proportion to your population, and to the organisation in question?—Yes, one reason of the smallness of the number is the enormous amount of migration which has been going on from Cornwall during the last two years. I had occasion last year to make special inquiries on that subject, and I found that 8,000 men had left the country, and of course, those 8,000 were the best of their class, for they were naturally the self-reliant men. About 1,000 of them have distributed themselves over our own collieries, while the others have gone to Foreign Countries.

1877. Some of them to Australia, and the gold mines?—Yes, and to the copper mines, a large number have gone to Lake Superior, and many of them to California.

1878. You find, I suppose, that one difficulty in your way is the ignorance of the miner class in elementary education?—Yes, that is one of our greatest difficulties, the complaint of the teachers is, that the men do not write with sufficient facility to take notes, that they have not sufficient knowledge of arithmetic to enable them to calculate per-centages.

1879. Has your attention been called to the proposed extension of the Factories Act, and the application of its provisions to youths of the mining class?—I have long seen the importance, as far as the mining class is concerned, of introducing the same system of rudimentary scientific education, or improved education, into the schools generally of the county of Cornwall.

1880. You are aware, are you not, that now under the Factories Act, attendance at schools would be compulsory?—Yes.

1881. And you think that the greater spread of elementary education would give you greater facilities for the further spread of technical education?—Yes.

1882. You were saying that there was a prejudice on the part of owners of mines against what they call "Kid-glove workmen," do you find that that militates against the spread of technical education?—Yes, there is that prejudice, and there is also a prejudice among the mine agents, which may be rather called a fear, lest the young men should grow up with more intelligence than they themselves possess, and push them from their places.

1883. So that it hardly pays for the young miners to devote much time to study, because there is first a prejudice against them on the part of their employers, and then this other prejudice?—Yes.

1884. You mentioned a young man who still handles the pick-axe, though he had taken the gold medal in mineralogy at the Department of

*R. Hunt,
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Science and Art?—Yes; and I might mention other things of the kind, though I must add that I hope that he will soon get a better position, because he deserves it.

1885. You think, I presume, that there is a want of attention generally on the part of the public to these studies?—Yes.

1886. And you state that there is no such institution elsewhere as this miner's association in Cornwall?—Cornwall and Devonshire.

1887. Do you think it would be possible to introduce them elsewhere, and that for that purpose a little further assistance on the part of the department might be advisable?—We know what has been effected in Cornwall by the efforts of two or three individuals, and by similar efforts in other districts, I believe similar schools might be established.

1888. Would you leave it to individual efforts, or would you not rather organise some association to carry out such schools elsewhere?—I think that would be most desirable; for the present, I think it must be left to individual effort in any district.

1889. You stated that the average age of the Cornish miner was only 35 years?—Yes.

1890. Has your association done anything to inculcate sanitary science among those miners?—Only to a very limited extent, we have had quite sufficient on our hands, but I might mention that working in immediate connection with the Royal Cornwall Polytechnic Society, a good deal has been done to inculcate those matters.

1891. Do you not think that lectures on physiology and the art of preserving health would have great value in adding to what you are now doing for those miners?—No doubt.

1892. Mr. Dixon.] In what precise way do the working miners themselves expect to derive benefit from science education, is it solely that they may be able to rise above their class, or is it that to some extent they may earn greater wages in it?—On the one hand, certainly they hope to rise from the position of working miners to that of being captains or mine agents, or directors of such works generally, but on the other hand there is a system of payment in Cornwall which is called working by tribute pitches, that is to say, the miners become shareholders with the adventurers of the mines, receiving a certain proportion of the value of the ore which they get out of the lode. Hence it is that they feel the importance of such scientific knowledge as would enable them to determine what might be the value of the metal contained in the ore. Then again, also there is a very strong desire among a large number of young men for the mere acquirement of knowledge independently of all thought of profiting by it. The simple desire to know.

1893. Is the sole cause of the falling off in the number of the classes of the Mining Association from twelve to three, the diminution in the amount of voluntary subscriptions, or is it in part owing to a falling off in the number of pupils wishing to be taught?—The falling off of the subscriptions has been greatly owing to the depression of the mining interest, a large number of the mines subscribed annually to the Association, but now there is only one so subscribing, consequently we have been obliged to dispense with one teacher, and have now only one teaching, and then again a large number of the more intelligent young men have gone abroad.

1894. So that even if the Government had

been disposed to make up the deficiency in the subscription list, still there would have been a falling off in the number of classes?—If we could have employed a second teacher instead of having three classes at work, we should have had six, we could have doubled the number of classes at once; there are several districts which are very desirous of having classes established, they are compelled to wait until the classes now established shall have finished their courses of instruction.

1895. Do you think that the various schools in the mining districts alluded to as having been discontinued, would have continued to flourish if Government aid could have been granted to them?—I think I may certainly say for Glasgow more especially that the schools fall off entirely from the want of funds to pay the teachers.

1896. You would therefore advocate Government aid being granted to schools of that description?—I think I should be rather sorry to see the Government supporting a school, but I believe a great deal might be done by the Government giving a certain amount of assistance to maintaining a school which had once been established.

1897. Chairman.] In addition to the payment on results?—In addition to the payment on results, with regard to the operation of the association we have had two teachers, and we have just elected a third, our first two teachers, who were both of them very excellent instructors, left us because we could not afford to pay them more than 100 l. a-year. They have now got something very much better; one is a manager of a department of the Williams' Copper Works at Swansea, and the other has gone out on the mineralogical survey for the Viceroy of Egypt; if we could have insured them 200 l. or 250 l. a-year we might perhaps have kept them. It is a very serious thing for us to lose teachers in that way; if a grant of 50 l. a-year were allowed to the Association, and then if something in addition was obtainable on results the income would be brought up to the sum required.

1898. Mr. Dixon.] Speaking generally of the schools in the mining districts, are not buildings required to be erected before a school can be opened?—We have had no such thing done in any one case, we have either been allowed the use of the National or British school rooms, or we have got a room which had been the counting-house of an abandoned mine, and in those places we have been allowed to put up a furnace and arrange all our little material. Then in some cases we have connected ourselves with the Mechanics' Institutions of the district, who have rooms available for those purposes. The expense of a room has not at any time been a point of any moment. We require that the classes when formed in any district should provide for themselves a room for the teacher.

1899. You have never had any difficulty in that respect?—None.

1900. Have there been any other preliminary expenses such as providing a laboratory?—In each of those class-rooms we have been at the expense of providing a certain quantity of apparatus and material.

1901. Has there ever been any difficulty about that?—The only difficulty has been the difficulty of our finding funds; of course the material is costly and some of it is constantly being destroyed, so that the expense is considerable.

1902. But that difficulty has never prevented the establishment of a class?—Never; at one time the

the Department of Science and Art provided us with chemicals and also with material, now anything which is liable to destruction is not supplied by them, and we are thrown entirely on our own resources.

1903 *Chairman*] But do they not make a reduction of 50 per cent. on apparatus of all kinds? On permanent apparatus they do, but not on the class of things which are destructible.

1904 *Mr Bazley*] Are you aware that a considerable number of workmen in Cornwall have emigrated to Portugal?—I am aware that some of them have done so.

1905 What may be the extent of the diminution of the mining population of Cornwall by that emigration?—Last year I found that within the previous two years 8,000 miners, in round numbers, had left the country.

1906. Do the wives and families of the emigrants generally accompany them?—Not generally.

1907. As the precursor to any considerable amount of attainment in scientific knowledge, you are decidedly of opinion, that more preparatory elementary instruction is necessary?—Certainly

1908. *Mr Read.*] Did those miners, who emigrated to Portugal, leave wives and children behind them, or were they chiefly single men?—I cannot speak particularly with regard to those who went to Portugal; but nearly all of those who emigrated, left wives and families at home, since that time, some of them who have done well, have sent for their wives and families.

1909. To what class of pupils did you especially refer, when you stated that their knowledge of reading, writing, and arithmetic, was so limited, that they could not satisfactorily follow the lectures?—To the working miners who attend the classes of the Miners' Association

1910 Adults, or young boys?—At ages varying from 16 to 25.

1911. Have you any pupils from abroad?—None

1912 Do any of those men that you educate go abroad?—A great number.

1913 To what parts generally do they go?—To Australia and the district of Lake Superior.

1914. *Chairman.*] Do any of them go to the west coast of South America?—I do not remember any who have gone there; but there are several in California, and it is possible that there may be some in Chili.

1915. *Mr. Lowther*] Did you go to the Paris Exhibition?—No.

1916. Then you do not know how we stand with regard to our neighbours in relation to mining?—No; but I might say that I am perfectly satisfied that in many departments of mining we are behind the German miners.

1917. On what do you found that opinion?—On my knowledge of the machinery which the Germans are using in their mines, that is to say, merely from their published descriptions of machinery: their winding machinery, and their machinery for dressing are superior to ours as a rule.

1918. Can you state why the English miners do not adopt the superior machinery of the German miners?—I can only refer it to Celtic prejudice.

1919. *Chairman.*] You are now speaking of metallic mines, and not of coal mines?—Just so.

1920 *Mr. Lowther*] There is an unwilling-

ness, is there, to adopt new ideas from abroad?—A considerable amount of unwillingness

1921 They do not see the value of them, I suppose?—No, they think they have gone on very well with such appliances as they now have, and that they may still go on with them

1922. Though these young men of whom you speak are anxious to acquire knowledge upon the mines, they do not wish to acquire a knowledge of that improved machinery then?—They do desire to acquire the knowledge, and they do acquire it in fact, but the difficulty is to get that knowledge applied, because there are so many conflicting interests to interfere with it.

1923. Do you not think that if the Government were to give money towards those schools, the Government would have to interfere with the management of the schools?—I do not see why it should be so, though possibly the granting of the money might lead to some interference. But where a sufficient sum was raised by the locality, I suppose the locality would still retain a sufficient amount of power in the direction of the school to prevent any feeling in the district with regard to Government interference

1924 *Chairman*] You would expect, that if any Government grant were given besides a payment on results, there should be some guarantee for the permanence of the school?—Certainly

1925. *Mr. Lowther.*] Do you think that these people sufficiently feel the importance of more knowledge of mining matters?—I think there is a strong feeling that something is to be gained by scientific knowledge. Perhaps they could not tell you what they expected to gain, but there is now a feeling of that kind, especially with regard to our deep mines. Seeing that our miners are working under the greatest possible difficulty in those mines, as they are in competition with the Foreigners, with much richer mines. They feel that it will be necessary to improve their machinery for working those deep mines, and their apparatus for the dressing of the ore.

1926. And they could only do that by advanced science, combined with experience?—Just so

1927. *Chairman.*] I believe you have taken an opportunity in the course of your instruction of bringing before your pupils examples of the mode of conducting mining operations abroad?—We have now two meetings in the year, a general meeting and an annual meeting. At the annual meeting, more especially, we endeavour to get all the information relative to the appliances which we deem may be useful. We have also endeavoured to organise, but not with entire success, a system of mutual instruction by the members of the Mining Association. A proposal was made to have quarterly meetings, at which the mine agents and experienced miners might give us the result of their experience; but those have failed, mainly from the difficulty the men have in writing a paper, the failure in that respect is really a most serious one. We are continually losing, from that cause, the valuable knowledge which experienced miners have gained. A man gets most important knowledge in a certain district, with regard to the distribution of the lodes within that district; he keeps that knowledge to himself, he dies, and his son has to begin again where his father began. I have been for years trying to encourage those meetings, but we have not been very successful.

1928. *Mr Lowther.*] There is no general inter-

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change of ideas among the miners on these matters?—No.

1929. Do you belong to the Mining Association yourself?—Yes.

1930. Are there other associations of the kind in England?—There are several so-called miners' associations in England, but they have most of them rather a political than a social or educational bearing.

1931. Do you among yourselves have any interchange of opinion, by means of reports, with any other mining association?—No.

1932. You remain perfectly alone?—Yes.

1933 *Chairman.*] But as keeper of the Mining Records, you circulate throughout the country the information which you collect from all the different mining localities?—Yes; the mineral statistics, which are published for the Government, circulate throughout the kingdom, and I may say throughout the world.

1934. Mr *Lovther.*] Do you get anything in exchange for those papers?—Yes, we get the publications which are issued by the South Wales and by the Newcastle mining engineers, for example, and they form part of our library. We also get in exchange papers from abroad. My mineral statistics go to France and Belgium, and their mineral statistics are sent to me.

1935. Do you read them?—Yes, or I would qualify that, by saying that I examine them.

1936. Mr *Acland.*] You have at present no local connection with Cornwall but what you have as a Government office?—I have no connection beyond that.

1937. I understood you to say that you have had great difficulties in promoting the advance of scientific education among miners?—Yes.

1938. Will you kindly point out some of the difficulties so far as they arise, from the ordinary occupation of the wages-earning miners; at what age does the son of a miner begin to earn money?—In the metalliferous mines generally boys and girls begin to work at a very early age. You will find on the dressing floors of Cornwall children of six years employed in picking over the ore, and from that time they begin to earn money; they are kept at their work in fact to the exclusion of the possibility of school education.

1939. Has the law made any provision affecting those children who are now earning money without having received any education?—The only provision made by the law is, that they are not allowed to go underground under a certain age, but there is no restriction with regard to their working on the surface of the mine.

1940. What sort of education does an ordinary Cornwall miner get when he is a boy; does he go to the National or British School, or to the Wesleyan Sunday School?—Yes, to the National and British School and to the Wesleyan Sunday School.

1941. Are there a very large number of miners in Cornwall who get no education whatever beyond that at the Sunday School?—A considerable number of them, and a considerable number of them, who go to the National or British School very irregularly.

1942. Then the whole life of the miner is necessarily regulated by hours unlike those of other people?—Yes.

1943. And that of course has a tendency to unsettle the hours of the family?—Yes; they work eight hours and rest 16 hours; that is, day time and night time alternately; at least the

arrangement of the hours in that respect is continually changing.

1944. And that of course acts prejudicially upon the education of the miner?—Yes, and it operates upon the Miners' Association; there is great irregularity in the attendance of the students, which cannot possibly be avoided.

1945. Will you point out in what way you think the higher education can be brought to bear on the population, when children can begin to earn wages at that early period; is it possible to introduce much scientific knowledge or training into schools in the midst of such a population?—With regard to the primary school, and the National and British School, I should desire to see something more than is done at present—which might be called scientific instruction, even with regard to the young. We now give them reading, writing, and arithmetic; we give the children the signs for expressing ideas, but really we do not cultivate ideas in them as we might do. When we look at the delight with which a child will receive instruction on any subject in natural history, I think it is very unfortunate that some effort is not made to improve their knowledge in this respect. When I was secretary of the Royal Polytechnic Society of Cornwall, from 1840 to 1845, I have again and again gone to those schools and have shown the children some trifling chemical experiments, with a little accompanying explanation—perhaps telling them the composition of water, showing them the effect of the combination of oxygen and hydrogen;—and the interest created has been very great indeed, and I have been over and over again begged by the children to tell them some more about it. I think some simple instruction of that kind would very greatly improve our present system in those schools.

1946. Assuming, then, that we could introduce a little science training or knowledge into our primary schools, we come to what is to be done for the boys after they get to work. Now, do you think it is possible to combine steady, effective instruction with the life of the miner when a boy?—I have this morning made arrangements to be at Redruth on the 21st instant, to meet some gentlemen there, with the view of organising, if possible, some evening classes, which may stand between the primary school and our other classes.

1947. At what age do your classes begin?—In one or two cases we have had boys of 14, but generally speaking the students begin at 16 years of age, about the age at which they commence working under ground.

1948. What is that age?—Not under 14. What we propose doing is this: we have at present three young miners in the classes who have very fairly educated themselves; they are prepared to give evening instruction of a preliminary character. In the case of Breage, I am told there are 40 young miners ready to join the evening classes, where they would be taught writing and arithmetic, and mechanical drawing. We hope we shall by that means prepare some of them for the more advanced classes, and therefore we shall be able to do better than we are now doing in these classes.

1949. You would hope, either by improving the primary schools, or by these intermediate classes, to be in a position to require that a boy of 14 should be able to write and draw, and should have some knowledge of elementary arithmetic?—Yes.

1950. Now

1950. Now, assuming those qualifications to be attainable, what would be the course of education which you would recommend for young men of 14, who are themselves to be working miners, hoping for advancement in due time?—I should recommend their attendance at classes where instruction was given to the extent which I have intimated as desirable. I must remark that from the first, all the science instruction given in these classes has been only to the extent of what is directly applicable to the bread-getting of the miner.

1951. Should you think it possible at the age of 14 to begin with a strictly technical or what some people call a practical course, or should you rather endeavour to lead the young miner at 14 years of age to train his mind generally with a view to qualify himself for a higher position afterwards?—I think we should be compelled to confine ourselves to instruction in some special branches of science, for instance, chemistry—which is particularly useful to metalliferous miners—would be taught so far as it is applied to the analysis of minerals; of course the simple theory of chemical combination would necessarily be taught, but beyond that everything would rather be practical instruction.

1952. Should you think it desirable with a view to affording the greatest amount of scientific instruction in connection with mining, for the general advantage of the country that all persons, whether among at the position of intelligent workmen, or foremen, or masters, should pass through the same course which you are now describing?—I think it would be a very great advantage to the industry of the country generally.

1953. But have you, in framing that course, excluded, for example, general mathematics, or should you include geometry and trigonometry if you could?—Those things should certainly be taught, and I think it should be left pretty much to the selection of the student himself which he should learn.

1954. Would you act rather on the Scotch plan of offering teaching on certain subjects, and leaving the pupils to select and pay for each subject separately?—Yes.

1955. Will you now be so good as to sketch out to the Committee as far as you can your scheme of mining education, bearing in mind that there are two classes to be considered, first those who will never be more than first-class workmen or foremen, and those who will stand in the highest scientific position which the mining interest can place a man in?—In the first case supposing you offered such education to the miners you would only get the better class to avail themselves of that education; you will make, so to speak, a natural selection from those men. Then, again, they will naturally divide themselves into those that are industrious and steady in application and those who are not industrious and steady in application. It appears to me that we should offer in those schools the rudimentary principles of physical science and mechanics, especially the laws regulating physics, heat especially, and hydrodynamics generally, of course the higher branches of arithmetic and mathematics, with geometry and trigonometry, should be offered for those who would avail themselves of those branches of knowledge. It is a curious fact that we find special aptitudes prevailing in particular districts. When we do find a special aptitude for one particular kind of knowledge it would be advantageous to avail ourselves

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of it. When we go into the north of England we find the men have a special mathematical aptitude; there are good mathematicians among the working colliers of Durham. At Saint Just, in Penwith, we find working men among the miners teaching themselves mathematics. Why these things are so we cannot tell, but they are so. Therefore it would be important that these considerations should be included in a scheme of education leaving individuals to make selection of their own subject of study, and trusting a good deal to the managers of those schools in particular districts.

1956. Taking the subject of steam in mining would there be any good in including that subject?—When I spoke of heat I included that, for I was thinking of its laws of elastic fluids generally.

1957. Would there be any peculiarities in connection with the mining districts in the study of the application of steam?—There would be peculiarities for example, in Cornwall you would begin your instruction with a greater amount of knowledge in the men, of the principles involved in the pumping engine than you would find in any other district in the kingdom, perhaps.

1958. Do you contemplate persons making mining a study who had carried on their general education without going underground, up to the age of 18, or thereabouts, and then commencing the study of mining as a science, or do you think that all persons who are to guide the great operations of mining must be practical miners underground?—If I could do it, no man should attend the school in Jermyn-street until he had worked three years underground, so satisfied am I of the necessity of combining practical knowledge with scientific acquirement.

1959. *Chairman.*] But suppose Jermyn-street were in Cornwall, would you not then somewhat change the distribution of time between practice and theory, would you not arrange it in some other way than the way which you have now suggested, that of taking the three years underground first?—Then it would be possible to combine instruction in the school with instruction underground in the mine.

1960. *Mr. Achland.*] Would you be so good as to explain why you think it desirable that the three years underground should come prior to scientific instruction, at the age of 18, rather than it should be brought into the course later?—I think there are one or two reasons; in the first place, the student would be able to follow the lecturers better if the practice came first. Take Mr. Warrington Smith's lectures on mining. He would take in the facts more readily, and would see their application, whereas the young men who attended those lectures on mining first, would have a very imperfect knowledge, in all probability, of some things which it would be necessary for him to know, when he had to apply the principle to practice afterwards, he would not get so much knowledge as the man who had combined practical with scientific instruction.

1961. But you have not yet told us why you think this three years' practical knowledge should come in the boyhood of the student. You have not, in fact, told us why his general education should not be carried on up to 18 years of age, and the practical knowledge come either with or after the technical instruction in the case of persons who are to stand at the top of the whole mining interest?—I presume your question rather refers to the young man who contemplates making

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mining his profession, and who has the means of supporting himself up to that period. We have educated at Jermyn-street several young men who have become the managers, especially of coal mines. These young men have received two or three years' education there, before they have had any acquaintance with mining operations beyond that which they had obtained by paying a visit of a week or two during the recess, with the mining professor, to some mining district or other, those young men are now conductors of large establishments, and they are found to conduct them much to the interests of their employers.

1962 I understand you, then, to think it a subject not to be left out of sight by this Committee, that young men coming up from good secondary schools, whether grammar schools or private schools, having had a good private education, may come to Jermyn-street, or any other such institution, to make themselves masters of the whole subject of mining?—Just so.

1963. What special course of education would you then give them, presuming they had had a good general education?—Such a man would require then to be taught surveying, both on the surface, and with its application to mines, underground. It would be necessary that he should have instruction in applied mechanics, with special reference to mining machinery. Then a fair knowledge of physics would be necessary, embracing hydrodynamics and pneumatics, and heat in its operation on water in the production of steam, and the like; beyond that there would be chemistry, and its application to metallurgy, and also geology.

1964. Now, are all those subjects, such as you are now able to teach in Jermyn-street?—They are all taught in Jermyn-street, and more, because we teach natural history.

1965. *Chairman*] Is mechanism taught in Jermyn-street?—Yes, by Professor Willis.

1966. At what age do you receive pupils into your course at Jermyn-street?—We have no particular limit; but generally they are about 18.

1967. *Mr. Ackland*] Now, with regard to preparation for this course of scientific instruction, what do you think the student ought to bring with him at the age when he commences your course?—He should have had a liberal education at one of our best schools, and a fair amount of mathematical knowledge.

1968. You would require him to know arithmetic pretty well with the elements of Algebra and Euclid, or some other geometry?—A fair knowledge of Euclid would be of great advantage.

1969. Would practical geometry without Euclid answer the purpose?—It does answer the purpose; very many of our students are not acquainted with Euclid.

1970. Have you any opinion yourself with regard to making Euclid the basis of geometry for industrial students, or should you prefer introducing some other book?—I prefer Euclid.

1971. You would teach trigonometry in its simpler forms, I suppose?—Yes.

1972. You would not require spherical trigonometry?—No.

1973. Nor the higher Algebraical application?—No.

1974. You would require some knowledge of

mechanics, perhaps?—I think that would be better left until he came into the hands of the teacher of mechanism.

1975. Have you any remark to make with regard to Languages or Physical Geography?—I could only speak to the general advantages of such knowledge.

1976. Physical Geography in connection with mining would be of great importance, would it not?—Yes, unquestionably.

1977. There is a great difficulty, is there not, in bringing men to Jermyn-street, for all the scientific knowledge that we wish to circulate through the mining population, that difficulty being felt on the ground of expenses and other circumstances?—The number of the students, for such a school, appears to be small, looking at the high character of the teachers and the small cost at which that amount of knowledge is obtained; independently of the cost of residence in London.

1978. Do you think the expense of residence in London practically keeps people away?—I am quite sure that a large number of the better class of our colliery viewers, for example, would send their sons to town if the cost of keeping them in London was not so great as it is; or if, again, they could be placed in some establishment where they would be under the eye of the master.

1979. Do you think it possible to do for the superior miner what you speak of doing for a workman; bring the science to him rather than take him to the science?—I think it is possible.

1980. Have you considered whether it would not be possible to have branch colleges under Jermyn-street in our principal mining districts?—What I have often thought would be desirable is this; that miners' associations or similar associations in various parts of the kingdom, should train up as many young miners as they could; that they should then eliminate by examination from time to time the best of their class who should be sent on to the higher establishment, to Jermyn-street to finish their education, looking at those men as being the future managers of important works.

1981. Is there any particular requirement made of the students in Jermyn-street with regard to going through any particular course in order to the getting of a diploma?—Those who enter as matriculated students must continue there for two or three years.

1982. Have you ever considered this question, which has been considered at Oxford University, namely, whether, with regard to degrees it would be possible to allow the students to gain the simpler portion of the requisite knowledge of the first year in the country, and then to come up to the school or college for one year's study before receiving the diploma?—No.

1983. But supposing competent scientific institutions were maintained in the very centres of mining industry, and a plan of that kind were practicable, would you see any great objection to it?—No; an examination by the professor of the school would readily determine that point; if the young men come up with sufficient qualifications I see no reason against their getting their diploma in that way.

1984. As I understand you, you think it would be possible, first of all, greatly to improve the education of the young miner from 14 years of age upwards, and to give to him a chance, first through his class in the local institution, and ultimately

ultimately through Jermyn-street, to reach the top of the tree?—Yes.

1985 It would also be possible, in your opinion, to offer to the best pupils from the middle-class schools opportunities, both for practical and general instruction, without disturbing their general education prior to 18 years of age?—I think so

1986. *Chairman.*] Suppose schools similar to, Jermyn-street were established in the mining districts, do you think the population of those districts would avail themselves largely of those schools, taking as an example the locality of the Durham and Northumberland coal field?—Whether they would be largely attended or not I can scarcely venture to say, but that considerable efforts would be made by the young men to attend such schools in the colliery districts. I feel sure, but I have found that if you have to remove a young man from his family, it matters but little whether you remove him 20 miles or 200 miles from home. The failure of the school at Truro arose entirely from the circumstance that the distance between the mining district of Penzance and Truro was about 20 miles.

1987. You are now speaking rather of a lower grade of school, are you not?—I fear that there would be the same difficulty to a certain extent, though not to the same extent, with a school even of a higher grade.

1988 You do not think that many more young men would come from the city of Durham to Newcastle for purposes of study than would come from Durham to London?—I think not many more.

1989. That is assuming that there were no boarding houses in either case?—If it were possible to connect with such a college a boarding establishment, so that the parents of the students should not have the expense of boarding them with individuals who made a great profit out of them, that would materially alter the case, I think.

1990. But is it not more likely that a parent residing at Sunderland would have friends at Newcastle than in London, to whom he might entrust the custody of a boy during his education?—Yes; certainly that would materially influence the question.

1991. In that respect you think that schools established within reach of the locality would be likely to be more generally visited than schools in London?—Certainly.

1992. With respect to economy of fuel in

metallurgical operations, have you noticed that there has been any great advance in England within the last seven or eight years?—A very great advance indeed

1993. Would you say that with regard to the smelting of iron only, or with regard to any other metallurgical operations?—Nearly all metallurgical operations, in iron largely, in copper to a very great extent, and to a limited extent in tin perhaps it does not apply so much in zinc, but in nearly all other metallurgies, there has been greater or less improvement in the consumption of fuel.

1994 Are you able to say whether the calorific effect of fuel is in fact as fully utilised in this country as it is in other countries?—Yes, I think it is.

1995. *Lord Frederick Cavendish*] You have found much difficulty in the classes connected with your Mining Association, from the want of elementary education on the part of the young men?—Yes.

1996. In mines the Half-time Act is not in force, is it?—No

1997. Have you considered whether the necessary amount of elementary instruction could be made compulsory before any youth was allowed to work in a mine?—It has appeared to me to be most important that that should be ensured; every individual should, in my opinion, be compelled to receive a certain amount of knowledge, I think it is the duty of the State to enforce it.

1998. Do you see any practical reason why what is required in the colliery districts should not apply equally in the case of the mining districts?—None.

1999. *Mr. Read.*] With regard to young miners, from six to 14 years of age, you would, I presume, advocate the adoption of a half-time system, such as is in use in factories?—I think it would be a great advantage.

2000. In order to create a better foundation for further instruction?—Yes; when mere infants go upon the dressing floors as they do, there can be no means of getting elementary instruction except at the Sunday school.

2001. Is the picking of ore a healthy occupation for children?—It is not unhealthy. I have thought that the little things were exposed to too much moisture, and that it might generate rheumatic disease, but still they seem to grow up pretty healthy; they are under shelter, where there is a free circulation of air, and they do not appear to suffer in any way.

R Haut,
Esq., F.R.S.

7 May 1868.

Monday, 11th May 1868.

MEMBERS PRESENT:

Mr. Acland.
Mr. Akroyd.
Mr. Bazley.
Mr. Henry Austin Bruce
Lord Frederick Cavendish.
Mr. Dixon

Sir Charles Lanyon.
Mr. McLagan.
Mr. Wm Lowther.
Mr. Edmund Potter.
Mr. Read.
Mr. Samuelson.

BERNHARD SAMUELSON, Esq, IN THE CHAIR.

Dr. W. B CARPENTER, called in; and Examined.

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2002. *Chairman*] I BELIEVE you are Registrar of the University of London?—I am.

2003 And also Vice-President of the Royal Society?—Yes.

2004. The function of the University, I believe, is not to teach, but to confer degrees?—To confer degrees, and to give out the programme of study on which those degrees are obtained. To specify what the University regards as the right course for obtaining that distinction.

2005. And has that course of study reference more particularly to pure or to applied science?—To pure science; the basis of our scientific degrees, as of all our degrees, is the matriculation examination. For degrees in art and science, in law and medicine, the same entrance examination has to be passed, and that entrance examination requires preparation in a great variety of subjects in which the elements of science enter. We have the elements of natural philosophy and chemistry, the idea of the senate being that all those objects should be taught in a good school education. The matriculation examination is considered to be the test of a good school education which the senate consider to be equally important for all branches of study qualifying for the higher degrees. I may state that this matriculation examination programme of the University of London exerts a very important influence over a large number of schools throughout the country, both public and private.

2006 Do I understand you to say that the matriculation examination is the same in all cases, whether it be the intention of the person passing it to take a degree subsequently in art or in science?—Yes, that is considered the common trunk from which all the higher studies should diverge.

2007. So that any person intending to take a science degree in the University of London, must pass an examination in the classics?—Yes.

2008. That would, in some degree, limit the number of preparatory institutions that would be able to send up pupils for your matriculation examination?—The examination is not so high in classics as to make the science degree difficult; I know of many cases in which candidates who had not had a good school training in the classics, have devoted, say, a year, to the study, and have mastered a sufficient amount of classics to enable them to pass. Speaking personally, my own feeling which I expressed to the committee of the senate, by which those regulations were framed,

is that German should be an alternative for Greek; I should myself prefer that both French and German should be alternatives, that is to say, a sufficient knowledge of them to enable the candidate to read a scientific work in French and German in place of Latin and Greek. We now require a sound elementary knowledge of Latin and Greek, and either French or German.

2009. Would you grant the alternative whether the intention was to take a degree in art or in science?—Yes, in art or science, medicine or law; my own personal preference would be to require a sound elementary knowledge of Latin, on account of the mental discipline which it involves, which I believe to be extremely valuable; but to let the candidates bring up French and German instead of Greek.

2010. For a degree in science?—Just so; for a degree in science.

2011. And, you would make French imperative?—I think so.

2012. Do you require a matriculation examination from students who have matriculated in other universities?—The only exemption is in the case of those who have taken a degree in other universities, there is no other university in which the matriculation examination is anything like as stringent as ours. We consider our matriculation examination is a more severe examination than the little-go at Oxford or Cambridge; we require as much classics, and as much mathematics, and several other subjects besides.

2013 With regard to Owen's College, any young men intending to come up from Owen's College for the degree of Bachelor of Science or Doctor of Science, would have to pass your matriculation examination?—Yes, there are a great number who do so.

2014. You would not accept the certificated associateship in Arts?—No, we accept nothing but the bachelor's degrees.

2015 That is the lowest which you take in lieu of the matriculation examination?—Yes, that is the lowest we take in lieu of the matriculation examination.

2016. Can you state briefly the principal schools that have sent up students for matriculation to the University of London?—The University College School, King's College School, the City of London School, which send up extremely well prepared youths, and the Merchant Tailors' School; I think those are the principal schools of London; we have some from the North London

London College School, and the Philological School, Owen's College sends up a large number. We carry on a provincial matriculation examination at Owen's College every summer, and that serves as a centre not only for the students of Owen's College, but for students in that part of England and Wales.

2017. Have you any other centres besides Manchester?—Yes, Liverpool also, but we also examine at several Catholic colleges.

2018. Manchester and Liverpool are your centres, and you also examine locally?—Yes, at several Catholic colleges, that is wholly for their own convenience, they do not admit any but their own pupils, now at Manchester and Liverpool any student may enter by paying a small local fee.

2019. You have no other centre for the accommodation of the country schools?—No.

2020. A large portion of your students are from proprietary schools connected with the various dissenting denominations?—Yes, a considerable proportion, we are now alluding to candidates for matriculation generally, but for science specially a large number come up from dissenting institutions.

2021. But you find there are fewer schools preparing candidates for matriculation with a view to science degrees than to degrees in arts?—Yes, the number of candidates for science degrees is comparatively small as yet.

2022. The number of schools able to prepare pupils for those degrees is comparatively small, is it?—Yes, I do not think that any school with which I am acquainted can be said to prepare for science degrees, collegiate institutions do, but they are very few as yet.

2023. Would the Royal Institution at Liverpool be another exception?—I do not think we have had any students from the Royal Institution at Liverpool, we have had several from the School of Mines in Jermyn-street.

2024. Have you had any students from the City of London School who have been sufficiently prepared for the science degree?—Not to obtain a science degree. I am speaking of the matriculation, several of the best men from the City of London School have gone on to Cambridge and taken their degrees there. One of the most promising men was Senior Wrangler, and Principal of the School of Naval Architecture at South Kensington—that was Mr Parkins, who came from the City of London School.

2025. From the old public schools I suppose you have very few?—Very few. Science, until recently, has not been taught in the public schools.

2026. Then, on the whole, would you say that the young men who come up for matriculation with the view of taking science degrees are young men who are going to devote themselves to an industrial career, or are they men who intend to make science the pursuit of their lives?—The best men among them, those who go in for our doctor's degree, are generally men who intend to make science the pursuit of their lives; to become teachers, or to devote themselves specially to chemistry as a profession, for example, but some of our Doctors in Science have also become teachers, and distinguished themselves in that capacity.

2027. But with regard to those who merely take the degree of Bachelor in Science, have you found a fair proportion who became manufac-

turers?—I think so from inquiries which I have made. It happened only two days ago, that a gentleman called upon me whose brother is one of our Bachelors in Science. I said I hoped he was coming on for the doctor's degree, he said he is so busy in our works as the practical chemist to our establishment, that he would find it very difficult to prepare for a higher degree, though he is very desirous of doing so, and I think that is the case with a good many who have taken our bachelor's degrees.

2028. Your bachelor's degree, I believe, includes a tolerably wide range of scientific subjects?—Yes; the purpose with which this programme was framed, was that any candidate who obtains a bachelor's degree, shall have gone through a good course of scientific study, not only in the experimental sciences, but also in the natural sciences. It was framed a good deal with reference to the course which the students pass through at the School of Mines in Jermyn-street. We had several professors from Jermyn-street before the committee, and they gave us very fully the scheme of instruction which they followed there, and that was partly framed with regard to our own degree of Bachelor of Arts, because it was desired to make the two sets of examination work together as much as possible. Mathematics are the same in both. Mechanical philosophy is the same in both. Animal physiology is the same in both, but logic and moral philosophy are not included in the Jermyn-street course. Considerable stress was laid upon that with regard to the mental discipline which it involves by the framers of this curriculum, and we do not find that it creates any practical difficulty, that is to say, it is a subject in which the candidates can readily prepare themselves from books without lectures, and the most important parts of the programme are those which involve a very full and complete course of practical study, that is to say, lectures on chemistry or botany, or experimental philosophy. The object was that there should be what was considered a complete course of scientific culture, both for special knowledge and as a mental discipline. And then on the other hand, in the doctor's degree, the examination is devised to test the very highest knowledge, but in a very limited department. If you will kindly turn to page 94, you will see a note that explains the object of the senate, namely, that a candidate is expected to be conversant with the very highest knowledge of one special subject, but he may limit himself to a very small part of the great range of scientific knowledge, for instance, he may come up in chemistry in four different ways, taking his own choice, he may come up in inorganic chemistry or organic chemistry, and then he may bring up his subsidiary subject as he pleases. If he takes inorganic chemistry as the principal subject, then either organic chemistry, that is to say a less complete knowledge of that subject than you would require if he brought it up as his principal subject, or he may bring up the principal applications of inorganic chemistry. If he comes up in organic chemistry, he may either bring up as a subsidiary subject inorganic chemistry with a general knowledge of the subject, or he may bring up the practical applications of organic chemistry. This programme was framed with very great care, and under the advice of men of the highest possible proficiency in the several subjects. Professor Faraday was at that time a member of the

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committee of the senate, so also was Mr Hopkins. The programme of the organic sciences was framed by Professor Huxley, and Dr Hooker and myself chiefly, and I believe, taking it altogether, the programme has been considered a very complete and effective one

2029. But with regard to the degree of Doctor of Science; you scarcely expect the persons who intend to apply themselves to manufactures, to pursue their studies so far as to take that degree, I presume?—It is not to be expected, I think, generally speaking, I think that degree would be sought rather by those who desired to become teachers. I could mention instances of that kind, one gentleman has now gone out to Sidney, and another is in a large institution at Manchester.

2030. Then the value of your degree of Doctor of Science is different from that of the degree of Doctor of Science in the German Universities?—I think in the German Universities they are called Doctors of Philosophy. We had at that time a gentleman who could give us very full and complete information with regard to the system pursued at the German Universities, and the general result was this—that there is a very great number of subjects there of which the candidate for the degree of Doctor of Philosophy (who is required to have gone through a certain previous education, though not to have taken any degree) chooses three. Out of those three subjects, he is required to be specially proficient in one, he may come up in chemistry, and bring up perhaps natural philosophy and mineralogy as his subsidiary subjects, while he knows nothing whatever of the organic sciences. Now our arrangements require that everyone who comes up for the degree of Doctor of Science shall have also taken a bachelor's degree, which implies that every such man shall have gone through a general course of scientific study, and shall therefore have had his mind brought in contact with various departments of science, and shall have acquired a certain amount of real proficiency in them, and not a mere smattering, I mean that kind of proficiency which supplies a basis for a higher culture in any department.

2031. Then you do not require any proficiency in the technology of any of the sciences?—No; we consider it our function to require a knowledge of principles.

2032. In that respect I suppose you would consider that your university would differ very much from a polytechnic school?—Yes, I think that would be the feeling of our senate. A few years ago the question was brought before the senate of the university, by Mr Lowe, when he was the Vice-President of the Committee of Council, with a request that we would give certificates to students in mining; it was desired to make the school in Jermyn-street more attractive, if possible, to those who were engaged in mining operations, and it was thought that if the university would give certificates of proficiency for one or two years of study, it would render the course more attractive. But the senate declined to entertain the proposal, they considered it was not their function to give certificates of technical knowledge without what they held to be a proper scientific basis, and the proposition was very fully discussed and negatived.

2033. But medicine is an exception to that rule, is it not?—Medicine is an exception, but I believe rather because, in all times since there

have been universities, medicine has been taught, and degrees in medicine given, in such universities.

2034. I suppose, then, you declined to entertain the question of technical degrees rather for traditional reasons than because there was any special ground for declining?—I could not say that the university had refused to give technical degrees because, though the university refused to give certificates of technical proficiency without a proper scientific basis, I am not quite sure that they would refuse to give certificates of technical proficiency to candidates who had gone through the science course, that is a subject that has never been brought before them, the proposal that was brought before them was, to give such certificates upon a very limited basis of education. Several universities give degrees in civil engineering, but that matter has never been brought before the University of London, so I cannot say how the idea would be entertained, and if it were proposed to give certificates of special proficiency in subjects arising out of our course for degrees of science, I am not sure that that would be objected to, though I am quite certain that the senate would require a full scientific basis in the first instance.

2035. In fact, the question of granting technical degrees has been brought before the London University, with limitations only?—Only in a limited form.

2036. You are aware at Edinburgh a Chair of Civil Engineering has recently been established, and it has been proposed to give degrees in civil engineering, and in agriculture?—Yes, and in the Queen's Colleges in Ireland.

2037. You would not consider that that would militate against the principle of the university, provided a complete knowledge in theoretical science were not lost sight of?—Just so.

2038. Upon the whole, however, the number of schools capable of sending up pupils able to pass your matriculation examination in science up to the present time is very limited, is it not?—There are a considerable number of schools, both public and private, which have introduced elementary science culture. I could name several in the neighbourhood of London in which very efficient elementary science culture has been given with a special view to our matriculation examination.

2039. As tested by your matriculation examination, the instruction of the pupils sent up to you appears to be very satisfactory?—Yes, I am quite certain it is very efficient.

2040. Have you considered the question of the establishment of technical schools in various parts of the country?—I have had my attention drawn to that subject partly by a visit which I paid to Zurich two summers ago. I went over the Polytechnic School there, and heard a good deal from my friends among the professors, of what had been done there in the way of technical instruction, and I was very much struck with the high scientific culture given there, and at the same time with the practical nature of the education. I find a strong opinion prevailing that something of that kind is required in this country.

2041. I suppose you find that the conditions which you would impose in the London University with regard to adequate training in pure science is also very fully carried out in the Polytechnic School of Zurich?—So I understand. I

did not see the programme, but from what I learnt from the professors, I understood that that was quite the case

2042 Did you visit the chemical and physical laboratories at the Zurich Polytechnic School?—Yes, I was there with my friend Professor Pick

2043 They are very complete, are they not?—Very complete

2044 Comparing them with anything of the kind which we have in this country, could you name any laboratory in the United Kingdom which is at all comparable to the laboratory of the Polytechnic School at Zurich?—Not being a chemist myself, I should scarcely venture to give an opinion on that point

2045 Have you considered at all the bearing of elementary education on subsequent scientific education?—Yes, I have considered that a good deal, and have been led to form a very strong opinion on the subject. I am perfectly convinced that elementary science is capable of being taught to pupils in all ranks of life, of both sexes, with very great advantage. I am convinced it tends to develop faculties which are left undeveloped, and even repressed, by ordinary systems of culture. If the Committee would allow me, I should like to mention a case which, within the last three weeks, has made a very strong impression on my mind. A very distinguished medical undergraduate of the University of London, who has shown extraordinary aptitude for the apprehension and retention of scientific knowledge, gave me this as his own experience before he came to London, he graduated at Trinity College, Dublin, and he was admitted by us without matriculation, as having graduated at Trinity College, Dublin, the Trinity College course includes the classics, and mathematics, logic, and moral philosophy, all of it book knowledge, but no applied science of any description. That student came over to London about five years ago, and entered at Professor Williamson's class at University College, he informed me quite recently, that when he first entered that class, he found himself so utterly at sea, and so incapable of apprehending the subjects which he was taught, that he thought of giving up his attendance at the class. He persevered, however, and being a man of remarkable ability, gained the gold medal in that class at the end of the session, and has since distinguished himself in an unprecedented measure in the University of London, having gained three exhibitions in one examination. Now my position is this, here is a man who has shown a remarkable aptitude for acquiring scientific knowledge, he must have always possessed that aptitude in his own mental organisation, but that aptitude was evidently repressed and smothered, during the earlier period of his studies, just for want of something to call it forth, but as soon as ever he had once got the knack of apprehending scientific facts, his apprehension showed itself to be most rapid and powerful

2046 Do you think this power of apprehending scientific facts exists to an appreciable degree in very young children?—I am quite sure it does, of course in the case of children it is more easily brought out than it is in others. I am quite sure, from my own experience in early life, when I was engaged a good deal in education, besides my having a family of sons, in whose training I have taken a large share; I say I am quite sure, from my own experience, that the simple truths

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of science are built up very readily indeed, on a foundation of ordinary experience, in the mind of a child of ordinary apprehension for instance, the law of falling bodies is very easily made intelligible to a child if it is only properly presented to him by a judicious teacher, and in teaching mathematics, there is very great advantage in constantly connecting the practical applications with the purely scientific teaching; for instance, when the parabola is being taught, and the algebraical expression is being given for the parabola, that is at once capable of being connected with the law of the falling body, the parabola described by the falling body having an onward movement, and being drawn by the force of gravitation towards the earth. If this is given to the child in the shape of objective illustration, an interest is awakened which pure science cannot possibly call forth. I have been extremely struck from time to time with the want of any ordinary scientific teaching in schools, and especially of that combination of pure science with the practical applications of it, I have been struck by finding that boys who had gone through their arithmetic, and had learnt, for example, the table of squares, had not the least knowledge of what that table meant, they had only learnt it by rote, but if you were to put before them a chess-board, and made them understand how it all applied, what was the relation between an inch and a square inch, and what was the relation between a foot and a square foot, that opened up new ideas to the boys' mind, that is still more strikingly the case with regard to cubes. Ask a boy how many cubes of one inch are contained in a cube of two or three inches, and very few boys would be able to answer such a question from want of this kind of practical instruction

2047 You have drawn your illustrations from mathematics and experimental science, what should you say, however, with regard to natural science, taking natural history, for example?—I think the great value of natural history is in encouraging habits of observation and correct description. The late Professor Henslow devised a method of teaching botany which was remarkably effective in that respect with young boys and girls in a village school. The effect of it was, that girls trained under that system were so much livelier and brighter than other girls, that they were constantly draughted off as nursemaids, or into service of various kinds, in preference to other girls, where intelligence was required

2048 Would you say, as a general rule, children would be able to profit by instruction in natural history at an earlier age than in experimental science, or in mathematics?—I think they might both go together. I should say, from my own experience and observation, that from 10 to 12 years of age the observing faculties are extremely active, and that there is in most children's minds a love of simple knowledge which enables them, under a good teacher (which I am always supposing), to apprehend the bearings of the facts which they observe. Teaching of the kind I am now indicating tends greatly to increase the general intelligence and activity of the mind. I could, if there were time, give some remarkable facts in illustration of the value of the introduction of science-teaching into an ordinary course of education. I had occasion, two or three years ago, to communicate with Professor Greenwood, the Principal of Owen's College, with regard to the requirements of the University, and

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and he wrote to me somewhat in these terms—"I am very much impressed with the value of scientific culture as a part of general education, for I have found by experience that boys who are dull in the acquirement of languages will often be amazingly brightened up if they go into the chemical class, they come back with fresh zest and vigour to their classical studies." I have had opportunities of verifying that statement within the last two years by information given to me by various teachers. At Rugby scientific teaching has been introduced, and very effectively; also at a large proprietary college at Clifton, a very flourishing institution, the head of which, Mr Peraval, is a man of high Oxford standing and very great general intelligence. I found, on visiting that college years ago, that scientific instruction had been introduced there, and the results were considered very favourable; that the minds of the boys were very much brightened up by it. Mr Peraval told me he did not consider that the time given to scientific instruction was at all so given to the loss of the time given to other branches of education, because the boys became more recipient, and more capable of applying their minds to other subjects. Since that time I have been able to recommend to that college an extremely able scientific instructor, namely, Professor Debus, one of the examiners at this time at the University of London, who is professor of chemistry and experimental science, and also of mathematics and natural philosophy. On visiting the college again, about two months ago, I found that his course of study was extremely popular; so popular that they were now about to enlarge his lecture-room, and the laboratory accommodation.

2049 Are you aware whether the teaching of science is being introduced into training colleges for elementary teachers?—I have no positive knowledge on that subject; but about ten years ago at the request of the late Lord Ashburton, I examined for a prize which he gave to schoolmasters and schoolmistresses of elementary schools in the science of common things. I believe the prize was limited to schools in Hampshire and Dorsetshire, and I was extremely struck with the quality of the answers which a good many of those masters gave, showing a remarkable comprehension and aptitude for the acquirement of that kind of knowledge; among the papers to which I assigned the prize was one with regard to which I remarked to Lord Ashburton that I really could not have answered the questions myself, that young man was a schoolmaster of 19 years of age, resident in the Isle of Wight.

2050. Mr Bruce.] Had he received his education at any Government training college?—I think he had.

2051. Charman.] Have you any knowledge of the working of the classes in connection with the Science and Art Department?—No.

2052. Mr Bruce.] Are you connected with any medical school?—Not now, I was for many years connected both with Bristol and with University College, and at one time with the London Hospital.

2053 I suppose you found there what is so generally found elsewhere, that one of your main difficulties in raising the standard of education was the low state of education in those who presented themselves?—Yes, I am quite certain that the difficulty which I mentioned in the case

I have referred to is a very common difficulty; I remember when I was myself a student at University College 35 years ago, I found I had no difficulty in apprehending scientific facts, because I had been trained in a knowledge of the elements of science from my boyhood; but things which were perfectly easy to me were very difficult indeed to many of my fellow students.

2054 I suppose there is a great waste of teaching power, and a great waste of time, in the course pursued at those colleges, from the state of inferior preparation in which the students present themselves?—I am quite sure of it.

2055 At University College the matriculation standard has been raised, has it not, of late years?—There is no matriculation examination at the University; any man may come and enter to any class he pleases.

2056 I thought that within the last three or four years, a certain increased amount of knowledge was required in those who presented themselves at all events to the medical classes?—All the students must have gone through some examination under the direction of the medical council in the same way as all students must have undergone the entrance examination.

2057 If my memory serves me rightly, I recollect a statement that the number of students who presented themselves had fallen off greatly in consequence of a more rigid test of proficiency being applied at the entrance examination?—That was with regard to the test imposed by the medical council about five years ago. That council was created by a medical Act of Parliament, and it instituted a regulation that every student before entering on his course of medical study should have passed one of a certain number of examinations. A very considerable range was given, for instance, taking the Oxford and Cambridge middle class examinations, at that time the junior examinations were admitted. They did not wish to make the test too severe at first, that junior examination does not involve even the necessity of Latin, because a large option is given. But the medical council now require, I think, the senior examination in which Latin must be one of the subjects. Then the matriculation examination of the University of London was one, and the Little-Go at Oxford and Cambridge was another. Every student entering on the medical curriculum must register as a medical student under the medical council, and he must, before he can register, show that he has passed one of these examinations.

2058 But the number of students did fall off considerably at first, did it not?—Yes, for a time.

2059. That has now recovered itself, has it?—Yes.

2060 Do you not think that is a proof of the immense service to general education which can be rendered by refusing the advantages of special education to those who do not give proof of possessing a certain amount of knowledge?—Yes, I was for six or eight years Lecturer on Physiology at the London Hospital. A great part of the students at the London Hospital, which you are aware is situated in the east of London, come up from the eastern counties, Kent, Essex, and Suffolk; and I found that the grade of the previous education of those students was so much lower than it was among the students to whom I had been previously accustomed in the Bristol Medical School, that I had to bring down my lec-
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ture standard very considerably to meet the comprehension of those students

2061 No doubt they left your course of lectures far less advanced than they would have been had they presented themselves to you with a greater amount of education in the first instance?—Certainly

2062 Was any action taken at the London Hospital to attempt to raise the education of those students, as was done in University College?—That was not done at University College. It was the Medical Council that did what I have been referring to, and it is required equally in all the schools

2063 In all medical schools whatever?—Yes. There was nothing special to University College

2064 Are you satisfied with the degree of education at which a great part of the medical profession now receive the licenses under which they act?—I hope the Medical Council will proceed still higher in their requirements, they have already made a step, but it was necessary to advance with great caution, because it would have inflicted a great injury if the standard of requirement had been made too high at once. In their first requirement I have already said they admitted the Junior Middle Class Examinations, but they either require now, or will require in a year or two, the Senior Middle Class Examinations as a minimum. I should myself be very glad to see the whole of the students of the medical profession required to go through an examination not inferior to the matriculation in our University

2065 But you think that could hardly be brought about without a very great improvement in preparatory general education?—Just so, we find, practically, in the university, that those who come up from good schools, at 16 or 17 years of age, do much better in our matriculation examinations than older men, because they come up fresh from their classes, and would not present themselves unless they felt they were pretty well prepared, but a good many persons come up at from 18 to 25 years of age who have had an inferior elementary education, and a very large number of them fail from the want of elementary knowledge, I mean, for instance, the want of the power to decline a Latin verb correctly, or to do a proposition in Euclid correctly.

2066 What are the particular branches of scientific study which you would suggest as most applicable to elementary school teachers?—I think it depends in part on the circumstances of the school, for instance, in country schools I should say, botany might very advantageously be introduced into every elementary school, I hope the time will come when every master or mistress of an elementary school in the country will be able to teach botany on Professor Henslow's plan

2067. At what age would you begin to teach botany?—At eight or 10 years of age

2068 Now, ascending a little higher, and taking the general preparatory schools to which our middle classes go, what is the amount of instruction that you would give there, and what are the branches of scientific knowledge which you would recommend?—I think the elements of natural philosophy, and, where practicable in the country, where there are fields and hedges within a walk, botany may be advantageously introduced. At Rugby, I observe, Mr Wilson has

a very strong opinion of the value of botany. I quite agree with those who consider that all these studies should be as practical as possible, and should be that which a pupil can acquaint himself with, objectively or tangibly

2069 With respect to elementary schools in town, and taking children of eight or ten years of age, would you substitute some other scientific study for botany?—I think elementary natural philosophy may be advantageously pursued, but I would have it also in the country, I think the two may be combined, I believe that in only an hour a week a good deal of the elements of natural philosophy may be taught. We have at present a committee sitting on the education of females, to carry out the provisions of a supplementary charter given to the University of London. I heard a member of that committee make an observation the other day which struck me very much. The question being, whether natural philosophy should be introduced into the curriculum for females, he said, "I think it is of very great importance that every girl should be taught what a law of nature means," and that observation turned the scale in the decision of the Committee. I have a very strong opinion that every child is capable of being made to understand, under proper tuition, what a law of nature means

2070 You would think that a very slight tincture of such knowledge given when young would greatly increase the taste for such knowledge among them, and so lead to the children availing themselves of the scientific classes, and other means of advanced instruction furnished by the Government?—Yes, it acts in two ways, it furnishes a basis of knowledge to which more knowledge is easily added afterwards, and it develops that power of apprehension which makes it easy to add the knowledge in question, in all education those two things have distinction to be considered, the actual knowledge communicated, and the cultivation of the apprehensive power

2071 You stated that you had visited the Polytechnic School at Zurich, and there you found a combination of teaching pure science with what may be called technical instruction?—Yes

2072 Is there any such institution in this country?—I am not acquainted with the college, but I have heard that there is a college which sends up a great many students for science degrees

2073 *Chairman*] To some extent you would, I suppose, consider Jernyn-street a school of that kind?—Yes.

2074 *Mr Bruce*] You would consider that there is no country in which the necessity for such a combination of studies existed so strongly as in England?—Certainly, I should think so, it is really a curious fact that in Birmingham which is a town in which you would expect Mechanics' Institutions to flourish, has never supported one heartily, there is an institution there which is called a Polytechnic Institution, but having a great many friends and connections in Birmingham, I have known a good deal of the history of institutions of that kind in Birmingham, and it is remarkable that there is that want of anything like a basis of scientific knowledge among the mechanics at Birmingham, and that they have never adequately supported an ordinary Mechanics Institution

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2075. Can you give any reason why they should be so much behind as the fact that you have just mentioned would appear to indicate?—I think it is their confidence in their own technical ability which makes them careless of what they would consider book-knowledge.

2076. And that may be called a truly British sentiment, may it not?—Yes, and there is another cause, men in all skilled departments of labour earn very high wages, and it is the habit of the place, which, I think, no one acquainted with Birmingham will deny, that those men who earn the highest wages spend them in the most careless manner. I have heard from many friends in Birmingham that a man who can earn 1 l a day readily will very seldom earn more than 3 l a week, such men are very commonly in debt to their masters, and the masters, in fact, prefer that it should be so, because they then know that the men will not go elsewhere. Those men will spend the earnings of those three days a week in sensual indulgence, they do not seem to care for anything else. I have never lived in Birmingham, but I have been much interested in the town, and that is the impression I have received.

2077. As a matter of fact, does not a great deal depend in these things upon the accidental impulse which may be given by some particular person or persons to the success of an institution?—Very much so, there is a period of success, and then a period of decadence in many of these institutions, then perhaps there is a fresh success, but, generally speaking, it is rather a new institution which rises upon a different basis, a new institution is more successful than an attempted revival of an old one.

2078. Do you imagine that there are other great towns which would, each of them, support some such institution as Owen's College?—They ought to do, I think Owen's College is now becoming a very successful institution, but for some time it had to feel its way; there was a difficulty in adapting its requirements to Manchester and its neighbourhood, but, I think, that under its present principal, there has been a great deal more done to extend its usefulness than during the first years of its existence, when it had to feel its way.

2079. At Owen's college they have, in fact, made an experiment by which you think other great towns might very usefully profit?—I certainly think so, my own feeling is very strong in favour of encouraging such colleges in great towns, partly by Government aid, and partly by local support. I think that where a body of men in a town are willing to do, for instance, as much as the people at Manchester are willing to do in extending Owen's college, the Government may very well come in to assist. In Glasgow the University is being rebuilt, the Government giving 120,000 l., as I understand, to the object, Glasgow itself having contributed something like 150,000 l., the people at Manchester, too, are liberally contributing to Owen's college. I think the value of Government aid partly consists in its calling forth the response from the locality—that has been remarkably the case at Glasgow—when once it was understood that the measure of assistance that the Government would give to the University at Glasgow would depend upon the amount of the local contributions, the local contributions poured in in a most extraordinary manner, so that at last the Government was

obliged to hold its hand, and say, "we will not give any more."

2080. Glasgow University has the advantage of having acquired a great reputation as a teaching institution, besides the advantage of being in a country where the value of education is very keenly felt; is not that so?—That is so.

2081. Would you have any doubt, yourself, that if within prudent limits similar institutions were raised in great towns like Liverpool, Birmingham, Sheffield and Leeds, the public would respond, and that a sufficient number of pupils would be supported to justify the outlay?—I have no doubt, if the thing were done with a careful study of the requirements of each place, if means were taken to ascertain what the manufacturers and other gentlemen of intelligence and ability felt to be those requirements, and to ascertain what response they were willing to make to the proposal for the establishment of such an institution, that with a combination in that way of Government aid and local contribution, placing the management essentially under local people who were qualified to manage it, the thing would be effectual; I do not say at once, because I believe a great deal of growth has to be allowed for in the history of these matters, but I believe the plan would ultimately be effectual in promoting a great increase of such culture as this Committee has in view.

2082. You would suggest, in fact, on the part of the Government an announcement that local effort would be met by a Government grant of an amount which would depend on the amount contributed in the locality?—Yes, I have already observed, that there is nothing more encouraging to local efforts than the expectation that the Government will step in. I believe Government grants judiciously administered will bring out the necessary response from the local people.

2083. Have you been much abroad?—No; chiefly in Switzerland, but I know pretty well the system in Paris.

2084. Do you know the state of education amongst the middle classes of Switzerland?—I am more acquainted with the system of education in the university of Paris, because in Switzerland so much depends on the local arrangements of the cantons.

2085. Would you be prepared to give an opinion with regard to the question, whether scientific knowledge was more generally distributed among the leading nations of the continent than it is in England?—Most certainly, but I do not think it was the case in Switzerland before the establishment of this Polytechnic School.

2086. How long then have they been producing that improvement in Switzerland?—The Polytechnic School does not date back more than about six years, and it has only within the last year or two come into full operation, the building was only completed about three or four years ago.

2087. You believe that in this country vigorous efforts in similar directions might produce very visible results in the course of eight or ten years?—I am quite sure of it, there is a rapidly awakening feeling on this subject, especially with regard to scientific culture. I judge by what I hear and meet with in society. Taking advantage of my official position, I make the matter a subject of conversation with those who can give me any information. A few days ago,
I dined

I dined in company with the new master of Shrewsbury School, a gentleman of great university distinction, he told me that he should be extremely glad to introduce scientific culture into his school, but that at present they were completely hampered at Shrewsbury by the want of accommodation, that they had no class-room, and there was no part of the building which could be used for the purpose, especially for practical instruction. He added that though his own studies had not lain in that direction, he was quite prepared to feel the great importance and value of scientific culture.

2088 Do you think that probably he has found the parents of the boys demanding scientific culture for their sons?—I think it was partly that, and partly what he had learnt of the progress of opinion upon the subject. I have been extremely struck with this within the last year or two, men whose own culture has been almost exclusively literary, now seem to feel the great value of scientific instruction as a part of general education. I think that is a most encouraging sign, because every one knows that the dead weight to be moved in this matter is the weight of the masters in the great public schools, who are men of Oxford and Cambridge culture, all whose traditions are in favour of a directly literary culture.

2089 In fact, you think that the time is ripe for a strong general effort to promote scientific education throughout every class in this country?—I have a very strong opinion that that is so.

2090 Mr Akroyd] I believe your experience has been chiefly in middle class education?—My experience is chiefly in connection with the matriculation examinations of the science degrees at the University of London.

2091 Those who enter for that examination are almost entirely of the middle class, I presume?—Yes, chiefly people who are going in for the professions.

2092 Among those students you would hardly, I suppose, have any from the artisan class?—No, there are a few men who work themselves upwards from that class, especially men coming from Swansea. There is a good institution there called the Normal School, from which we have several men who have passed our matriculation examination, and have gone on to take degrees in art or science, men who have themselves been working colliers.

2093 But that is almost an exceptional case, I suppose?—Yes, I am quite certain from what I see of the baptismal registers (because we require a certificate of the age) that there is a progressive elevation going on in those cases, the people who come up are the sons of artisans, and persons in a humble sphere of life who have been working themselves up to our matriculated examination, and that takes place in a degree which has surprised me a good deal, looking at the certificate of age, I see that several years ago, say sixty, or twenty years, the calling of the father at the time of the birth of the boy was something humble, but of course I cannot tell what it may be now.

2094 Have you any idea how those sons of artisans attain the means of preparing themselves, and of coming up and taking their degree at the university?—I presume the position of the parents must have been improved.

2095 Do you believe that that portion of your students which emanates from the working classes is an increasing proportion?—I think so.

2096 What is your average of matriculated students in the course of a year?—We have over 600 candidates every year, about 400 at our summer examination, and over 200 at our winter examination, but those are not 600 individuals, because out of each examination there are some who had been rejected at a previous examination, I should say about 500 individuals present themselves at the two examinations.

2097 And they must all have completed their sixteenth year, must they not?—Yes.

2098 What would be their average age, should you say?—We have a good many elder candidates, men from 25 to 40 years of age, but, regarding those as exceptional cases, I should say about 18 was the average age. Of course, however, if there happens to be a batch of those older men, it raises the average considerably.

2099 You were saying that you had some knowledge of education in Paris. May I ask you if you know anything of the *Ecole Centrale*?—I have no personal knowledge of it, my knowledge is more of the institutions in connection with the University of Paris.

2100 From the number of those who pass the science examination in the London University, do you believe that you are making an impression on the scientific education of the country?—I think the impression we are making, as yet, is chiefly through institutions and schools. We have decidedly made an impression on the schools by our requirements in chemistry and natural philosophy. I could mention a number of schools and institutions at which those subjects have been introduced in consequence of our requirements, and in which a very efficient course of instruction is now going on in both public and private schools, but I do not think there is at present, except in Owen's College, University College, King's College, and the School of Mines, much systematic preparation. Perhaps I ought to add the college at Chester, but I am not quite certain how far they keep our programme in view there.

2101 So that your standard of examination for matriculation has had an effect in raising the standard of scientific education in most of the schools throughout the country?—In a great number of schools it has, not those which are in connection with the old universities, but there are a number of schools which now habitually send up candidates for our matriculation examination.

2102 You were laying some stress on elementary science teaching in schools, were you referring then to the schools of the middle classes, or to the schools of the working classes?—I was referring to middle class schools.

2103 You were mentioning botany as a very desirable study in country schools; would you recommend entomology at all in such schools?—I think either is good, but botany is better. Girls have a natural fondness for the subject. I think any department of knowledge is good for which the locality offers special opportunities. Suppose a school were in a chalk country, the nature of the chalk, and the fossils found in the chalk, might be made a text for the teaching.

2104 Your object being to train the faculty of observation?—Yes; and to train the mind in reasoning upon facts observed. In the case of natural history it is scientific classification and learning to estimate the value of characteristics which would be specially taught, the mode of determining

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determining the value of plants, or animals, or fossils, according to their special characters. On the other hand in experimental science it is reasoning with regard to the application of principles on which I should lay stress.

2105. You were professor of physiology, were you not?—I was formerly, but I have given that up.

2106. Is not that science now part of your general curriculum?—It is now part of our curriculum, both for art and science.

2107. Do you consider that it would be a valuable branch of education, especially in the mining districts?—I myself should be very glad to see it introduced into general education more systematically, but I find that the examination papers on the subject are generally very unsatisfactory. At the bottom of page 85 you will observe a note calling attention to that subject. Years ago, in consequence of the very imperfect preparation which candidates made, just from want of practical knowledge in the application of facts, that note was added. They get hold of a book and try to prepare themselves for that examination from the book; and it is quite curious (I am not an examiner on that subject, but I often confer with the examiners) to see the wrongheadedness of the candidates on subjects with which they have no practical familiarity, so much so, that the examiners have over and over again said that this examination was really of very little use. The senate wished to continue requiring the subject, and hoped that better knowledge might be brought up, that note being intended especially to direct the attention of the candidates to the getting of some practical instruction where they can attend a short course of lectures. Several years ago I gave a course to a number of the art candidates, I was then the Principal of University Hall, which is in connection with University College. We had a number of young men coming up to the Bachelor of Arts examination, and we gave them about 16 lectures, making them all demonstrative, and they were exceedingly interested in the subject. Almost every man is interested to see an eye or a heart dissected, but when they merely try to work it up from books they seem to have that defect in the preparation of the subject to which I have already referred in the case of a certain student who afterwards distinguished himself.

2108. If all employers of labour were well acquainted with physiology, do you not think that it would help them to preserve the health of their workpeople, and even to prolong their lives?—There is no question about it. I remember a case in point some years ago, which very remarkably shows the ignorance of workmen. It was the case of a cotton mill in Manchester that had been built by a gentleman who was extremely desirous to promote the welfare of his workmen. It is well known in the cotton manufacture that spinning is conducted better at a high temperature, the thread being less liable to break, but on the other hand, the closeness of the rooms in which this temperature is maintained is very prejudicial to the workpeople. This gentleman, knowing by experience that the workpeople, if left to themselves, would keep their windows shut, and not allow any fresh air to come into the rooms, because it would lead to more breakages by diminishing the tenacity of the cotton, provided a number of openings in the ceiling of the room, which was very high, and naturally hoped that

the provision which he thus made for ventilation, and a thorough change of air in the room, would be maintained without the workpeople in the room being able to prevent it. He found, however, that the room became close again. At first he thought that there was something defective in his arrangement; but on examination it was found that all those holes in the ceiling had been carefully stopped up. It was difficult to conceive how the workpeople had done it; and the only feasible supposition being that they had got upon each others shoulders to do it. The fact, however, was, that some thousands of those small holes had been carefully stopped up.

2109. The external air being colder and of greater specific gravity, would have descended like a shower bath on the heads of the people, I suppose?—They knew that the ventilation gave them more trouble in the spinning of the cotton, and they did not know that it was very important for the preservation of their own health that they should have a supply of fresh air. I may mention here the result of an inquiry which I made some years ago in Mr. Marshall's great spinning mills in Leeds, that mill is on the ground, and not one room above another. It covers, I believe, three acres, there is air brought in from above, and that air is heated, when it is necessary, by hot water introduced for the spinning machines. The air is brought in by a fan which is turned by a small steam-engine. Going through the mill, I noticed how extremely fresh were the rooms, and I asked the overlooker whether he could name any results with regard to the health of the people. He said there was thus remarkable difference, that there was a mill belonging to the same firm which was very well ventilated on the ordinary principle, employing, like the mill I was in, about 800 persons, and he added, that it was a rare thing to have any one on the sick-list in the new mill, whereas in the old mill there were always a good many on the sick-list.

2110. You have observed many workshops in different parts of the country, and many large works, do you believe, from your observations, that the laws of health are in many of those almost disregarded, and that the conditions of health are there unfavourable to the longevity of the workpeople?—I have had occasion in former years to go into this question, as one of the sanitary commissioners, when I lectured on the subject of medical jurisprudence in the University College, but I have not of late years attended to it, I am quite certain from statistics I have got together, that there was at that time a very large amount of defect in that direction.

2111. You were alluding to the fact that there is no mechanics' institute in Birmingham, have you noticed that mechanics' institutes prevail to any great extent where factory education has been in existence for a long time, take Yorkshire and Lancashire, for instance, the elementary education must naturally be of a higher grade in those two counties than at Birmingham, may not that seem to explain the absence of mechanics' institutes at Birmingham?—I think that may very likely have something to do with it, but I have always understood that in Birmingham there are a very large number of excellent Sunday schools; for instance, I happen to be acquainted with some of them, and the grade of intelligence among the children of those Sunday schools is very considerable, perhaps more than the average at most Sunday schools, so that I doubt

doubt whether the want of general education has been the cause. I have always found it very difficult to assign a cause, there have been several such institutions, but they have never lasted long. I believe in Birmingham there has never been a thoroughly efficient mechanics' institution maintained for any length of time.

2112. Do you not think that some previous elementary education is almost necessary for the success of a mechanics' institute?—I should suppose it would be, but I am not prepared to say that elementary education in Birmingham has been less than in Lancashire.

2113. Mr. *Potter*.] With regard to the non-encouragement of mechanics' institutes in Birmingham, do you not think that may arise altogether from economic causes, are not the manufacturers much smaller capitalists, and employers of a smaller number of hands than they are in Lancashire and Yorkshire?—I am more inclined to attribute it to certain local habits, and certain idiosyncrasies about different places. At one time I was in the habit of lecturing in different great towns in the country, that is now about 25 years ago, and I found among professional men, my own avocations taking me among the medical profession, different idiosyncrasies and different types of character in different localities, which I cannot account for, but which were certainly very decided.

2114. Take Sheffield, does not the same reason apply there, smaller capitalists and smaller employers of labour?—I am not specially acquainted with that side of the subject.

2115. But of course a small capitalist, employing very few hands, would have less control over his workpeople than a larger one?—Yes.

2116. The force of example would not go so far?—My impression is that, both in Sheffield and Birmingham, where there is a considerable amount of manual dexterity brought out, everything has tended to foster that, to the exclusion of working on principle, the higher paid trades that I was alluding to are trades in which there is a special manual dexterity acquired by the inhabitants, and having got that, there is nothing further to do. They go on, day after day and week after week, without any intelligence being brought out. Take the manufacture of implements on the old method, it is mere rule-of-thumb work, of course for the manufacture of Bessemer's steel a very much higher scientific knowledge is necessary to carry it out thoroughly and effectively. It has always struck me that where the mere rule-of-thumb method constitutes the staple of the work, there is a less demand for intelligence.

2117. Have you not a still greater subdivision of labour, where it is applied to machinery, than occurs even in Birmingham?—I think the subdivision of labour rather tends, unless there is a basis of good education, to limit the mental development.

2118. Is not that subdivision of labour still further carried out in those very districts where mechanic institutions flourish, in Lancashire and Yorkshire?—I think there you come back to the general education; but the subdivision of labour is not so great, I should suppose, in the cotton districts, for example, as it is in the metal works.

2119. The subdivision of labour is much greater when it is applied to machinery than when it is not so; is not that the fact?—Where a large number of persons are employed in one

factory, all having charge of similar machines, it does not call out intelligent efforts so much.

2120. You made some remark about Owens College; you are aware that Manchester owes that college to the munificent gift of one individual, are you not?—Yes.

2121. Where there not one or two colleges or institutions previous to that in Manchester which did not succeed, I allude specially to the Manchester New College?—Yes, that was a denominational college.

2122. That college had at one time as high a class professors as any provincial college ever enjoyed, had it not?—Yes, no doubt. I was not alluding to the denominational colleges at all. Then there is the Independent College at Manchester, which has also very high class professors, we receive a large number of students from there.

2123. Mr. *Bazley*.] Will you kindly tell the Committee how many graduates have degrees of Bachelor of Arts conferred upon them annually in the University of London?—About 80, I should say, was the annual average; the degree requires a high standard and great range of ability; it includes more subjects than the degree of any other University.

2124. In that 80 you include those colleges that are in federation with you?—Yes; our degree is distinct at Cambridge or Oxford; a man may take a Bachelor of Arts degree in the science tripos, but we have now entirely distinct degrees,—Bachelor of Arts and Bachelor of Science.

2125. What is the aggregate number?—The aggregate number would be about 100; that includes both the Bachelor of Science and the Bachelor of Arts, the number of Bachelors of Science is small.

2126. Mr. *Acland*.] Does that include all those that pass on to medicine degrees?—No, that is a different faculty.

2127. They do not go through the arts?—No, medical candidates must have matriculated in the first instance, and then they must pass the examination, which is the same as the first Bachelor of Science examination, but on matriculation they are not required to bring up the higher mathematics, though they are required to have gone through the practical chemistry examination; but all the other subjects are the same for the medical candidates, and for the first Bachelor of Science examination.

2128. Mr. *Bazley*.] Now, as a rule, do you find that the best prepared students attain generally the greatest proficiency in your course of studies?—We find practically that the best prepared men are those who come up from the institutions. The university admits both for art and science degrees candidates from any source whatever, but the proportion of rejections among those is very large, a considerable number of candidates come up for degrees in arts who are themselves engaged in teaching, they are assistants in schools; they aim to elevate their *status*, and come up with a very laudable desire to get a degree; they come up to our first Bachelor of Arts examination, and may perhaps pass a fair examination.

2129. Then with better preparation there would be more success, would there not?—No doubt; when those very men come up to the second Bachelor of Arts examination, which takes a set of subjects which they are not in the

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habit of teaching daily, they fail in a manner which is very sad to see. The first Bachelor of Arts examination takes in Latin, pure mathematics, English, French, and history. Now those are subjects which nearly all fall into their daily routine; but the second examination takes Greek, which is not taught in a large number of the higher class schools, also logic and moral philosophy, which is altogether above the ordinary course of scientific school instruction, with animal physiology, and applied mathematics, and a large number of this very meritorious class are rejected at the second examination, and that is why the number of graduations is so much smaller, the proportion of rejections among those who come up from King's College, and so on, is very much smaller than among the outside candidates.

2130. Because there is a better preparation?—Yes; I would say the same with regard to science. We find a considerable number of those who have passed very fairly through the first examination in science break down in the second, it is so mainly because they do not come up from those institutions at which they get a thorough good educational training.

2131. You would say that to insure the highest attainment, that preparatory education should begin at the earliest possible age?—Yes, with a system of training conducted under scientific teachers; that is a point which I lay great stress upon. We get every now and then self-taught men who pass a good examination, but the general result is, that the success of our men depends mainly on the training which they have gone through. I could show you statistics which would prove that.

2132. Mr. Dixon] Do I understand that it is your opinion that mechanics' institutes have been less successful in Birmingham than in other large centres of industry?—That is what I have gathered from information that I have received at various times. At Manchester and Liverpool there are very large flourishing institutes, which I can recollect for the last 35 years, but I am very much mistaken if there has been any such institution in Birmingham which has held its ground, for a length of time, in a flourishing condition.

2133. Do you know the Birmingham and Midland Institution?—That is a model institution.

2134. I believe it has been 10 years in existence, has it not?—About that time; but that was got up as much as a middle class institution as a mechanics' institution.

2135. Are you not aware that there are considerably more than 1,000 pupils attending night classes in that institution?—I was not aware that pupils were attending the classes there to that extent; but I was speaking not so much of the present time as going back a good many years.

2136. You have no reason to suppose, then, that at the present time Birmingham is behind any of the other large towns in this respect?—No; I was speaking rather historically than of the present time; it happened that a number of my own family friends were concerned in the Philosophical Institution at Birmingham, which is defunct years since.

2137. But that was a middle class institution; was it not?—Yes, it was a middle class institution, but those who were interested in it were interested also in promoting mechanics' insti-

tutes in Birmingham. I think I am right in saying that mechanics' institutes did not take root in Birmingham as they did in other great towns.

2138. But you are now speaking of a number of years ago, and not of the present moment?—I am speaking historically.

2139. Mr. M' Lagan] Do any students come from Scotland for matriculation to the University of London?—Yes, a considerable number.

2140. Do you know from what part of Scotland those students come?—It is a particular class of students who come up from the schools there; they are chiefly schoolmasters, who have generally received their training in one of the normal schools or training colleges of Edinburgh or Glasgow, and they, generally speaking, are exceedingly well prepared.

2141. They are certificated masters, in general, are they not?—Yes; there are certain institutions from which I can almost say beforehand, "That candidate will pass"; and there are certain others with regard to which I say, "It is two to one that that candidate is rejected." And I always consider that those Scotch schoolmasters are almost safe to pass.

2142. Do they generally return to Scotland again, or go to some occupation in England?—Many of them go on for the Bachelor of Arts degree.

2143. But do they go back to Scotland, or do they settle in England?—I think they generally go back to their own schools, in the first instance, but what becomes of them afterwards I cannot say. My impression is, that their object is to raise themselves from the condition of parochial schoolmasters to the condition of independent schoolmasters.

2144. Do you think they very often go back and study for the church or medical profession; does that come within your knowledge?—I do not think they go and study for the medical profession.

2145. You resided in Scotland for some time, I believe?—I was a student in Edinburgh, and have been in the habit of visiting Scotland frequently.

2146. Is it consistent with your knowledge that schoolmasters in Scotland generally aspire to become clergymen?—I have often heard that.

2147. Did you ever come in contact with any students at the University of Edinburgh, the children of artificers or ploughmen, who were maintained entirely by their parents at the university?—When I was at Edinburgh I was studying medicine. I do not think there were any of that class there then.

2148. You are not then aware of the fact that there are often students educated at the University of Edinburgh whose parents are simply ploughmen or artificers, and who support them entirely?—I could not speak from my own personal knowledge.

2149. Can you tell us the comparative cost of education in Edinburgh University and in University College?—I can only speak with regard to medicine, but the fees are considerably lower in Scotland in medicine than they are in the University College. I think for the winter courses the fees were 4 guineas at Edinburgh, with some slight additional fee for the expenses of the lecture-room. At University College for similar courses it would be from 6 to 7 guineas. At Glasgow they are 3 guineas for the corresponding courses.

2150. In the case of the student from Trinity College who distinguished himself so much at the University of London, you attribute his difficulty in at once apprehending the facts of science to his previous training?—Yes; he has since shown such a remarkable natural aptitude, that I can only account for his difficulties, when he first attended the classes, by supposing that his natural capacity was repressed by the direction of his mind exclusively to book studies.

2151 You also stated you thought that the teaching of elementary science could be introduced with advantage into elementary schools?—I feel certain of it.

2152 Do you think that you could accomplish that so long as the present system of payment by results on reading, writing, and arithmetic is insisted on by the Privy Council?—It would be necessary to add another department to those three subjects.

2153 You think that might easily be done by adding any one of the sciences?—Yes, it is quite as easy to examine in the science of common things as it is to examine in reading, writing, and arithmetic.

2154. Do you think the children would attain as much proficiency in reading, writing, and arithmetic, if you were to increase the subjects of examination?—There is every reason to believe so, because an hour a week well employed is quite sufficient to impart this scientific knowledge. It is a change for them, bringing their minds into contact with external realities; and all our experience points to the fact that those who have really tried the system find that it acts by quickening the intellect and enabling it to move with much greater energy.

2155. Do you think the fact of including one of the sciences would, instead of diminishing, tend to increase their knowledge of reading, writing, and arithmetic?—I believe so, from the great intelligence which it would tend to develop. I am sure from my own observation that when the mind is once directed in an inquiring spirit into the reasons of things that are daily passing around us, it awakens a new interest in the subjects of study, when those subjects of study are brought to bear on the facts of daily life—take simple measurements, or what map means, there are very few children who have any knowledge of what a map means such as they would get by being made to make a map of a room, and put down the situation of the chairs and tables. I am quite certain that if an intelligent teacher brings in that kind of practical application, the children take a very great interest in it.

2156. You mentioned that Professor Henslow introduced a particular mode of teaching botany in a village school, can you describe that mode to the Committee?—It was essentially practical teaching, encouraging the children to collect flowers, and then to determine their character on a little scheme of his own. Professor Oliver of University College has published an elementary book on botany, which is essentially written on that method. He was asked to instruct Her Majesty's children on that method.

2157 Was that method carried out upon the natural or the artificial system?—Upon the natural system entirely. I was personally acquainted with him, and the interest it excited among the children was remarkable, and the quickness of intelligence which it brought out, as well as the extraordinary training in accu-

racy which it conferred upon them; a thing which mere literary knowledge does not bring out to the same degree.

2158 Lord *Frederick Cavendish*.] Have you observed at the examinations for matriculation at the London University any increase in the amount of science education in the country of late?—Yes, there is certainly a decided improvement in the style of answering in chemistry and natural philosophy.

2159 Has there been any increase in the number of those that pass in those subjects?—Yes. When I first became registrar they were not insisted on so much, and generally the general rule was, that if a candidate did well in the other parts of his examination he was not very much pressed if he showed that he had attended to the subject; but for some years past those subjects are placed on the same footing as the others. He must attain a certain number of marks or else he is rejected. Of course that operated at first to produce a large number of rejections, but of late years the papers are much better done.

2160 Has the University been enabled to raise its standard of requirements?—Yes, the papers are rather more difficult now, and the candidate must show higher knowledge than was required eight or 10 years ago.

2161 Mr *Acland*.] You require in your matriculation examination a knowledge of mathematics, natural philosophy, and languages?—Yes; and the chemistry of the non-metallic bodies.

2162. You require a certain minimum to be attained in each of those subjects?—Yes.

2163. Now suppose a candidate to come up possessing eminent scientific capabilities, but deficient in literature, I suppose he would fail in your examination?—Yes.

2164. And the same thing would happen if you had a good scholar presenting himself who was deficient in science?—Yes.

2165. The purpose of these matriculation examinations, as I understand it, is not to test the final fitness of the candidate for his place in life, but his capability of study?—His acquaintance with that general foundation of knowledge upon which it is thought any special knowledge may best be erected.

2166. The age at which these youths come up for examination may be as low as 16, may it not?—Sixteen is the minimum.

2167. I understand you do not allow eminence in any one of those branches to compensate for deficiency in any other?—No.

2168. Are you prepared to say that you think that that is not a discouragement to the intellect of the country, so far as that is affected by your matriculation examinations?—I can only say that the question has been very fully and repeatedly discussed among the examiners, and that in the senate last Christmas we discussed it in consequence of the rejection of a man who passed a very good examination, but had broken down in one subject alone. The senate came to the conclusion that on the whole it was better to adhere to the existing system. Proficiency in certain parts of the subjects has this compensating advantage—suppose a man is below the normal passing standard, a certain modification is allowed, but that is a matter for the examiners to decide. I am chairman of this board of examiners. I ask, "Does A. B. pass?" The examiners in classics say, "We have rejected him"; I then ask "Is that

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that rejection absolute?" "Well, yes; he has done so very badly that we were forced to reject him." On the other hand I may ask, "How has he done in other subjects?" and if he is found to have done well in mathematics or natural philosophy, or chemistry, that may redeem him, within certain limits. Mathematics includes two papers and for each of those 300 is given.

2169. What would be the minimum?—One hundred is the regular minimum. Suppose a man had got 90, then the examiner will say, "How has he done in other subjects?" and if he has done a fair amount in other subjects they may say, "Well, we will let him pass."

2170. But still the practical result is this, that the young man who has eminent scientific capabilities would fail to be admitted as the first stage of graduation in the university of London if he failed in Greek?—If he failed completely; if, for instance, he could not decline a Greek verb, or translate the subject given out; but it must be observed that the list is given out previously, say an easy book of Homer, and the man has a full opportunity of preparing himself.

2171. But is not the practical effect this, namely, to limit the action of your examinations very much in the direction of testing the scientific capabilities of those who are to make a living by the industry of the country?—Unquestionably, with regard to those who are looking to mere technical applications of science. I know to a certainty that many students at Jermyn-street would have come up for our scientific degree if it had not been for the matriculation examination; we should have a great many more medical candidates if it were not for the matriculation examination. I am continually receiving letters from men earnestly desirous of becoming candidates.

2172. Your attention has been drawn to the Schools Inquiry Commission, and you know that it was one of the recommendations of that Commission that there should be a school in England in which Greek should not be a necessary part of the curriculum?—Yes.

2173. Are you prepared personally, and apart from your official connection with the London University, to dissent from that recommendation?—No, personally I should fully assent to that.

2174. Apart from your position in connection with the London University, and going back to your former recollections as a medical professor, should you individually say that a knowledge of Greek was in the present state of England necessary for a medical man?—I should say that a knowledge of German was very much more necessary.

2175. You furnished the Schools Inquiry Commission with a list of all the schools from which the members of the London University came?—Yes.

2176. Will you be so kind as to furnish similar information in a tabular form to this Committee?—I will do so.

2177. Has your attention been drawn to the operation of the endowments for schools in England on the scientific instruction of the country?—I have been very glad to believe that it would be a very great advantage to the country if the whole system of those endowments were remodelled.

2178. Now, bearing in mind the particular object of this Committee, which is to ascertain what arrangements would be best for the scien-

tific instruction of those who are to live by manufacturing and other industry, are you prepared to make any suggestions with regard to the better application of those endowments?—I believe you will find, in my evidence before the Schools Commission, that I sketched out almost exactly the plan which the Commission reported in favour of, the plan which I sketched out before the Schools Commission was based on the fundamental idea, that the public has a right to require that the endowments shall be used efficiently for the advantage of the public generally. With regard to the administration of the funds, those schools are all responsible to the Commissioners of Charity and the Court of Chancery; and I think that in the same manner they should be made responsible to the public for the purposes of education. I suggested that there should be a board consisting of the representatives of the universities, with a portion of it nominated by the Crown, who should arrange the whole course of study to be pursued in those schools. My opinion has already been strongly expressed, that in every school, beginning from the lowest, there should be scientific instruction; meaning by the lowest, primary or elementary schools. I think they should all be based on this fundamental principle, that a portion of the school curriculum should have reference to objective phenomena.

2179. But with a view to that object, do you think it desirable that science should be generally introduced into all secondary schools without distinction; or do you think it desirable that there should be certain endowments devoted to the support and encouragement of institutions having a peculiarly scientific character, leaving some other schools to retain a more general character?—I think that with regard to ordinary secondary schools, scientific instruction ought to be everywhere introduced. I think that no boy or girl ought to be brought up in ignorance of common scientific truths. Where there are endowments in existence in particular localities, in which the higher scientific instruction would become peculiarly valuable, I should say that those endowments could not be better employed than in promoting scientific instruction for those particular classes.

2180. Taking the case of Yorkshire, where there is a large amount of grammar school endowment, should you think it desirable, while you would leave the ordinary grammar school with a certain amount of science, to devote, in addition to that, some of those institutions to the peculiar industry of the district?—Yes, wherever the local colour, if I may so speak, corresponded with that idea.

2181. Will you kindly indicate, generally in connection with Yorkshire, or Lancashire, or the Midland Counties, what you think would be the proper type of a secondary school in which science should be the prevailing characteristic; of course you would require arithmetic, algebra, and the elements of geometry?—Yes.

2182. You would desire, I presume, that in all the secondary schools above the lowest grade Latin should be taught?—Yes.

2183. Would you require Greek?—No.

2184. Would you permit Greek to be taught, running the risk of its absorbing other subjects?—No; I would require the modern languages, French and German—the scientific literature of Germany is so very rich.

2185. What

2185. What branches of science would you introduce to the school, bearing in mind that the age of the pupil would not exceed, perhaps, 16 or 17, because they would, at about that age wish to go into some kind of industrial training?—I should say experimental physics.

2186. With mathematics?—With simple mathematics.

2187. Would you treat those physics mathematically, or not?—Yes, on the basis of simple mathematics, not going up to the calculus, it is very much what we have in our own programme. Our matriculation examination includes Euclid up to the fourth book, with algebra up to simple equations. "The subjects marked with an asterisk are to be treated independently of mathematical symbols, or only by simple geometrical methods." The subjects marked with an asterisk are Statics, Dynamics, Hydrostatics, Hydraulics, and Pneumatics and Optics.

2188. Would you make chemistry a subject of education in such schools generally, or would you make it optional?—I think the chemistry of the non-metallic bodies should be a general subject.

2189. Should you make much difference with regard to the extent of the chemical knowledge supplied according to the manufactures of the place?—Decidedly I would carry it on with special reference to metals in a place like Sheffield.

2190. Passing now from secondary schools of a special kind, will you kindly state what you would think the best preparation for the higher courses of scientific instruction, such as would be desirable either for scientific teachers (always bearing in mind the practical aspect of their duties), or for the highest class of manufacturers?—The subjects which we have already enumerated, with the addition of natural science.

2191. Would you require such persons to go through a special scientific course, or would you give them a general liberal education?—A general liberal education, in which science should largely enter.

2192. You would not think it the best mode of preparing one of the highest manufacturers, or a scientific teacher for manufacturing purposes, to send him to this special scientific course previous to matriculation, but you would give him a general education in which science would be one element?—Decidedly; that is precisely the manner in which I have dealt with my own eldest son, who is now in a very large business at Bristol; and the effect upon him, I am informed, was that, when he was placed in business at about 19 years of age, he could learn in one year what it was calculated he might take three years to learn, and I am quite certain that that result was brought about by the wide range of the preparation which he had gone through.

2193. *Chairman.*] You would make your secondary schools more special in those cases where you did not suppose that the higher scientific instruction would ultimately be given, is that so; in other words, where the education was to stop at about 17 years of age, you would make the education up to 17 years of age more special than where it would be continued to 20 or 21 years of age?—Certainly, the longer the preparatory period of the education, rightly conducted, the better, I believe, would be the ultimate result.

2194. *Mr. Acland.*] That is very much a question for the pockets of the parents, is it not?—

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Very much so, and also a question of what I must call the moral training which the candidate is going through, I mean moral in respect to the disposition in which he is trained, because I know that among manufacturers the feeling is very strong that if a young man comes in to be above his work he will not learn technical matters well. I had an opportunity of judging of that when I was principal of University Hall, where I had under my charge many sons of eminent manufacturers going through the university course, and I found the dread which all the fathers had was, that they should receive a training which would put them above their work.

2195. Do you not think those sentiments are a good deal modified by the advance of general scientific education?—Yes, I think so. One of the students under me, after he had taken his degree, went to his father's mill, and I asked how he was getting on, the answer was, "Extremely well, nothing can be better, except that he does not possess the technical knowledge that we want, and he never will," but if he had gone into the mill at an earlier period he would have grown up among the workmen, and picked up a knowledge of the natural properties and qualities of cotton which now he will never get, because he comes down to the mill as a master.

2196. Then how would you say that that difficulty is to be got over?—I would say by a combination of the two kinds of training; when there is a distinct object to be gained the technical education might be begun in combination with the general education.

2197. Do you think it points to the necessity of giving scientific education locally, instead of bringing the pupils up to central universities?—Yes, I have a very strong feeling about that, I think the multiplication of local institutions is very desirable.

2198. Supposing that multiplication of local institutions to be a great national object, have you considered how far the central government and the general funds of the country should contribute to the foundation of such institutions, or whether they should be confined to inspection and organization?—I have already stated that, with regard to the general funds of the country, I thought the Government might properly give a portion of the amount required, where there was a disposition to meet it on the part of the local people.

2199. Do you think that that would be a permanent state of things, or that it would be only necessary during the earlier stages of the question, until the country had got into the habit of supporting those things for itself?—I think it should be permanent in the direction of the maintenance of scholarships, nothing could be more valuable or efficient in operation than the creation of a number of scholarships, say in Manchester. To an institution like Owens College, the Government aid might be by giving a sum of money for the reconstruction of the building, and that continued aid might be given most advantageously in organising scholarships, which should enable young men not possessing means of their own to go and study at such an institution and pay the class fees. That would benefit the institution and the professors, of course, and assist in maintaining the *personnel* of the institution.

2200. Might not those scholarships be created out of existing endowments now lying fallow, or devoted to grammar and other schools, or endowments

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ments which are now uselessly or unachievably applied?—I think so

2201 Do you not think it would be important to utilize those in the first instance?—No doubt; but, with regard to central organisation, what seems to me of the greatest importance is a normal institution. My feeling is very strong that Jermyn-street, with its most admirable staff of professors, could not be better employed than in training teachers. It is a complete mistake with regard to mines, I believe; but as a school of science for training teachers I think the Jermyn-street institution might be used most efficiently

2202 Do you think London the best place for that purpose?—Decidedly; you would not get

such a set of professors in any other part of the kingdom, as Professors Tyndall, Huxley, Frankland, and Percy; they are the most eminent men in the whole country, in their respective departments.

2203 Besides Jermyn-street, are there not in London two or three important institutions capable of giving any amount of scientific instruction?—University College and King's College, certainly.

2204 Then do I gather from you that the two points which you are most desirous to impress upon this Committee are perhaps these; the importance of objective knowledge for training the mind, and the importance of systematic teaching in educational institutions?—Just so.

Professor JOHN TYNDALL, called in; and Examined.

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2205 *Chairman*] You are Professor of Natural Philosophy at the Royal School of Mines in Jermyn-street?—I am

2206 The instruction which you give is not class instruction, but instruction conducted by lectures?—Yes.

2207 You have no class instruction whatever?—None.

2208. Is the nature of the subjects which you profess such as to refer itself so directly to technical teaching as that of some of your fellow professors?—I should not like to draw a comparison between the relative bearings of my subjects and those of my fellow professors, but I think the subjects with which I deal have a very direct reference to technical teaching. Take, for example, electricity, that at present is a most widely applied power in this country. Take the case of the electric telegraph, you have, in fact, in this land of England, at the present time, a race of engineers calling themselves telegraphic engineers and electricians, whose efficiency depends in a great measure on the knowledge of that branch of physics which we call electricity. The laws of light also have immediate application in the construction of dioptric and catoptric apparatus for our light-houses, even in the construction and disposition of looking-glasses in our homes. The practical optician, the constructors of our telescopes, microscopes, and photographic apparatus, ought to be intimately acquainted with the laws of light. The engineer also finds frequent occasion to apply the principles of optics; while of late years a branch of the subject, entitled physiological optics, has been greatly developed, and an acquaintance with which would be of immense value to the practical oculist, and to the medical profession generally. I need not say a single word about the subject of heat with its applications to the steam engine, and particularly of the modern notions with regard to heat. Of course they have incessant practical application, my course of lectures takes in electricity, magnetism, some lectures on the mechanical properties of air and water, with lectures on acoustics, optics, and heat.

2209 In your lectures, do you point out the application of those subjects to industrial occupations?—I cannot say that I do more than glance at the industrial applications of those subjects, but once properly furnished with the principles, the student can at once adjust his previous knowledge when he comes in contact with the industrial applications of the principles.

2210 Your students come to you, I believe, from various schools, and, in fact, without any scholastic training at all if they choose, you have no matriculation examination at all, have you?—There is no matriculation examination at all at the School of Mines.

2211 Do you find that, as a rule, the students who come to you are well prepared or otherwise?—I am obliged to avoid entering very much into mathematical considerations; I think I should rather shoot over their heads if I entered very much into mathematical considerations. We have, however, a final examination at the end of the session, and I find that there is a great deal of sound and definite knowledge imparted by those lectures to the students.

2212 In spite of their want of mathematical knowledge?—Yes; many of them send in papers of an exceedingly high character, and the average I should call decidedly good. Some of them come entirely unprepared, not only unfitted to pass anything like an examination, but apparently unprepared to learn much with regard to science.

2213. *Mr Acland.*] Do you often find that very good papers are produced by men who are quite destitute of mathematical knowledge?—Sometimes we find men who have naturally mathematical heads who are able with perfect precision to visualise the facts brought before them, and reason upon them with perfect accuracy without the intervention of symbols.

2214. *Chairman*] But with regard to the majority of your pupils, you would consider the absence of mathematical training a great disadvantage, I suppose?—Mathematical training is exceedingly desirable, even where it is not formally applied. The habit of mathematical thought cannot be too strongly desired.

2215. Then this absence of mathematical knowledge must be a detriment to your course of instruction generally, inasmuch as you are forced in some measure to place all your students on the same level, which places the few who have mathematical knowledge at a disadvantage through the fault of those who have not, because with the latter you must begin at a lower stage?—Yes, there is some truth in that; but still to a man who looks closely into his subject, and observes the bearing of phenomena upon each other, it is very surprising what an amount of sound knowledge can be conveyed without the intervention of formal mathematics. I would, however, make a certain

a certain amount of mathematical culture an essential element in any system of education.

2216. What is the length of your course?—Between 30 and 40 lectures. I believe 32 is the number advertised, but I usually extend it a little, perhaps adding a few lectures, or making some of the lectures a little longer. I lecture five days in the week, and I require about seven weeks to complete the course.

2217 Your course is comprised within a single session, is it not?—Yes; I give only one course of physics.

2218 You find that that single course really affords the large amount of information of which you have spoken, to your pupils, do you?—I think the instruction imparted in that course is of immense value to the students who come forward there.

2219. The instruction at Jermyn-street, I believe, is intended specially for those who intend to devote themselves to mining and metallurgy?—That was the original intention, I think, a great many of the students who come there devote their subsequent lives in that way; but still we do not confine our students to persons of that class. We have, first of all, a series of regular students, who come in for a certain course there, and then we have, besides those, occasional students, who come in by subscribing to the lectures.

2220. In fact, Jermyn-street might be described as a school of science, and to a certain extent also as a technical school, might it not?—Dr Percy lectures on metallurgy, Professor Smyth lectures on mineralogy and mining, those are eminently technical subjects, the subjects on which I lecture myself have a most direct and important bearing on technical knowledge.

2221. Probably not many more subjects would be required to be introduced in order to make the school in Jermyn-street a technical school resembling some of the large technical schools on the Continent?—It would not require any profound alteration of the institution, as it now stands, to convert it into a technical school of very considerable efficacy. The only serious difficulty would be want of space for the models, which would be essential in a course of technical education.

2222. Is there any comprehensive technical school in this country at the present moment?—I am not acquainted with one.

2223. Do you consider it desirable that we should have in this country what other countries possess in that respect?—I think it is highly desirable.

2224. Would you consider it desirable that Jermyn-street should be adopted as the basis or nucleus of such a school?—That is a question upon which I should like to ponder before giving an answer; I have not thought of the matter.

2225. Mr. Acland.] Perhaps you will kindly inform the Committee whether the main scope and purpose of your own lectures is rather to supply an elementary knowledge of science to those who are likely to turn it to immediate account in business, or to give an impulse to the diffusion of the higher scientific knowledge in England?—My object in lecturing and teaching in Jermyn-street is certainly not to give knowledge to be turned to immediate account in business. In the first instance I try to provoke a desire and love for the science that I teach. I endeavour to keep this love and interest awake throughout the course,

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communicating at the same time as sound and as extensive a knowledge of experimental physics as the time which I can devote to it (which is limited to 30 or 40 lectures) enables me to do.

2226. If Jermyn-street were converted into a technical institution, should you then have either to modify your present course of lectures or to provide other lectures more directly bearing upon industry?—I think that either I or the gentleman who might occupy my place would certainly have to deal more fully than I feel called upon to do with such matters.

2227. Chairman.] But you could imagine that, without at all changing your plan of instruction, there might be other professors who would continue that instruction in a more technical form?—I quite think so.

2228. Are you practically acquainted with the foreign polytechnic schools?—I am not so far acquainted with them as to be able to give any authoritative evidence about them.

2229. With regard to instruction in science in secondary schools, have you any experience on that subject?—My experience of secondary schools, as measured by time, has been very small; but during about two years of my life, when I was very much among young people, I took great interest in observing the effect of scientific instruction upon boys. I remember I worked a good deal with them at elementary mechanics. I had apparatus which illustrated the action of the lever, the wheel and axle, the pulley, the wedge, and inclined plane, the so-called mechanical powers; but I drew my principal illustrations from the objects of daily life, such as the plough, the crowbar, or the seesaw in the playground, while I chiefly used my apparatus to give precision to my illustrations. I can assure the Committee that those boys and myself went over the ground in a kind of triumph. I shall never forget the influence of those days on my own mind, and the intense and living interest which those young people took in their studies. Those boys were perfectly enthusiastic about their studies in practical mechanics, I would simply take that as an example of the interest that may be excited and the good that may be done in such directions.

2230. What was the limit of the age of the students in the class to which you refer?—To the best of my recollection the ages varied from 11 or 12 to 16.

2231. And you found the boys of 11 years old were quite capable of joining in studies of that description?—I have before my mind's eye at this time a boy who was certainly under 12 years of age and who was one of the most advanced in the place; he was a boy of considerable natural precocity, but I think boys of 12 years may very well be made acquainted with a great deal of knowledge such as I now refer to. I had taken many of these boys over the first six books, and the 11th and 12th books of Euclid, and also taught them the elements of plane trigonometry.

2232. Was that school a classical school?—Classics were taught there very considerably.

2233. And you found that the teaching of science did not impede the ordinary progress in their classical studies?—I never heard that it did; still I think that in that school science had perhaps a fairer chance than usual, its claims being rated as very nearly equal to those of the classics.

2234. Mr. Bruce.] Were the class of boys who

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who attended at that school the sons of professional men, or what were they?—Sons of professional men, officers in the army, doctors; a good many of them were the sons of farmers, a considerable number were the sons of manufacturers in the north of England.

2235. *Chairman*] Were many of the boys being prepared for the old universities?—I ought not, perhaps, to say many of them, but I know some were.

2236. Did you find that those boys who were pupils in your class were, generally speaking, tolerably proficient in the classics?—Yes, I think so, there was a general intellectual health and strength about them which made itself felt in all their studies. Still I would warn teachers against multiplying subjects too much. This is, in my opinion, one of the greatest dangers of the present age.

2237. With the exception of what I must, in your presence, call your own extraordinary aptitude for imparting scientific instruction, I suppose there was nothing peculiar in the general curriculum of that college or in the boys who attended it, so that you would say that, with an apt teacher, the same thing might be done in a great many other schools if the same attempt were made?—Yes, I have no doubt whatever of it. All that we did there would be open to most schools, we had a chemical laboratory, which was superintended by a man of distinction in science, and we worked together, one at chemistry and the other at physics, but I must say, with regard to our success, that I have a strong natural liking for boys, and entered with intense zest into the work during my short stay there, though I had had no previous experience as a teacher.

2238. You prepare the examination papers in natural philosophy for the science and art examinations, do you not?—Yes; I set the examination papers in acoustics, light and heat, and in magnetism and electricity.

2239. Do you also review those papers after they have been worked?—The papers of late years have been very numerous, amounting to more than a thousand, and I could not think of undertaking that duty at all. But I set the papers, and I have the good fortune of having the help of two or three very eminent friends, who are all Fellows of the Royal Society, and who assist me in looking over the papers. The next batch of papers that comes to me from South Kensington, I shall send, for example, to Dr Matthiessen, a man of very great distinction, last year, after they had passed through his hands, they passed, in great part, through the hands of my friend Professor Hurst, who compared his results with those of Dr. Matthiessen, and although there might have been a difference in their estimates of special questions, still, when the total results of each candidate were taken and compared, it was found that there was a most extraordinary agreement between them; so that I can rely with a safe conscience, upon the correctness of the judgments which are pronounced upon those papers.

2240. Do you revise any of them yourself?—Yes, if any doubtful point arises, indeed, I may say that always, whether a doubtful point arises or not, I run my eyes over a number of the papers, and compare my own results with those of the gentlemen who have looked at them; but I do not and could not look over every paper.

2241. But from your own knowledge, and also

from the perfect confidence which you feel in the examination of the papers by those gentlemen, are you prepared to say that the answers given to your questions show a competent knowledge of the subjects treated in a large proportion of those who stand for examination?—I have no hesitation in saying that a vast quantity of perfectly sound knowledge of a most valuable character is sown broadcast throughout the country, through the agency of these examinations. You will always find, where a considerable number of students come up, a per-centage consisting of people who have no business to make their appearance at all at such examinations; but I do consider the results of the examinations at South Kensington to be in the main in the very highest degree satisfactory.

2242. Does any large number of those who stand for these examinations come under your own personal cognizance, in consequence of being brought under the instruction given in your lectures?—No, I should say not a large number; but there is one here and there.

2243. Are many of the science teachers men who have attended your classes?—I hardly think so. We instituted evening lectures at Jermyn-street some years ago, with a view of meeting in some degree the wants of schoolmasters among others. We lectured alternately, first of all to the working men, who reward us the most, and then to people of a grade above working men, including schoolmasters. I have received letters from men who have attended these lectures over and over again, who speak in the most satisfactory terms of the good they have received there.

2244. When you say that working men reward you most for the pains you take, have you any means of testing the amount of good done among working men by your evening lectures?—We do not examine the working men, but they come there night after night. I have sometimes to lecture before another audience, at the Royal Institution, composed of what you would call a higher stratum of society, but, with regard to gentlemanly demeanour and courteous attention, I cannot conscientiously say that I prefer one of those audiences to the other. I have purposely looked round the filled benches in search of a yawn, I never once saw it among these working men. I often receive letters which are perfectly touching, in the name of 20 workmen, or 30 workmen, in such and such a factory, expressing their intense disappointment at not being able to get ticket for the lectures; so that though I do not examine these working men, yet, if there is any trust to be placed in human sympathy, or in one's observation of the human countenance, we may safely infer that those working men get a great deal of good out of the lectures.

2245. What is the number of working men who commonly attend them?—Advertisements are put into the papers that 600 tickets will be disposed of at a certain time, and they are sold as fast as they can be given out.

2246. Do you see the faces of the same men frequently in more than one session?—Yes.

2247. You find, in fact, that the same persons return to you?—Not a doubt of it; and I am persuaded the working men derive great profit from the lectures. Sometimes, while the lectures were going on, I have gone up from my club and stood opposite the door in Jermyn-street, and seen those men entering. The eagerness to get in, and at the same time the perfect

fect order which is maintained among them, is something quite extraordinary. I believe, if you could expand the room to four times its present size, you would, instead of 600, have 2,400 attendants.

2248 Is it frequently the case that the men who have attended those evening lectures of yours, afterwards enter themselves for your afternoon lectures?—I hardly think so, these are for the most part *bond fide* working men, hard-handed earnest people, who have no time to devote to study save the time which they take at night.

2249 They have no opportunity of continuing their studies, then, in the daytime?—None

2250 But you would, I suppose, say that if similar lectures were delivered in our great manufacturing centres, it would be a great benefit to the working men in those centres?—There is not the least doubt of it. Perhaps you will allow me, before the examination closes, to read a letter which I received only yesterday, and which will show you the spirit which is abroad with respect to the examinations at South Kensington, it is a letter addressed to me from the teacher of the Model Schools at Balieboro', county Cavan, Ireland. "Model Schools, Balieboro', County Cavan, Ireland, 8th May, 1868. John Tyndall, Esquire, F R S, &c. &c.—Sir, I beg leave to remind you of your promise contained in your letter of 22nd January last, in reply to mine of a previous date I had stated that Major

Dalton, the chairman of our local Committee, had offered seven medals, one gold, three silver, and three bronze, for competition to the members of our class especially (who have been engaged this session in 'acoustics, light, and heat'), and that it was the wish of all parties that the decision should be left in your hands. In your reply you very kindly consented to undertake the additional trouble of deciding the order of the first seven of our class. The members of the class are most anxious that it should be understood that Major Dalton has offered his prizes *in addition* to those given by the department, and that the special prizes are not to exclude them from their chance of obtaining the medals and prizes of the department. The latter, of course, carry with them a greater distinction, they would be more highly valued, and the candidates therefore hope that their prospects in regard to them may not be interfered with by the local rewards. These latter have contributed to a great extent in keeping the members of our class hard at work. I venture to say, that for the last six months, physical science has received as much attention here in the centre of a rural district as has been given to it by any class in the metropolis itself. I have the honour to be, sir, respectfully, your obedient servant, J J Doherty, Head Master, Model Schools" I beg leave to hand that letter in to the Committee as a sample of a class of letters of which I receive a good many.

Professor
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Thursday, 14th May 1868

MEMBERS PRESENT.

Mr Acland
Mr Akroyd.
Mr Bazley.
Mr. Henry Austin Bruce
Lord Fredk Cavendish.
Mr Dixon
Mr Graves

Sir Charles Lanyon
Mr Mc'Lagan
Mr. Wm Lowther.
Lord Robert Montagu.
Mr. Edmund Potter.
Mr Read.
Mr. Samuelson

BERNHARD SAMUELSON, Esq, IN THE CHAIR

Professor FLEEMING JENKIN, called in; and Examined.

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2251. I BELIEVE you are a Fellow of the Royal Society, and a Member of the Institution of Civil Engineers?—Yes.

2252 You are professor of Civil Engineering at University College?—Yes

2253 But, I believe you have resigned that appointment, and have been appointed to a similar chair at the University of Edinburgh?—Yes

2254 You are an engineer by profession, are you not?—I am an engineer by profession, and have practised for some years on my own account, both as a civil and as a mechanical engineer I began life as a mechanical engineer, as a pupil of Mr William Fairbairn, of Manchester. I then went to Messrs Penn's, and afterwards practised as a civil engineer.

2255 You did not serve a pupilage in the office of a civil engineer?—No

2256 Before you went to Mr Fairbairn's works, did you receive any scientific education in an English school?—In the new academy of Edinburgh, my scientific education may be said to have begun The elementary mathematical teaching was very good there, afterwards, I went abroad, and was educated both in Germany and France, in private schools, and subsequently, at the University of Genoa, where I took a degree, and where the scientific education was also fairly good

2257 At what age did you enter Mr. Fairbairn's works?—I was 18 when I went there.

2258. In what capacity?—As a regular pupil, or apprentice

2259 You worked in the workshops?—I was there for three years, part of the time in the workshops, and part of the time in the drawing office

2260 The three years included the time you were in the drawing office?—Yes

2261 Comparing the amount of preparation in your own case with that of others, would you say that the scientific education which you had received was of great advantage to you?—Very great advantage to me, I found few of the young men equally well prepared with myself, one man who certainly was as well prepared came from King's College, where he had received a scientific education

2262 What was his age?—He was one year older than I was, 19

2263 Did you find your having entered into the practical department at so late an age any

serious drawback to your success?—Not the slightest; during the first six months, I felt very awkward. I was behind the man who had received some previous instruction of the same kind at King's College; he had six months the start of me, but after that I found no inconvenience whatever I should not advise a young man to enter the office of a mechanical engineer before the age of 17 or 18

2264. Your fellow pupil had availed himself, I suppose, of the workshop instructions at King's College?—He had.

2265 You consider that that gave him about six months' start of you?—Yes.

2266 At the end of say 18 months, comparing yourself not with that pupil, but with an apprentice of 18 months' standing, would you say that you were decidedly inferior as a workman to the average of uneducated workmen having served for a similar length of time?—Not to those who had served for a similar length of time, but I was undoubtedly inferior to workmen of my own age who had begun much younger; still, at the time I left Mr Fairbairn's, I was a fair average workman I could have erected a locomotive, and I had had charge of the pattern shop for a time

2267 In fact you could have taken the position of a foreman at the end of that time?—I could.

2268 You are in a position to speak generally of the skill and education of the civil and mechanical engineers in England?—I think I am. Without entering the office of a civil engineer as a pupil, I have had a good many opportunities of conversing with and meeting young civil engineers, the preparation is extremely simple for a mechanical engineer The lad comes at the age of 17 or 18, and enters the workshop, having paid a premium, that being the sole condition of entering the workshop of a mechanical engineer My experience is that these young lads are most wonderfully unprepared, they literally know nothing that they ought to know, except reading, writing, and some arithmetic

2269 Much arithmetic?—Not much. A few know a little algebra, but very few indeed are able even to use the formulæ that they find in the Engineer's Pocket Book without very considerable risk of misapplying those formulæ, because they do not understand even the algebraic notation with any certainty

2270. Such a book as Templeton, for instance, which

which is in the hands of every foreman, they would not understand?—Just so, there is very great risk of their misunderstanding even results; they trouble their heads very little with proof, and they very seldom in after life (except a few clever men) acquire that knowledge of algebra or geometry which they certainly ought to have before entering the workshop.

2271 Do they understand the use of the slide-rule?—At Messrs Penn's they did understand the use of the slide-rule; or, rather they learnt it when they came into the office, that being a popular instrument there, but I think it was imported by a Brazilian. We all took a fancy to that and learnt to use it. I have continued to use it ever since, and have found it of great advantage. I may here add a few words to the position in which pupils find themselves when in the workshop, and the facilities given them for learning their work. In the first place, no one teaches them anything: neither the master nor the foreman. The foreman thinks it his duty to get as much work as he can out of those who will work, and, consequently, keeps them as much as possible to one kind of work, however uninteresting it may be. I remember passing six weeks doing nothing but polishing those brass valve boxes that you see outside locomotives, from which I did not learn very much. They not only get no teaching, but there are actual barriers opposed to their learning much. For example, it is considered improper for a pupil to take sketches. In the workshops that I was in, Messrs Penn's and Mr Fairbairn's, we were not allowed to take sketches of the machinery which either existed in the workshop or was being made. If we did it we did it surreptitiously.

2272 Is that a universal state of things?—I think it is very general, but I do not know, at all events there is no encouragement to do it. I know, especially at Penn's, the taking of any sketches, or the copying of any drawings, was considered a crime.

2273 What should you say is the average result of such an apprenticeship?—With the best men the result is better than you could possibly expect. Idle men scarcely learn anything at all, but there will always be a certain proportion of young men of great energy and considerable ability, who, even under these disadvantages, will pick up a practical acquaintance with machinery, which they could not obtain in any other way. In addition to the disadvantages that I have already mentioned, there is another, which is, that these pupils have no opportunity of learning what anything costs. I never could myself learn the value of any piece of machinery, either its cost complete, or the cost of executing any part of it. The pupils generally leave the place, knowing next to nothing of the cost of carrying on any of the operations in it.

2274. That is to say, they are not admitted into the office in which the cost of the machinery is calculated?—They are not admitted into the office in which the cost of the machinery is calculated, I am not now proposing a remedy for these things, because there are difficulties in the way of remedying them, and objections, as any manufacturer can well judge, to letting the pupils become acquainted with the cost of what he produces.

2275 Will you state in what way the education of these pupils differs from that of those who pay no premiums, but receive wages at the rate of 0.72.

mencement?—It differs in no respect whatever, except that the pupils receive a certain amount of social consideration which the mere artisan apprentices do not, they are sometimes allowed to come at eight in the morning instead of at six, and their absence from the works is not strictly commented upon, I think a lad would be in a far better position who simply went and paid no premium, and received wages, with this exception, that I am sorry to say that he would perhaps be scouted by pupils who had paid premiums, that would be the case probably in some of the works, but not in all of them, when the pupil leaves the works, the master generally feels himself bound to give some sort of certificate, stating that he has been a diligent and useful pupil, or perhaps the master tries to find him some employment, but, as nearly all the pupils get this kind of certificate, there is no test whether the pupil has really benefited by the time which he has spent in the workshop, or not, and the number of pupils is so large in great works that it is impossible that the master should find them employment in the workshop, so that the young men must seek employment elsewhere, and beyond a mere letter of recommendation from his master, there is nothing to distinguish the able man from the stupid man, or the idle from the industrious man.

2276 There is no attempt made on the part of the master or the engineer to acquaint himself sufficiently with the acquirements of the pupils then?—No; sometimes as a matter of accident a pupil will be employed by the master directly, because the master happens to be brought in contact with him, and sees that the pupil is a clever man and can be made use of, in that case he probably does make use of him, but there is no systematic attempt of the kind to which your question points in any workshop that I know of.

2277. Mr. Acland.] Could you give the Committee any idea of the number of pupils sometimes taken into large establishments?—At Messrs Easton's factory, they told me that they had 25.

2278. What would be the proportion of pupils to the number of workmen?—I think they employ about 800 workmen, and that would not be an uncommon proportion.

2279. Chairman.] There are 25 pupils paying a premium?—Twenty-five pupils paying a premium.

2280 Now, with regard to the office of a civil engineer, what is the course pursued in such an office?—The students come equally ill prepared, though they are generally of rather better social position, they work in the office and in the field, very much in the same way and with no special supervision on the part of the master, just as the mechanical engineers do, but inasmuch as they have to be in contact with the resident engineer, and the subordinates, where they are employed in works upon the ground, they do learn more, they are more taught, because the resident engineer finds them useful in the minor operations of surveying, levelling, and taking out quantities, so that I think they get more teaching than the mechanical engineers, not from the masters, but from the resident engineers, and from their fellows in the drawing office, and that teaching is altogether of a practical character, they very seldom indeed attend any classes, but they gain some theoretical knowledge generally from the men in the drawing office, and from the resident engineer.

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2281 For instance, are they employed to calculate the strains and thrusts in erecting bridges?—Yes; a clever pupil would sometimes be employed to do that, towards the end of his apprenticeship; he has to pick it up very much for himself, but I have known cases of that kind.

2282 And what should you say was the general result of such an apprenticeship?—The young civil engineer comes out of his time very well fitted for his immediate duties, if he has really worked during his time; I mean very well fitted to carry on the minor operations which are required in a civil engineer's office and on the field; he has seen works actually going on, and he has been in contact with that class of men whom it will in after life be his duty to superintend; he has become acquainted with the whole course of business, so that he is a useful man, and I think a more useful man immediately than the more scientifically trained engineers of the Continent when they first leave their schools.

2283 Do you find that any large proportion of the young men who have been trained for civil and mechanical engineers abandon their professions?—A very large proportion, indeed; and I think it is very much due to that natural selection, that we have in England the good engineers which we undoubtedly possess in large numbers.

2284 On the whole you would say that a very large number of these young men in training for the professions have learned very little?—Yes; I should say that a large number have learned nothing.

2285 So that if they remained in the profession they would not be of much use in it?—Of no use at all, and the special education they have received is not such as to fit them for other employments, such as those of manufacturers.

2286 I believe you have considerable acquaintance with the routine of education for such professions abroad?—Yes. First of all, I have executed works abroad, and come in contact with foreign engineers, and latterly I have made it my duty to visit several of the chief establishments on the Continent; and inasmuch as the system is very different in France and in Germany from our own, it might, perhaps, be convenient if I were to describe one or two of the establishments for training engineers in those countries.

2287 You have visited France quite lately, have you not?—Yes, quite lately.

2288 And Switzerland and Germany?—And Switzerland and Germany.

2289 Will you be kind enough to tell us what is the course of instruction in the French schools for engineers?—In France the engineers are divided broadly into two classes; the civil engineer, as we understand the term, does not exist, he is there a Government official.

2290 He is an *ingénieur des ponts et chaussées*?—Yes; he is an *ingénieur des ponts et chaussées*, or else an *ingénieur des mines*. To obtain that Government position or appointment, for it really is an appointment, the man has to enter the Polytechnic School, passing an extremely severe examination.

2291. An entrance examination?—An entrance examination, in which there are 900 candidates for about 150 pupils received, and that examination is of such a nature that I think there are few men in England who could take it who would not also be competent to take honours at Cambridge.

2292. At what age do the students pass this matriculation examination?—They must not be younger than 17, and they must not be older than 20.

2293. May we take the average age, then, at 19?—Yes, that is nearly the average, the examination is very difficult. The heads of it are, first of all, geometry, including solid geometry, to a considerable extent (they do not employ Euclid), then algebra, which includes equations, the general theory of progressions and series in general, the binomial theorem with its applications, logarithms, and their use, derived fractions, the decomposition of rational fractions into simple fractions, etc.; plane trigonometry is very complete; then there is analytical geometry, including conic sections; and analytical geometry of the three dimensions, also. There is descriptive geometry, which is not taught in England, in the sense in which they understand it. Physics are complete, with electricity, magnetism, hydrostatics, hydro-dynamics, and the general properties of bodies. For chemistry there is a very complete course. Free-hand and mechanical drawing are also required, and some knowledge of German. There is no special examination in mechanics. Physics are divided into the general properties of bodies, which does, of course, include a certain limited amount of mechanics; and drawing is also required. Evidently this course does not include all the subjects which would be required in an examination for honours at Cambridge, but what I meant just now was, that I do not think there are many men who could take this severe examination who could not also go up for honours at Cambridge.

2294. You have now been speaking simply of the Matriculation Examination, have you not?—Yes; it is really a competitive examination for Government appointments, they remain at the school two years, and during those two years the education is still what you may call purely theoretical; mechanics is then taught to a large extent, wonderfully taught as theoretical mechanics, but it is still not taught as applied mechanics.

2295. Then what is the next step, what becomes of those young men?—Of those young men, perhaps 30 or 40 only obtain civil employments; and the competition for these among the 150 students in the school is extremely intense, the military appointments being considered very inferior; among those 30 or 40 civil places, there are three which are considered the best of all, viz, the appointments at the School of Mines; and this great competition in the school keeps the standard of work at a very high level. They come out of the school most admirable mathematicians.

2296. The civil appointments are appointments on railways, I suppose?—No, they are appointments of a kind to which we have, I think, nothing analogous; they are almost entirely, in the first instance, administrative appointments; but the men, when they leave this school, do not go to those appointments, because their scholastic education is not yet finished. The three men who obtain the best of the appointments go to the School of Mines, and remain there three years more; the 20 who become civil engineers go to the *Ecole des Ponts et Chaussées*, where they stop also for three years, and get what is called practical teaching. That school I visited, though I did not visit the School of Mines; and I must say that after leaving the Polytechnic School, they

they must find this mere child's play, the courses are extremely simple, and I have no doubt that by the time they get to this point, the young men have had quite enough of it, and that they would be incapable of going on under the same pressure as in the Polytechnic School.

2297. The mental strain having been very great?—Very great indeed, they are paid at the second school. They go in at nearly 20 years of age; they are two years at the Polytechnic school, and three years at the *Ecole des Ponts et Chaussées*, so that they do not come to be employed until they are nearly 25 years of age.

2298. Mr. Acland.] What are they doing, or learning, during those three years at the *Ecole des Ponts et Chaussées*?—I think the best answer to that question would be, to go through the courses which they follow: they receive lectures during six months of the year, and those lectures are on the strength of materials, and stability of constructions; there is a course of political economy, a course of geology, a course of agriculture, and agricultural hydraulics, a course of roads, a series of lectures on bridges, and on internal navigation by canals, and so on, a course of lectures on steam engines and locomotives; a course on railways. There is then a series of what they call *conférences*, which is, I believe, a special mode of teaching, consisting of lectures, in the course of which the pupils almost converse with the teachers; there are then lectures on maritime works, and on architecture; one on administrative law, one on applied chemistry, one on telegraphy, one on photography, one on pisciculture, and one on sketches and plans; then there is German and English. This is really technical education; it is an attempt to teach men to be engineers by giving them lectures on everything which an engineer can ever have to do.

2299. Will you kindly state whether all the young men go through all these courses?—Yes.

2300. Is there any practical work going on side by side with the lectures?—No; not side by side with the lectures; but in the six months of each year, when they are *en mission*, they are sent out to be with some engineer in the departments to see practical work, though they are not practically employed by the engineer. I spoke to several of the students, who told me that the engineer made very little use of them, they are obliged to make sketches, and to write essays on the work they see going on; but that is a very different thing from carrying out the work practically for one's self.

2301. Chairman.] Those young men being prepared as civil engineers, do many of them enter into the service of the great railway companies?—They do, but not at first; they go first into small places where they receive from 80 l. to 120 l. a year, and where their duties are almost purely administrative.

2302. As *ingénieurs des Ponts et Chaussées*?—Yes; they would have to see that the laws concerning navigation, and roads, and bridges, were carried into effect in some out of the way department. I know that they suffer very severely in consequence of this change from the highly intellectual work to which they are accustomed, to routine work, for which they have received no specific education.

2303. Do many of them become mechanical engineers or managers of factories?—I think not; I have not met with any, at all events.

2304. You have hitherto spoken of the Poly-

technic School, which is a Government School, the primary object of which is to train Government officials?—Yes.

2305. There is another very important school in France of the highest class, namely, the *Ecole des Arts et Manufactures*, ordinarily called the *Ecole Centrale*?—Yes, that educates an entirely different class of men.

2306. I suppose that school educates men who follow industrial occupations?—It educates men who either become civil engineers in the sense which we attach to the word, or mechanical engineers, or manufacturers, and, so far as I know, the *Ecole Centrale* is the great school for mechanical engineers, for whom the *Ecole Polytechnique* furnishes no education whatever.

2307. Is there an entrance examination at the *Ecole Centrale*?—There is an examination, which is almost as severe as that at the Polytechnic School, and in which almost the same subjects are required as at the Polytechnic School. I think in the one or two instances in which they differ the requirements are not so high, perhaps, as for the Polytechnic School; for instance, the examination in physics is less complete, but they require in addition natural history, subdivided under the heads of physiology, zoology, and botany.

2308. Is it not the case that they do not require the classics at the *Ecole Centrale*?—Yes.

2309. Whereas the Polytechnic requires the classics?—The Polytechnic requires that a man shall have taken the degree of Bachelor either in science, which, I think, does not require the classics, or in arts, that is to say, the ordinary Baccalaureate.

2310. Then this school receives pupils at what age?—At about the same age as the other.

2311. At about 18 or 19 years of age?—At about 18 or 19 years of age, it was originally a private establishment founded in 1829, then it passed into the hands of the Government, I think, in 1857, having been self-supporting up to that time.

2312. The *Ecole Centrale* is visited by a good many foreigners, I believe?—It is visited by a good many foreigners, I should have mentioned that a certain number of external students are admitted to follow the course of the school of the *Ponts et Chaussées*, but under very stringent regulations.

2313. What is the number of pupils in the *Ecole Centrale*?—They received last year 220 out of 500 candidates, and they have 490 pupils in the school, so that although the competition is not so intense as for the places under Government in the Polytechnic School, it is a very satisfactory competitive examination; wonderfully so, considering that no appointments whatever are attached to the school.

2314. But does not custom lead the students to expect that if they have passed through the course satisfactorily, they will receive employment from directors of private enterprises?—Yes; and hitherto that expectation has been realised, but now these students are beginning to meet with some difficulty in finding places.

2315. Because the supply is greater than the demand?—The supply is greater than the demand.

2316. Is that to be attributed in some measure to the depression of manufactures which prevails in France as well as elsewhere, or is it from any other cause?—I attribute it to the depression of

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trade, and that is the cause to which I have heard others attribute it

2317 It is regarded as only temporary?—Only temporary; the pupils come at eight in the morning, and leave at four in the afternoon, and they are occupied during the whole of that time, except for half-an hour or an hour at luncheon; and after that time they must necessarily work for three or four hours every evening; I attended several of the classes, and I have no doubt that the description given me is quite correct, so that the hard work these men go through is very marked.

2318. You are speaking now of the *Ecole Centrale*.—Just so

2319. What should you say was the result of the course followed at the *Ecole Centrale*?—The result is to turn out men who have received a very good scientific education indeed, and who are very competent to take places immediately, as draughtsmen especially, and who, if they receive practical instruction afterwards, will probably prove to be very valuable men. Those young men leaving the *Ecole Centrale* would be hardly as well qualified to assist in engineering work as the best pupils who follow the ordinary course in England. That is to say, at their entrance into life, it would be so, but later on in the life of the English pupil, as he progresses in the profession, and greater responsibility is thrown on him, he begins to feel the want of scientific knowledge very much indeed. The pupil of the *Ecole Centrale* would then, I should say, have the advantage. There is a peculiarity in the instruction at the *Ecole Centrale* which, I think, ought to be stated; whereas at the *Ecole des Ponts et Chaussées* the young men are taught by lectures only. At the *Ecole Centrale* they not only receive lectures, but they have a certain number of what are called *projets*. They receive eight *projets* every year, and those eight *projets* correspond exactly to the kind of work which the young men would have to do in mechanical works. They have a month allowed them to get out the drawings, the estimates, and the specifications for these particular *projets*. For instance, a short description was given to the students of a drilling-machine, and, at the end of the month, each pupil was obliged to bring in an independent original design for a drilling-machine, with specifications and estimates, and on that design he had to go through a cross examination. There are eight *projets* such as that yearly. One of them on shafting; one of them on boilers, one of them on girders, one of them on locomotives; and, at the end of the three years, these students have thus gone through a very large amount of practical work under the immediate superintendence of the professor, who corrects every one of the drawings, specifications, and estimates. That is a peculiar feature at the *Ecole Centrale*, which enables them to turn out practical men, as, in fact, they do.

2320. So that a man leaving that school would be conversant with every department of practical engineering?—He would be conversant with a great many.

2321 Did you examine any of their work?—I examined a considerable number of those essays and drawings, and found them remarkably good

2322 Did you go into the specifications at all?—I did not go into them critically; but I looked through them, and found that they were tho-

roughly practical, such as would be employed in actual work in after life.

2323. You have hitherto been confining yourself to the subject of mechanical engineering, but I believe the *Ecole Centrale* is also a school of chemistry?—They subdivide the subjects at the end of the first year, and during the two remaining years the pupils follow their special professions; there are the mechanicians and the builders or constructors. I do not know the exact sense which they would give to the word, but I think the constructors would very much correspond to what we call building contractors. Then there are the metallurgists and the chemists, making up the four divisions.

2324 Mining is not included, then?—Not specially, but metallurgy would be a preparation for mining.

2325 First of all, the teaching is entirely theoretical, and then, after that, there is a division into special branches of study?—Yes.

2326. Could you compare the *Ecole Centrale* with anything which we have in this country?—I think there is nothing whatever corresponding with it; the only thing that would at all approach it is, the teaching given in King's College, but that is on a much lower level, for a young man leaving the *Ecole Centrale* would be immediately useful in entering an engineer's office, and would be entitled to expect a salary; we could not say the same thing of a young man leaving King's College; nor is King's College intended to answer the same purpose, the *Ecole Centrale*, like the *Ponts et Chaussées*, endeavours to teach young men to become engineers

2327 Comparing the *Ecole Centrale* with King's College you would say that the teaching at King's College was only secondary, I suppose?—It is only secondary teaching

2328 With regard to University College, how does it compare with the *Ecole Centrale*?—Up to the present time it has not organised any definite course of instruction, although they have got special lectures. My own lectures for civil engineers are only preparatory lectures. It would be absurd to suppose that a young man, after attending them, would be fit to go and practise his profession; the intention being at the *Ecole Centrale* that when he leaves and has received his diploma he should be quite fit to act as an engineer.

2329. But leaving out of consideration special cases, and taking a young man at the end of the general course at the *Ecole Centrale*, how would you compare the instruction which he had received with that which he would receive at King's College or University College?—The instruction is very much more advanced at the *Ecole Centrale*. I heard a lesson in mechanics given in the second year, which required the student to have a very considerable amount of mathematical knowledge before he could at all follow it. In the first year they have the differential and integral calculus, and they become very fairly familiar with it during that year.

2330. Did you visit any of the secondary schools?—Only the *Ecole Chaptal*.

2331. That is a municipal school, is it not?—It is a municipal school. It is a special school of science as opposed to a school of classics. I attended one or two classes there, and they seemed to be exceedingly well taught, but that school was inspected by Mr. Arnold, and as I knew it would be reported on by him, I did not spend much

much time there, the teaching seems to be exceedingly good, and a large proportion of the pupils are successful at the polytechnic schools, and they are also able, with only two years of Latin, to pass the Baccalaureate examination.

2332 Are you able to say to what degree instruction in science is carried in the *Ecole Chaptal*, and schools of that class in France?—It is carried so far as to enable the pupils to pass this entrance examination, either at the Polytechnic school, or at the *Ecole Centrale*. It is this examination which determines what shall be the standard of this so-called secondary education in France. There are 900 pupils trying to get in every year to the *Ecole Polytechnique*, and perhaps 450 trying to get in at the *Ecole Centrale*, and it is those two examinations which determine what scientific education shall be in France.

2333 Can you rank the results of the secondary science education in France with that which would arise from the preparation for honours at Cambridge?—Yes; there are at present very few men, who when they leave King's College, or University College, would be competent to take those examinations.

2334 That is to say, the examination of boys who have passed through a secondary scientific school in France?—Yes, the higher classes. In the *Lycées* they follow special classes of mathematics, coming after a complete course which would perhaps be called a secondary course in England.

2335. You also visited the *Ecole des Arts et Métiers*, at Chalons, did you not?—Yes; that school, I confess, did not impress me as being one which could advantageously be imitated, and I think I might almost call it a bastard school, it is neither a school for engineers, nor a school for workmen; the young men work there for seven hours a day, and it is very largely recruited among the working classes who get bursarships for that school, but it also receives paying pupils, who come from the small manufactories, foremen, and managers. The theoretical education which they receive is certainly good, and such as young men would find great difficulty in getting in England, but the instruction is not of so high a class as the instruction at the *Ecole Centrale*; so that though the pupils from that school at Chalons cannot compete with those from the *Ecole Centrale*, yet the education is too high for them as workmen, or even as foremen; and, moreover, inasmuch as the work done in the shops is of a small kind, they do not get that thorough education as workmen which a man would get working in a large mechanical workshop.

2336 There is, then, no comparison between the workshop there and a mechanical workshop of even ordinary importance in England?—I think not. A man at Chalons would see a little of all kinds of work in a methodical way; but his standard of work cannot be the same as that of a man who is learning in a real workshop.

2337. Would you say that the training in the workshop at King's College was at all analogous to that given in the school at Chalons?—No, in the workshop at King's College, a man only works a little; so that he gets a slight familiarity with his tools, whereas, on leaving the school at Chalons, men go into workshops, and get from three to four francs a day, which is, however, low wages.

Q.72.

2338. They become fair, ordinary workmen?—Yes.

2339 And at the same time they receive a considerable amount of scientific instruction?—They do.

2340 Your impression is, that the school leaves them at last in a half-way position, they being neither workmen nor fit to be foremen or managers?—Yes.

2341 Still, I believe that the *Ecole des Arts et Métiers* has turned out very good men, has it not?—No doubt of it, the teaching is very good, and the drawing is wonderful. I never saw any drawing in France or Germany, or England, at all to be compared with it.

2342. How do you account for that?—I believe it is due to some special requirements made by General Morin, or by the inspector general of the schools, they require a particular class of extremely delicate drawings.

2343. Do you know what is the office of General Morin?—I cannot answer that, I think he is inspector general of the three schools.

2344. Did you visit the *Conservatoire des Arts et Métiers* in Paris?—Yes; and I was extremely pleased with the lectures I heard there; they were, several of them, very interesting, and such as workmen could follow; but I could not characterise those lectures as being strictly educational, they serve the purpose of diffusing a certain amount of general information among the workmen, and they are very largely attended; but I do not think they could be described as educating the workmen.

2345 Would you compare those lectures at all with the evening courses in Jermyn street?—I have not followed those evening courses in Jermyn-street, but I should think they were very similar.

2346 But in no way comparable with the class instruction given in connection with the science and art department?—No; there is no class teaching; any person can attend the *Conservatoire*; they can come in when they like, and go out when they like; and there is no examination whatever in connection with the lectures, they do not, strictly speaking, teach, they only give general information in the shape of lectures.

2347 Did you visit the *Ecole St Nicholas*?—Yes, that is a very curious experiment, showing that in certain cases the ordinary apprenticeship for workmen may be dispensed with, and a rival system adopted, combined with theoretical instruction. I think such a system might be applied in particular cases, though I do not see the special advantage of it.

2348 But is it the fact, that theoretical instruction and apprenticeship are combined there, or are they not consecutive?—They are consecutive chiefly; but the apprentices pass two hours in the classes daily, and have three hours of drawing weekly besides.

2349. Speaking of that simply as a school?—how would you rank it?—The drawing is exceedingly good, I should describe it as a very good primary school for workmen.

2350. Do you know any primary school in this country to which it could be compared?—I do not; indeed, I am pretty certain that there is none.

2351. Do the boys remain there until the age of 13 or 14?—They do, at the primary school, and

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and then a limited number of them enter the apprenticeship shops

2352 That is a special institution?—That is a special institution.

2353 I think you said you were particularly struck with the drawing in the primary school?—Yes; it convinced me that workmen can be taught the elements of plane geometry, and mechanical drawing at a very early age.

2354 You think that boys leaving school at 13 years of age could be taught mechanical drawing and practical geometry?—Unquestionably

2355. Have you also visited any of the Swiss and German schools?—Yes; I visited Zurich, where there is the large Polytechnic school of Switzerland, and where the education given is, to a great extent, analogous with that given at the *Ecole Centrale*, the aim being the same, and the general course of instruction exceedingly similar, that also is a day school, and it is divided into eight departments, a school of architecture, a school of civil engineering, then mechanics and chemistry, and a knowledge of the management of forests, a school for teaching the mathematical and physical sciences, then come the *belles lettres*, and the moral and political sciences, and lastly, a preparatory course of mathematics; so that it is more than the *Ecole Centrale*, it is almost what might be called a scientific university.

2356 I think I understood you to say that there is a preparatory course, though you mentioned that last?—It is the last on the list; but there is a preparatory course for the entrance examination, which is of very much the same character as that required for the Polytechnic school, and for the *Ecole Centrale*.

2357 Then this preparatory course would hold the rank of a secondary school in France?—Yes

2358 But apart from that preparatory course, is it the case or not, that there was a theoretical course common to all subsequent to the preparatory course, before the special examination is given?—No, I think not, they begin here from the very first to follow each their special division.

2359 They are supposed to be sufficiently prepared, either by that preparatory course, or by a previous training elsewhere?—Yes.

2360 Did you visit also Karlsruhe?—Yes; I should not omit to state that at Zurich the cost of instruction is only 4 l. a year, with an entrance fee of 4s. One very remarkable thing is the enormous number of professors there, there are a number, also, of what they call *agrègés* or *privat-docenten*, who give free courses for fees of 4s. a half year for each hour a week

1361 To revert for a moment to the *Ecole Centrale*, what is the expense of the instruction there?—Thirty-two pounds a year. It is very much higher than the expense at the school of Zurich. Then adults at Zurich are admitted as occasional students without going through those extremely severe examinations, but they are not permitted to take the diploma. I may add that there is a discipline in connection with the school at Zurich, which they have not at the *Ecole Centrale*, nor at the German Universities; that is to say, the authorities punish young men even for misconduct out of school. They exercise a certain supervision over them in the town.

2362. How does that work?—I believe it

works badly; there was a revolution in the school a few years ago. Again, the Polytechnic School also gives diplomas as the *Ecole Centrale* does. I should wish to direct particular attention to that, because these diplomas are found exceedingly useful, but the number of them is very small, whereas the number of students is upwards of 600, there were only 47 diplomas given last year. One in architecture, 12 in chemistry, 13 to engineers, 14 to mechanicians, while three were to foresters. These diplomas have a real value in the way of distinguishing the very best men from the others.

2363. They are given after examination?—Yes, after examination. At Zurich it is necessary that a man should have followed the whole of the course in each profession. There are about 50 professors with salaries varying from 80 l. to 500 l. a year. The school is supported by a Government grant of 10,000 l. a year, so that really it is a school giving gratuitous instruction of the highest class.

2364. That 10,000 l. a year is found sufficient to support a school of nearly 600 pupils in Switzerland?—Yes.

2365. That would be at the rate of 16 l. or 17 l. a pupil, in addition to the 4 l. paid by the student?—Yes; and in addition to the original cost of the building, which was about 100,000 l., it is the finest building of the kind I have ever seen, with most admirable arrangements in the class rooms

2366. Have we anything in this country comparable to the laboratories at Zurich?—I have not seen anything equal to it, either with regard to the class rooms or the laboratories, either there or at the Polytechnic school at Karlsruhe. The *Ecole Centrale* is very inferior, the rooms there are not so good as what we have in England. Of these pupils at Zurich, only 243 are Swiss, while 308 are foreigners. I have often heard the remark made that no Englishman goes there. You see one or two in the list, but they are mostly men either of semi-foreign extraction or who have been educated abroad, and the reason, I believe is, that among the English the class of boys does not exist who could take these examinations, I mean that the entrance examination is so severe that it would turn back all except those who would either have a chance of distinguishing themselves at Cambridge, or of getting direct admission either into the artillery or engineers, or into civil service appointments, and the men who could take these examinations need not go to the school at Zurich. There were in the winter 149 different courses of lectures, and 146 in the summer, 139 engineering pupils, 156 in the school of mechanics, and 70 in the school of chemistry.

2367. Do the pupils when they leave that school readily find appointments?—They used to do so, but almost always out of Switzerland; but now, probably owing to the depression in trade, there is great difficulty among them in finding appointments. They chiefly find appointments as draughtsmen in England, and also in Germany; but afterwards, when they have had practical experience, I believe they have generally done extremely well, and the teaching is very good. I may state that I went abroad convinced that it was impossible to teach men to be engineers at all by means of lectures and practice in universities of that kind, but I have had to modify my opinion, and I do now believe that men can be taught where you have such admirable professors. I believe they can

can be taught to be useful practical men even if they have had no actual practice at all

2368 Taking the professors of the technical courses (say the professors of mechanical construction), are they men who have had any practical training?—Yes, they have received a practical training, they have all come there because they preferred the life of a professor. They have all had a theoretical training, after which they have had practical training, and they do, in fact, teach practical work, they are a class of men which I think does not exist in England at all.

2369 We might, perhaps, instance yourself, but that would be exceptional?—I should hardly like to put myself on a level with those men, they are so extremely well prepared for their work, all one does go to the school, it is very difficult to understand what the nature of the teaching is, the mere names of the courses in the programmes give you very little idea of what it is, the nomenclature is quite peculiar. They have classes in analytical mechanics, and the technology of railway machines, the design and erection of machines, with practice, the technology of mechanics, civil constructions, and the construction of bridges and railways. Now these names really give you no idea of what is taught in these courses, but still when I examined into the course myself, I found that each of these headings had a definite meaning, and that each of such courses gave really useful instruction.

2370. Do you think that that extreme subdivision is desirable?—It is really a nominal subdivision. These courses could be much better named than they are, and they are found in practice to form one continuous series, beginning with theory, and proceeding to the details of machinery, and then to general designs of machines, and their application. It is found that at the end of the time the student can design a complete machine

2371. The course is consecutive, and not contemporaneous?—It is consecutive, and not contemporaneous. There are sometimes, however, three or four courses on the same subjects, given by different professors, so that there is a competition for pupils going on.

2372 That partly arises, I suppose, from the great number of pupils who are under instruction?—Yes, and partly from the German system of allowing men to teach who call themselves *privat-docenten*; men who are attached to the universities, and give courses of lectures, receiving payment in fees from the pupils. It is a facultative course, in fact.

2373 The *privat-docenten* receive no other payment than the fees they have from the pupils?—None, I think.

2374 What is the number of the professors who are paid by the State?—I think there are 50 who are paid by the State, and that the *privat-docenten* are in addition

2375. Does the school at Carlsruhe resemble the school at Zurich?—They are very much alike, although the discipline is not so severe, and the sub-division of the studies is also slightly different; I like the mechanical teaching at Carlsruhe still better than the mechanical teaching at Zurich, and I prefer the arrangement of the courses at Carlsruhe, there are also some minor differences with regard to the examinations; at Zurich they are very strict and they turn back all the men who cannot pass year by year the examinations fitting them for the higher

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courses, those examinations at Carlsruhe are not so strict as those at Zurich; then at Zurich, in examining for the diploma, they require that you shall have followed the courses at Zurich itself, whereas at Carlsruhe you may have followed the courses in the other polytechnic schools if you like, and have come to Carlsruhe only for the diploma, some of the questions they asked at the examinations are altogether excellent, and they are of the same kind as some of those at the *École Centrale* where the man has practical data given to him, and is required to carry them out so far as the drawings, estimates and specifications are concerned, into some practical piece of work, he is given two months to do it in, and then he brings up his work, and is cross-examined upon it, so that in that way they are able to test the practical knowledge of the men, as well as their theoretical knowledge, they often take those diplomas after they have had some practical experience, which is a better plan than the plan pursued at the Zurich Polytechnic; there are 40 professors and 451 students

2376 This school at Carlsruhe is, I believe, the Government school of the Grand Duchy of Baden?—Yes

2377 Supported entirely by the State?—Almost entirely supported by the State, the students pay 6 l 12 s a-year

2378 As against 4 l at Zurich?—Yes; it differs from Zurich, inasmuch as the diplomas have an official value, at Zurich the diploma has no official value at all; the man holding a diploma has no rights which the man who does not hold a diploma does not also have, but at Carlsruhe the man must hold one of these diplomas before he can be one of the official engineers of the State

2379 The State of the Grand Duchy of Baden?—The State of the Grand Duchy of Baden in which there are 8 or 10 appointments yearly, there are also two or three Government appointments as architects yearly made from that school, and there are about 12 appointments of officers connected with the administration of forests, there are 12 to 15 students from the school appointed to places in the financial department of the Government.

2380. Is it not the case that most of the students at Carlsruhe, as well as at Zurich, enter into private undertakings in their after life?—No doubt; but still there are those prizes which are worth having, and which help to fill the school. I may add, that the laboratories are quite admirable, and the course of instruction given in the laboratory is very superior to anything that I saw in France. In France, at the Polytechnic School, for instance, there are 12 chemical manipulations, which must be a mere farce if done according to a regular series year after year. I know the students dislike them exceedingly, whereas at Carlsruhe students are engaged in independent examinations into new subjects, so that they take a very lively interest in the work they are pursuing, for instance, when I was there they were conducting analytical investigations into the properties of wines, they had the wines themselves, and the soils, and the vines, and all those were analysed, and the results published. At Zurich the same system was pursued with the same lively interest in the work on the part of the students.

2381. Is anything of the kind done at the *École Centrale* in Paris?—I think not, I think there also the laboratory exercise is part of a

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course, not a fresh investigation into a new subject. What those 12 manipulations specifically mean, I do not know, but I believe they mean going through a certain number of well-known, and well-ascertained chemical re-actions.

2382 Did you visit any of the secondary schools in Switzerland or Germany?—I am sorry to say not; I can only judge of the secondary schools by these examinations.

2383 Does the standard of examination resemble that of the Ecole Centrale at Paris?—Almost exactly, I should say that those four schools, the Zurich School, the Carlsruhe, the Ecole Centrale, and the Ecole Polytechnique, all stand upon the same level, but at the Polytechnique they can be somewhat more severe on account of the enormous number of the candidates.

2384 Would you say that some of the secondary schools in Germany and Switzerland, what you have said of the secondary schools of France, namely, that the pupil who has passed those schools, and who is able to enter the higher school, would be able to pass the examination for honours at Cambridge?—Yes, I should say that the same amount of work which would enable him to pass the entrance examination, would allow him to go up for honours at Cambridge.

2385. You mean that the degree of instruction given, and the degree of mental power displayed, would be about the same?—Yes, of course the subjects are not the same.

2386 How would you compare the results of all this in an industrial point of view with what we have in England?—We get a somewhat similar result, though it is arrived at by extremely different paths, our system of pupilage does not exist on the continent. On the other hand we have not got a system of theoretical education; at all events, if it does exist in some schools, it does not affect the engineering profession; nevertheless, I do think that certainly the young men in the English professions of mechanical and civil engineering are quite as useful men, and indeed more useful men, than those pupils who come from those large polytechnic schools. If I had a work to execute, I would rather employ, as resident engineer in a subordinate position, an English pupil after one or two years' work, than I would employ a pupil of the Ecole Centrale, or one of those polytechnic schools of the same kind.

2387 That is, assuming that in each case the pupil should have had one or two years' work?—Yes; or assuming that he should be a thoroughly good pupil, I should then rather take the man who was simply out of his time of pupilage in England than I would take one of those pupils for such a subordinate position as I have named; the pupil in England has actually seen some kind of work of the description that I should employ him in, which is an advantage to start with. But when, in after life, the two men came to fill higher situations, the English engineer would begin to feel the want of the elementary training very severely, and he is at a disadvantage as compared with the man abroad, in judging of new problems which come under his eye.

2388 Can the Englishman supply that deficiency, and if so, how does he do it?—He succeeds generally by means of a very strong dose of common sense; the men in England who rise to high positions in their professions are naturally men of considerable ability and good judgment,

and these do actually supply the want of theoretical education more than any one would at first sight believe.

2389. Taking the test of quality and cheapness combined in the work of civil engineering, how would you compare the work of our engineers in England with the work, say, of the engineers of Germany?—I think that at the present time there is very little to choose between English and German engineers in that respect, either on the score of excellence or on the score of economy. As to France, we are certainly the superior. For instance, in the waterworks which I had to carry out at the town of Rouen, we were able to effect a considerable saving and improvement in the work as it was proposed by the French engineers of the Ponts et Chaussées.

2390. That was a work of mixed and mechanical civil engineering and mechanics?—Yes; looking to the bridges which are executed in France, I think the work of English bridges is cheaper and better designed than the work in France.

2391 With regard to Germany, you would say that they are now on a level with us?—Yes.

2392. Do you attribute the improvement which has taken place in Germany, to the much greater experience which they have gained of late years?—Yes, up to the present time, or rather tall within the last few years, we have had almost a monopoly of the experience which enabled us to do without any great amount of theoretical knowledge, but the foreigners are now getting more and more practical experience, and inasmuch as the German education is excellent, and they take advantage of it, I think they have now caught us.

2393 Formerly they had all the theory, while we had all the practice?—Yes.

2394. And now they have all the theory, and a portion of the practice?—Yes, all the theory, and a portion of the practice, but I do not see how in England you are to imitate those large continental establishments. I admit their great excellence; but when I ask myself how in England we are to create such establishments as the Ecole Centrale or the German polytechnic schools, I fail to see how it could be practically carried out. First of all the students are wanting; we have not got the young men who are sufficiently advanced in their education to enter such establishments; and secondly, we cannot find the professors, certainly the class of men combining practical and theoretical knowledge, such as they have in Germany, does not exist in England as a class, and if it did they would not be tempted in England to leave practical work for the moderate salaries which professors must expect.

2395 I suppose a salary of 300l or 400l a-year would be a large salary for a professor of mechanical technology?—Yes, and for that he would have to give up almost the whole of his time. Many of the professors work 28 or 30 hours a-week at the polytechnic schools. Then, in addition to the want of students and the want of professors (which, perhaps, might be considered only a temporary deficiency), you have the question of the very large endowments which would be required. The endowments which are sufficient in Germany would not be sufficient in England; and I do not think this country is prepared to grant the very large sums which would be required. Even supposing that all these difficulties were well got over, unless we were prepared to abandon the pupilage system, I do

not

not see how a young man could find time to attend those special schools. If he has to be a pupil, he must remain for two or three years in the office or works, and could not find time for another three years of special courses in those large teaching establishments, and I am sure he could not get a thorough theoretical education without the three years of study, so that he would not be able to begin practical life until 25 years of age, which is too late in England.

2396. You think that a man's time is commercially of too great value in England to permit his going through such a course?—Too great to allow him to pass through a preparatory course such as is required for the entrance examination. A course of three years' study at the school, and then three years of pupilage without pay, but paying, on the contrary, a heavy premium, all that, I think, would restrict the profession to the very richest class of people.

2397. Then, do you think that there is no instruction that we can gain from what is going on upon the continent?—I think there is. If we could get students to enter upon their pupilage as well prepared as they are when they enter on those special courses, I think we should then get a class of very much better engineers, a class possessing, in fact, all the theoretical knowledge we need. The truth is that pupilage is with us parallel to and replaces the technical teaching in those great schools; but whereas in those schools the men have the elementary, mathematical, and physical knowledge, which enables them to understand what is taught, our men have not got that knowledge, and cannot apply it to the problems which they constantly see before their eyes. What I think is wanting is, that the pupils should be as well prepared to enter an engineer's office in England as they are now prepared abroad to enter those large polytechnic schools.

2398. You would stop, in fact, at the secondary school?—Yes.

2399. But you would make that secondary school something very different from anything which exists in this country in the way of secondary schools?—Yes.

2400. Where would you find your teachers for those secondary schools?—I would get them from the universities. Those schools would be almost entirely science schools, and I think we could find men with theoretical knowledge amply sufficient to teach others. Our mathematicians are quite as good as the foreign mathematicians.

2401. But you do not know of any schools in England which would occupy that rank, do you?—No, possibly Cheltenham may approach to it, and King's College approaches to it, but I think the examination at King's College is not sufficiently scientific or sufficiently severe. At Edinburgh, I think, we shall have a course which will fulfil this purpose very fairly. We are there organising, and we have in fact organised a two-year course, at the end of which the students will have the theoretical knowledge of which I am speaking.

2402. At what age will your young men leave at Edinburgh, and at what age will they enter?—I expect them to come to me at about 16 years of age, and to leave at about 18 years of age.

2403. But the teaching in the secondary schools, as you have described them to us, is theoretical?—Yes.

2404. The course which you propose to give 0.72.

in Edinburgh, I presume, would be partly theoretical and partly practical?—It would be almost wholly theoretical, I think the practical part should be kept in a low proportion as compared with the theoretical part. What you want to give the men is the elementary knowledge which afterwards they are to apply in practice. You want to teach them mathematics as far as they are required to enable men to apply them to ordinary engineering problems. You want to teach them physics and chemistry; and then they want to be shown how that knowledge is to be applied in a certain number of cases. You cannot take the whole range of engineering, but you can show them, for instance, how geometry is applied in mechanical drawing. In my own course I can show them how physics and chemistry, and mathematics, are all applied in certain definite examples. I may take bridges and locomotives, and show the application of science to these examples somewhat fully, and then, if a student has common sense, he will see how those different elements are applied in practice to other examples; and if we may draw a conclusion from what our men now do with very little teaching, they would be well able to apply the principles we gave them to other things as they arose in the course of their career.

2405. But do you think there is anything in the instruction of the workshop which would serve as a substitute for your course?—No, I think not.

2406. And that course is a technical one?—Yes.

2407. And I suppose you would say the same of chemical technology?—Probably, but I do not know enough of that to give a competent answer.

2408. But with regard to civil and mechanical engineering, you are convinced that a technical course added to theoretical instruction is highly useful?—Yes, a technical course, but not a series of technical courses, taking up the whole of the student's time.

2409. That technical course, however, would not be superficial, but would enter seriously into some of the more important divisions of machinery and civil engineering?—Certainly, it would not be superficial. At the beginning of my examination I observed that there was at present no means of knowing whether an engineer had profited by the time which he had passed as a pupil in the civil engineer's office, or in a mechanical engineer's office, I therefore think that other universities might, as the Edinburgh University has done, institute a special examination for the purpose of giving a diploma, which examination should be passed by the pupil after he had served his time. The result of that would be, that the students who had really profited by the time they had passed with the civil engineer or the mechanical engineer could come to the university and claim the right of being examined to test their proficiency. I think that examination should be very similar to those examinations which I have described as taking place at Carlsruhe, that is to say, that they should be partly theoretical and partly practical. I think that the practical examination should consist in giving the man a piece of practical work to do, allowing him to choose his own special subject, if he chose marine engineering, for example, give him a piece of marine engineering to design, you might then give him a month

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month to do it in, and require that the drawings and designs should be executed, say, in the rooms of the university; but you should allow the man free access to every possible source of information which he would have at his command in practical life. It is nothing short of ridiculous to shut a man up in a room and tell him to design an engineering work without the advantage of any authorities or books of reference when that is a thing which he would never be expected to do in practical life, and a thing which it would be foolish to do.

2410 But I presume you would take care to ascertain that the design was really the student's own design?—Yes, certainly, and I would have him examined upon it by such examiners as would be competent to test his knowledge. I would cross-examine him as to why he did this and why he did not do the other. In combination with that practical examination I think there ought to be a theoretical examination, the object of which would be to show that the man, instead of going back during the time he had been a pupil had progressed in theoretical knowledge, he could scarcely, while he was actively engaged, have progressed in a very large number of subjects, but you might allow him to choose his own subject, such as the higher calculus or applied mechanics, or some branch of physics, and examine him also in that. If he passed the two examinations you might then give him a diploma which would be a real certificate that he was fit to practice his profession.

2411. Would you say that he should be matriculated in the institution which gave him the diploma?—It has been so decided in Edinburgh, but I think the advantage of it is doubtful. I should be disposed to allow the man to come up from any other institution, if he had only gone through some course of systematic theoretical training before entering an engineer's establishment.

2412 Or at all events, before he came up for his diploma?—Yes.

2413. Reverting to what you said with reference to the Government appointments given to successful students at Carlsruhe, you are aware that that is a very small state with a population of a million and a-half, or less?—Yes, but nevertheless they do manage to find a certain number of Government appointments as rewards for the men who pass the best examinations, and I am very much afraid that unless some inducement of that kind is held out in this country, in the first instance, we shall have very great difficulty in filling those preparatory classes, which certainly will be established at Edinburgh, and perhaps at University College, and elsewhere, and still greater difficulty in getting men to come up for the final examination.

2414 You think that the positions which private enterprise would offer, would not be a sufficient inducement to men to devote themselves to the labour of following out such a course of instruction?—I think it would not with regard to theoretical knowledge. Appointments in England are very seldom indeed given upon the ground simply of theoretical knowledge, take the case of a civil engineer, he gets his appointment in England generally from his master after he is out of his time, and really in such subordinate positions as those a little more or less of

theoretical knowledge would not be of much consequence.

2415. Do you think that the giving of certain Government appointments to men who had distinguished themselves would tend to raise the character of the profession?—I think it would tend to raise the character of the profession very much. What I should like would be this, that, say, a certain number of Government engineering appointments in India should be given to such establishments as do actually institute a methodical course of instruction, such as I have described. It would be necessary, of course, that the Government should take means for ascertaining whether the examination had been as strict as was required. I think they should appoint examiners of their own who should act along with the university examiners, if that were done, and if those appointments were not given permanently, but only temporarily, I think there would be very little danger that the Government would get a less instructed class of young civil engineers than they now get.

2416 But you would not exclude men from competing who had been otherwise instructed than at those institutions, I suppose?—I would not do that now, because I do not think we are prepared for it; but after a certain number of years I think I would recommend that the giving of the appointments should be limited to men who had received methodical instruction at such institutions.

2417. There is now an examination for engineer appointments for India, is there not?—Yes, the engineer appointments for India are now given on a competitive examination, and I think that examination is precisely an example of what an examination ought not to be; the examination upon theoretical subjects, such as algebra and geometry, is of the very feeblest kind, requiring merely a little knowledge of plane geometry, and very little algebra indeed; and then the examination upon practical subjects is as bad upon quite other grounds. I do not know what kind of answers they get at these examinations, but I know that some of the questions which are asked of the students, and which they are required to answer at once, without having any means of reference at hand, are precisely of such a nature that if they were given abroad the student would receive a month, or perhaps two months, to answer them in. Here, for instance, is one of the questions. The following is a practical application of the foregoing question: "It is required to construct pumping machinery, consisting of two engines, two pumps, and two boilers, capable together of forcing 50,000 gallons of water per hour through 3,600 yards of 12-inch main, and into a reservoir 370 feet above level of water supply. How would you determine the dimensions of the principal parts of the machinery?" Now I have no objection to that question, I object to the time allowed to answer it. There are questions too, which, if asked of me, I should like to take a month to answer. That is one of 24 questions which are asked about water. Here are some more questions which, perhaps, still better illustrate the superficial nature of the answers which are expected, it being remembered that 49 questions are put, in all, to be answered in a few hours without books of reference: "Describe briefly the different means employed to supply towns with water, and give illustrative

illustrative examples." "Describe gravitation and pumping systems, pointing out their comparative advantages, and state the principal conditions and requirements to be considered and attended to in adopting either system." "If professionally employed to make a report on this harbour, as to its capabilities, and as to the works necessary to render it suitable for a naval station and harbour of refuge, state how you would proceed to make the necessary surveys, take soundings, and reduce them to a common datum, ascertain the nature of the bottom, and whether affording good anchorage; and also the direction of the prevailing currents," &c "Should it appear, on investigation, that in particular states of the wind or tide additional shelter is required on the outer harbour, mark on chart the position where you would recommend a breakwater to effect this object, give a cross section of it, showing sea-slope or face, and specify how you would make the foundations, and the character of the masonry you would recommend for the purpose Explain the nature of 'purre perdue' foundations Having laid out the breakwater and other works, included in the foregoing questions, point out what you consider will be the probable effect (if any) in altering the existing conditions of the harbour, as to the currents, and the deposition of mud and salt or other material," &c. &c "Describe and make free-hand sketches of the following forms of wrought-iron girders the trellis, the warren, the tubular, and the Brunel girder Specify which form would be most desirable for India, taking into consideration expense of carriage, facility of erection, or where skilled labour was either expensive or difficult to obtain, and describe which of the above forms require staging to get them into position, and what forms can, under certain conditions, be erected without staging." It is also worthy of remark, that in 1865, 1866, 1867, illustrations have been taken by the examiner from the advertisement of the Swidale Company (Limited), which, perhaps, the students may consult with advantage

2418 But I suppose the students are only required to answer a very small number of the questions?—No, I think it is not so at all Another question at the same examination is, "If a landing stage should be required, give a freehand sketch of a simple form of one, and describe those at Liverpool, or any other well-known or important examples" Then the student is asked to criticise the decisions of the Railway Commissioners "The Railway Commissioners recommended in their Report that a railway should be carried over Garnish Island and across the harbour at the narrow entrance by a viaduct, where there is 60 feet of water; point out the engineering difficulties and disadvantages of such a line, and mark on map where you consider the best route for a railway, making the embankment subservient for docks and other purposes"

2419. You consider that the answers given to such questions as those must necessarily be so superficial that they would be of no value whatever?—Of absolutely no value whatever, the Government would have an infinitely better chance of getting well qualified men for those appointments if they either gave the appointments entirely to such bodies as the Universities of Edinburgh or Glasgow, or even Owen's College, or if not they required in addition to the competitive examination that the student should

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have passed through a methodical course of study

2420 Whatever the Government examination might be?—Whatever the Government examination might be, there is another practical suggestion which I would make as an alternative, the Government might very easily allow a certain number of marks to be given as gained by those diplomas, or they might allow the colleges a certain number of nominations

2421 But as we are not in the habit of relying entirely on Government patronage in this country, is there no way in which our engineers and the proprietors of our great mechanical workshops might contribute to encouraging a more extended course of scientific education?—I think they could do it perfectly, without the assistance of the Government if they chose, but it is against their immediate interests to do so, all they would require to do would be to insist that every pupil who came to them and wished to study under them, should have received the training necessary to enable him to profit by practice in their works, if engineers would do that, no Government appointments or any other appointments would then be required, and good secondary instruction would by that means be secured, but inasmuch as every pupil they take is worth from 300 to 500 guineas, you cannot very well ask them to refuse pupils, because they cannot spell even; but I think, perhaps, engineers might be induced to grant some decided advantage to pupils who were thoroughly trained A leading engineer cannot take as many pupils as he is asked to take, and if they were to show, even without a reduction of the fees, a preference for those who had passed good examinations, they would do something for one of the objects of this Committee, and if, as I hope, they would reduce the fees also for students who were properly prepared, they would do still more to encourage good scientific education for England

2422. Do you think that the fees to be received from the pupils are any consideration to such firms, for instance, as that of Sir William Armstrong at Elswick, or Mr. Whitworth, or Messrs Beyer and Peacock, at Manchester?—I have asked many engineers of my acquaintance to endow my class with a single free pupilage, and I have been told with a smile, "That would cost us 500 l"

2423 Is not that a proof that they set very little value on the results of your teaching?—I think it is a proof that they set very little value upon the results of any preparatory study whatever.

2424 I suppose you would say that if a young man had been properly taught he ought to be of considerable value during his apprenticeship?—He ought to be, but those very facts show of how very little value he is at present, the habit is to count the pupils as rather a nuisance than otherwise, apart from the question of the fees.

2425 The employers are not convinced that any course of training would make them of any value?—They do not believe that it would make them of the value of 500 l. paid down, but I may add, that I have not tried many mechanical engineers, they may possibly be more liberal One recommendation that I wish to make is this that the different universities should organise methodical courses, such as we have organised in Edinburgh, and that they should give diplomas, because, even though they had no official value, and were of no value for obtaining a reduction of

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the fees paid with pupils, the value to a young man in after life of a certificate of capacity would not be inconsiderable?—Reverting to your experience at University College, I believe it is the case that at your own class pupils are admitted without any preliminary examination?—Yes: anybody may come that likes; and I have thus a class of young men of very unequal ability, and I do not think that they profit very much by the lectures.

2426-7. Do you receive any remuneration from the college in addition to the fees which you receive from the pupil?—At University College none, and therefore it is my interest to take whoever comes. At the Edinburgh University, thanks to Sir David Baxter and the Government, I can say boldly, and have said, no; I only take men who have passed a proper matriculation examination, such as would be required for medical men, or men entering for other special courses.

2428. You consider your position at Edinburgh more advantageous, not only to yourself, but also to your class than your position at University College?—I am convinced of it; and moreover, I can give a much larger amount of my time than I could were I dependent simply on the fees; with an endowment I could afford to give a considerable amount of time to the college, the fees would in that case be a secondary consideration.

2429. Suppose that instead of being paid by capitation fees, you were paid by results, would you consider that comparable to the system of receiving a stipend either with or without a capitation fee?—No, I am afraid that you cannot test the results of professional teaching sufficiently well, you must be able to attract professors, if you are going to increase this teaching in England, and you would not attract really competent men at all events in the first instance, unless you offered some tangible inducement.

2430. You would say that payment on results even for secondary instruction, would not supply a sufficient inducement to such a class of teachers as you would require?—No; but with regard to primary instruction, the case is entirely different.

2431. That is owing, I suppose, to the very great geographical range over which the instruction is spread, and the difficulty of providing any other mode of remuneration in the case of primary instruction?—Yes, if the more advanced pupils were all to be examined on one system, you would not get the benefit of the individual peculiarities of the professors, and I do not think we ought to imitate the French plan of reducing all to one standard.

2432. You would not adopt the same uniformity of instruction in secondary schools, as you would in what might be called elementary science schools; I mean the science classes in connection with South Kensington?—No, I should not approve of that.

2433. With regard to the education of artisans in theoretical and applied science, have you inquired into the degree of instruction which prevails upon the continent?—I had occasion to employ foreign workmen in foreign works abroad, and English workmen in England, and I confess I have never been able to discover this scientific or technical instruction of artisans abroad.

2434. To what country are you now specially referring?—Take France; Rouen, for instance, and some parts of Germany; I found the primary education of the Germans was better, but there was nothing which could be called technical edu-

cation among the artisans, and I confess I do not see how artisans can receive any technical education, except what they receive in the workshop.

2435. Did you find that there was much scientific instruction among artisans on the continent?—I could not find it among the workpeople generally, as a body; the workman, having to begin his work early in life, has no time to get anything which could be called scientific instruction.

2436. With regard to France, you would probably say that such establishments as those at Creusot, and the *Messageŕies Impariales* at Marseilles, are exceptional?—Yes, they are exceptional; and I dare say something of the kind could be found in England, specially protected by the patronage of the people in the neighbourhood. I do not go so far as to say that leading artisans, during or after their apprenticeship, may not, in night schools or in Sunday schools, acquire such a degree of scientific instruction as would fit them to be more intelligent workmen than they now are; but I do say that workmen, as a body, can never, in my opinion, be supposed to receive scientific instruction. We can, however, improve our primary instruction, and make those men more intelligent, though I think that is the utmost we can hope for. The difference between ourselves and the continent is, not that artisans have better technical instruction on the continent, but that the masters and managers on the continent have better scientific instruction.

2437. You would apply that equally to Prussia, West Germany, and France?—Yes.

2438. With this exception, that elementary instruction is much more advanced in Germany than it is here, I suppose?—Yes, elementary instruction is better in Germany and Switzerland than it is either in France or in England.

2439. You would not be surprised if you found that the proportion of persons attending science classes at Creusot, for instance, was only five per cent. of the whole mass?—Not at all; it is quite what I should expect. I do not see how a practical knowledge of chemistry is to be of use to workmen who are employed to carry out manufacturing processes. It is impossible that they can have such a knowledge of the theory of chemistry as would enable them to alter or modify the processes in any way; and I should think a little knowledge would be almost objectionable if they were allowed to use it for such a purpose.

2440. You would say, at all events, that the same amount of knowledge possessed by the manager of the works would be very much more useful?—Yes, because he could apply it.

2441. If the State paid for the instruction of artisans, or of masters and managers, you would rather it paid for the instruction of the managers than for the instruction of the workmen?—Yes, certainly, for that kind of knowledge.

2442. From that point of view you would say that the system of science classes as established in connection with South Kensington was beginning at the wrong end?—I think it is beginning at the wrong end. I do not at all wish to do away with those classes, because every kind of instruction that can be given has a value of its own; but if there is any difference between ourselves and the continent with regard to scientific teaching it is in the upper classes and not in the lower classes.

2443. But do you not think that the scientific teaching

teaching of the lower classes might be useful as a stimulus to the upper classes?—Perhaps it might, but I am entirely sceptical with regard to the possibility of giving any general scientific teaching to the lower classes. With regard to teaching artisans, I should like to say that if night classes were established with competent men teaching them, I have no doubt a certain portion of artisan students might and would attend them with advantage. I suggested to a trades union of carpenters, the well-known amalgamated society of carpenters, that they should establish such classes, and they have already established a class of upwards of 100 in Manchester, a class of 100 in one part of London, and a small class also at Hammersmith. I have very little doubt that they will establish more classes; they appoint their own teachers, the chief difficulty they have met with has been in finding rooms; it does seem to me that a very proper expenditure might be made in granting some assistance in payment for rooms for classes of artisans who had organised themselves in that way.

2444. Mr Bruce] These are evening classes, I suppose?—Yes.

2445 Very similar to the Government science classes, I suppose?—Yes, but the men say that they prefer not being put side by side with boys, and they prefer managing the classes in their own way and dressing as they please; they like to be where their peculiarities of language and manner are not subjects of ridicule to lads of other classes of society who may happen to be better educated than themselves

2446 Lord Frederick Cavendish.] I think you stated you considered it would be inadvisable to adopt the continental system, and that all we can hope to do with reference to scientific education is, that the pupils should be enabled to come better prepared?—Yes

2447 Do you not think it would be possible that while those pupils were attending the workshops they should also attend lectures by first rate professors, such as those at Jermyn-street?—There are very great difficulties in the way of their doing so. With civil engineers the lads are very seldom for a long time in one place; they are sent about the country to different works, and, in fact, they are best employed when they are sent about in that way. As to mechanical engineers they have such hard physical work during the day that they are very little inclined to attend lectures at night, though one may hope that a certain number of them would always be found who would do so. The examination which I propose to open for them at the end of their term of pupilage would serve as an inducement to them to attend such classes.

2448. Do you think that it would be a great advantage to have scientific lectures given in the great centres of industry, such as Birmingham and Manchester?—Yes, but I should very much prefer science classes at which pupils were forced to attend and take notes, and afterwards pass a certain amount of examination.

2449. You would consider, I suppose, that an engineer who charged 500 L for receiving a pupil would not work the pupil so hard at any practical duties of his profession as to take up all his energy?—The mechanical engineer does so, because in that case it all depends on the foreman rather than on the master, and the foreman generally manages to tire the pupil out in the course of the day, but the civil engineers send their

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pupils all about the country, and they are often very idle

2450. But, no doubt, arrangements might be made that there should be sufficient time given them for attending classes where they might receive scientific instruction?—No doubt

2451 Mr Lowther] I think you stated that you had been employed on some works in Germany, will you kindly state what works they were?—I only surveyed some roads and railways in Saxony, and I have been engaged on telegraphic work in the north

2452. Have you visited any of the large scientific schools in Saxony?—No. I saw Mr. Hartmann's establishment at Chemnitz

2453. Are you aware that there is in Germany a kind of club organised by the workmen in which lectures on scientific subjects are given?—No, I was not aware of that

2454 You stated, I think, that the pupils attending some of the establishments which you were in were not allowed to make sketches of machinery?—Just so.

2455. Why was that?—Each manufacturer thinks that he makes the best machinery in the world, and that copying his machines is an act of piracy. I think, myself, that the restriction is ridiculous, if for no other reason, for this, namely, that the machines can be copied by any one as soon as they leave the manufactory.

2456 Nothing can be kept secret?—Nothing can be kept secret

2457 Will you state what amount of premium was paid by the pupils attending that establishment?—Mr Fairbairn's pupils paid 300 L each, Messrs. Penn's 400 L, I think.

2458 Mr Graves] What do the pupils pay when they are at the *Ponts et Chaussées*?—They do not pay at the *Ponts et Chaussées*. They are paid, for they receive 72 l a-year; but at the Polytechnique they pay 40 l a-year, and they have also to find their outfit, which amounts to 24 l. Each student costs the State about as much more, so that each student may be supposed to pay about half his board there. At the *Ponts et Chaussées*, besides the 72 l a-year, the students get their expenses when they are travelling on one of those missions

2459 Mr Lowther] At the Ecole Centrale, where foreigners are admitted, are there any Englishmen?—None; I believe it is because they cannot pass the entrance examination, but there have been Englishmen there, and there was one American

2460. Sir Charles Lanyon] Do not you think those pupils, both in civil engineering and mechanical engineering, would be capable of higher work, if they were better prepared before they entered the engineer's office?—Yes, that is the very gist of my recommendations, and if we get that, I think we need not have those large schools, such as they have on the continent. All we want is to see that the pupils are equally well prepared

2461. Mr Read] You stated that you considered the primary education of the labouring classes in Switzerland and Prussia better than it is in England?—I do

2462. Does the same observation apply to the primary education of the middle classes?—I hardly know, but I should think not.

2463. Would you not think one of the greatest drawbacks to scientific education in England is the miserable state of primary education generally given

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given in middle-class schools in England?— Under the name of primary schools, we are speaking of two different things; I do think that the scientific education given in middle-class schools in England is exceedingly bad, and much worse than it is in Germany

2464 With regard to this very excellent scientific education which you say is given abroad, has it any particular application to agriculture, besides that one instance which you gave, in which the wines were analysed?—They have an agricultural department at one or two of the large schools, especially at Carlsruhe, where they give diplomas in agriculture. I do not know what the success of those schools is

2465 Can you give us any idea of what particular sciences are taught in those departments?—I can give a list of the sciences, a list which would certainly surprise any English farmer; it includes plane trigonometry, the elements of mechanics and mineralogy, geology, botany, botanical excursions, zoology, experimental physics, and there is an examination in physics and chemistry in general. That is for the first year.

2466 Mr. Bruce] But I suppose this is rather for the training of men who are afterwards themselves to teach, than for the training of mere practical agriculturists?—No, I read in the programme that this school of agriculture has for its object the giving to those young men, who are to devote themselves to agricultural business, a really scientific basis of knowledge in their callings, to give to practically instructed farmers a possibility of becoming well grounded in science. And then, also, to teach men who expect to be connected with the administration the principles of rational farming. Those three are the objects

2467. I think you stated that there was very superior drawing in the schools in France?—There is very good drawing done at the *Ecole St Nicolas*, by lads of 14 or 15, but the magnificent drawing, which I saw at Chalons, was done by young men of 17 or 18 years of age.

2468 Mr. Read] How old do you think a boy should be before he was taught the elements of linear drawing?—I think he may very well begin at 12, but, with freehand drawing, he may begin much earlier, before 12, however, he could hardly acquire the necessary geometrical knowledge for linear drawing

2469 Chairman] Should you be surprised to hear that they begin mechanical drawing at the *Ecole St Nicolas* at 10 years of age?—If that is so, I stand corrected.

2470 Mr. Read.] Do you think that any neglect of the study of drawing in early years can be made up by after instruction?—I think it is very desirable that drawing should be taught very young, and that is the only exception which I would make as to giving technical knowledge to artisans

2471 Mr. McLagan.] I think you stated that you were appointed professor of civil engineering at the University of Edinburgh?—Yes

2472 Are you aware that there is an agricultural diploma given in Scotland?—Yes; that was arranged at the same time as my own diploma.

2473. Are you aware that there have been for some years agricultural diplomas given by the Highland and Agricultural Society of Scotland?—I heard so in Edinburgh.

2474. And that the subjects which you men-

tioned are the subjects in which the candidates are examined?—That I did not know.

2475. You are not aware that some of the most celebrated farmers of England have gone up to that examination, and taken those diplomas?—I am very glad to hear of it.

2476. Have you ever examined the schools in the north of Italy?—Not since I took my own degree there.

2477. Are you aware that there is an agricultural school established in the neighbourhood of Pisa?—No.

2478 In which all the branches of education which you mentioned, are taught to gentlemen who are to practice agriculture, and civil engineering?—I did not know that, but I see no reason why gentlemen who can afford to pay for a liberal education, and afterwards intend residing on their estates, should not learn those things which would be an excellent education for country gentlemen

2479. You stated that there were diplomas in agriculture given at Carlsruhe?—Yes.

2480. You stated also that the Government encouraged scientific instruction in other professions, can you state whether it is encouraged in agriculture?—I did not ask any questions about that, but I should think it was, because one of the chief objects of the institution is to teach official knowledge which would be found useful for Government purposes in agricultural districts.

2481. Are you aware whether, in Carlsruhe, there is any special officer of the Government who takes charge of agricultural matters?—I do not know

2482 I think you said you did not see how it was possible that artisans, in this country, should receive technical scientific knowledge?—Yes.

2483 But I suppose you think it is quite possible that they might receive elementary scientific knowledge in elementary schools?—Very elementary.

2484 Such elementary knowledge as would be of use to them?—I should be very sorry to see in elementary schools any attempt made to teach physics or chemistry. I think up to the age at which an artisan or labourer must leave school, he has enough to do in learning to read and write, and to calculate with a little facility, and perhaps to draw, and have some slight knowledge of elementary geometry; beyond that, I think, it ought not to go.

2485. Do you not think it would be possible, for instance, that labourers should receive so much useful scientific information as to know how to ventilate their houses properly?—No; I do not think so.

2486. I think you stated that you had employed both here and on the continent, English labourers and continental labourers, did you find the labourers on the continent were better educated than the English labourers?—Only in Germany

2487 Did you find they were better workmen, for instance?—No

2488 You found that you could get through as much work with the English labourer as with the German labourer?—It may be prejudice, but I think the English labourer is the best workmen there is.

2489. Did you find the English labourers as intelligent as foreign labourers?—I use the word "labourer," to signify the lower class of unskilled workmen; I do not think they are particularly intelligent

intelligent in England; I do not think their standard of culture varies very much in different parts of Europe; but the English mechanic or skilled workman is, I think, as intelligent a man of his class as you could meet with anywhere.

2490 Mr *Bazley*] Although the students in engineering establishments are not allowed to sketch or copy the engineering works which are before them, do they not keep private text books in which they record from day to day what has been placed under their inspection, and do they not make private sketches for their own use?—The better class of pupils do take notes, but if they were caught making sketches they would be very sharply reproved for it.

2491 What I am speaking of is making sketches from memory, in their own rooms?—We used to do that surreptitiously, but we were liable to be well blown up for it, if we were caught.

2492 You think students in engineering establishments learn more perhaps out of the teaching or training they give themselves, than they do from any knowledge conveyed to them by their employers?—They owe absolutely nothing to their employers, except permission to be present in the workshops.

2493 Then would you really say that the efforts of the students at self-improvement were much more important than the amount of scholastic instruction, such as is afforded them in those establishments?—I do think that the system of pupilage is better adapted to produce good engineers, provided they were properly trained before they began, than any merely scholastic education.

2494. What proportion of the young men in those establishments succeed in becoming efficient engineers?—I have been told that 75 per cent. of the young men in such establishments do not attain any considerable proficiency, should you think that is anything like a correct estimate?—I should say that 75 per cent. of them waste their time, and the worst is this, that when they give up the profession of engineering they find that they have received no instruction which fits them for anything else, but supposing a man had gone through a course of school training, and did not prosecute his profession, then the general information which he had received would be useful to him as a manufacturer, or in other positions in life.

2495. You have been employed in France and Germany, have you not?—Yes.

2496. Did you owe that employment to any personal favour, or to your repute for skill and knowledge?—I owed that employment to my connection with men who happened to have capital in London. An engineer in England does not now, except in rare instances, owe his employment to any special knowledge, but to connections which he has formed with men who find the money, of course, that connection depends to some extent on his merit, but rather on his merit as a man of business, and on his general ability, than on his scientific knowledge.

2497. And yet you think that those engineers are practically more efficient professional men than the engineers who have received this very high mental culture in the schools of France?—Yes, as to the schools of France; but as to the schools of Germany, it is different. The young man, after he leaves those schools, has at first no advantage over the young Englishman, who has

received no such training, because the foreigner has not the practical knowledge of the young Englishman, but in after life I think the two men are equal.

2498. What age should you suppose a man would be accomplished and efficient in all those high requisitions which you have been describing, my reference now being to the completion of his studies?—At Zurich, and Carlsruhe, and the *Ecole Centrale*, he completes his studies at from 21 to 22 years of age, or perhaps 23 years of age, at the *Ponts et Chaussées*, he does not complete his studies till he is 25 years of age.

2499. Then you would say it was impossible to get the middle class of this country to devote that amount of time which would be necessary for reaching these high attainments?—Yes, in addition to the privilege, I have already said so.

2500. Mr *Dixon*] I think you stated that those premiated pupils in such establishments as Penn's, were no better off than the common apprentices in the same establishment?—In my opinion, certainly not, except that they have the entry of the drawing-office for some time in their pupilage, that is one privilege which they possess, and I do not think it is the most valuable privilege they could have.

2501. But do not they have a great variety of opportunity given to them in changes from workshop to workshop?—They do pass from workshop to workshop, which is an advantage, but when they are in those shops they get very inferior work to do as compared with the work which is done by the apprentices.

2502. The ordinary apprentices get what we may call a more teaching class of work to do than the pupils?—Yes.

2503. Do you happen to know what salaries are usually gained by those very well educated gentlemen who, in France, have passed through the *Ponts et Chaussées*?—Yes, an ordinary engineer of the third class gets about 100 *l.* a-year for three years, with the prospect of gaining 140 *l.* a-year. The men then pass on to the second and third class, where the position is worth perhaps 200 *l.* a-year, then we come to the first class, of whom there are about forty, and that position would be worth about 300 *l.* a-year. Then we have the Chief Engineer, in the first place, and the Inspector General in the second place, and there is a regular series of promotions, just as there is in the artillery, and when a man gets into that rank he attains a post worth perhaps 800 *l.* a-year. But then they are allowed to act as consulting engineers, and are employed a good deal in arbitration cases, and in expert cases, and from those different sources they may, if they get on in life, increase their income considerably; but the maximum that I have heard named as earned by any one person was 4,000 *l.* a-year, by uniting private practice with their Government practice men may make as much as that, in the very highest positions.

2504. Do all of those students become Government employes?—Yes, a small number of them take civil places, others get into the State factories, after all this high mathematical training they go to look after manufactories of gunpowder and saltpetre, and telegraph establishments, one man becomes a hydrographic engineer, and one goes into the naval commissariat. Those are all civil places, which are better than military places. Then comes the staff of engineers of artillery, the marine artillery, and the naval officers

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2505. I suppose the great bulk of those students would never get a salary exceeding 400*l.* or 500 *l.* a-year?—I think not.

2506. Sir Charles Lanyon.] Do these men rise by merit or by seniority?—Almost entirely by seniority; it is so in the main, I know; they naturally fall into positions of routine, and a large portion of them neglect their scientific attainments, and become mere administrative officers.

2507. Do those students who have passed through the *Ecole Centrale* usually enter manufacturing establishments?—Chiefly so.

2508. Do they usually become masters, or only managers?—A large portion of them are masters; another portion become managers; there is strong evidence to show that they do get these positions.

2509. And I suppose that these positions are lucrative in France?—I should think that they were lucrative.

2510. Can you account for the Government of Switzerland continuing to support this University when only two-fifths of the students are Swiss?—Upon the basis of our English ideas, I cannot account for it, but the Swiss do attach extremely high value to education, they think the success of their manufactures depends on their high training of the masters, and even of the subordinates, and that these educational establishments help the State so much that it is worth their while to pay for them; the thing being once established for their own subjects, they think it is wiser to allow the students to come from abroad, as they do not entail much additional expense.

2511. And you think that is wise policy in an economical point of view?—Yes, I should think those students were worth more than ten times the money spent upon them.

2512. Is that policy adopted in any other countries besides Switzerland in the Government schools?—In Germany certainly, and in France, at the *Polytechnique*, they do not in the *Ecole Centrale*.

2513. Only that in those cases, I suppose, the number of foreign students is not so great?—At Carlsruhe a large proportion of the students do not belong to the Grand Duchy of Baden. Out of 451 students, only 201 belonged to Baden, 5 to America, 27 to Bavaria, and 3 to England, though they were not really Englishmen, 5 were Frenchmen, 9 came from Hesse, 1 from Holland, 111 from North Germany, 21 from Austria, 11 from Poland, 39 from Russia, 15 from Switzerland, 2 from Hungary, and 1 from Wurtemberg.

2514. Do you know whether in any of the educational establishments of England, connected with, or partially supported by the State, there is any restriction placed with regard to the admission of foreigners?—I do not know, certainly there has been no restriction placed on any foreigner coming to Edinburgh, and following my course, although the endowment is given by the Government.

2515. Charman.] With regard to the school of Naval Architecture, is not special permission required to attend the courses there?—I do not know.

2516. Mr. Aroyd.] Will you kindly define technical instruction, as separate and distinct from scientific instruction?—I should say that technical instruction meant scientific instruction, with the addition of a small portion of applied science, science applied to the special profession which the man intended to follow, in fact; tech-

nical instruction in the main, is identical with scientific instruction.

2517. Would you not rather consider technical instruction as the instruction to be derived from the workshop?—Of course, it all turns upon the use you make of the word, but if the word is used in that way, then I think technical instruction should not be given in schools at all.

2518. Referring to your own case as a promoted pupil under Mr. Fairbairn, did you go to that establishment to acquire technical skill, or to perfect yourself in engineering?—I went there to attain technical skill.

2519. The artisan apprentices, in such places, are paid some small wages, are they not?—They receive wages. I may say that I wish the apprenticeship system were general in all trades. I think that artisans who do serve their time as apprentices, receive a better technical education, in the sense in which you employ the word, than those who are not apprentices, but who work only for such wages as they can get, and go where they please.

2520. Will you let me ask you whether apprenticed artisans do not receive a more perfect technical education than the artied pupils?—They do in that sense, the term technical education is a word which I am sorry to see introduced, because it can be used in the sense of learning a business, and also in the sense of getting scientific knowledge.

2521. May I ask what premium was paid with you?—I think it was 300*l.*; but I believe the premiums since then have risen all over the country, and that now it is 400 *l.* or 500 *l.*

2522. You say that you had a fellow pupil who had received his education at King's College, and had received some technical education in the workshop?—Yes.

2523. But I think you said that he had no great advantage over you?—It gave him six months start.

2524. And then you overtook him, I suppose?—No, he was six months in advance of me all the way. At the end of the time he was a better workman.

2525. Would you recommend that workshops should be introduced into our scholastic establishments?—At such a place as King's College, I think the workshop is a useful adjunct, not indispensable, but useful. I think it is very popular with the students, and it does give them a certain education, undoubtedly.

2526. As a general rule, you would say that a man might acquire that kind of practical knowledge better in a workshop than in a school or college?—Yes, far better, even if he gets a little in a school he must acquire his chief training in a real workshop afterwards.

2527. Would you not think that for any man to rise in any profession he must acquire both technical and scientific knowledge?—No, I think that a man very often does rise in England without possessing scientific knowledge.

2528. But must he not possess that knowledge in order to attain eminence in his profession?—We have had eminent men in England who possessed no scientific knowledge.

2529. But did they not acquire the scientific knowledge later on in their career, though they had not acquired it in early life?—There have been eminent engineers guileless of algebra.

2530. But have they been guileless of applied mechanics?—We have had such men who could not

not calculate the strain on any portion of a machine, they have acquired mechanics as an art, not as a science

2531. But in many of our large works at the present time, I presume the heads of the establishment, when they advanced a young man in the establishment, would insist on his having some scientific knowledge?—No, I do not think so.

2532 With respect to the *Ecole Centrale*, at Paris, that school was founded originally by private individuals, was it not?—Yes

2533. But in time it was absorbed by the State?—Yes

2534 And it is really now one of the model schools?—It is quite one of the model schools.

2535. I think in what you said of the branches of education carried on there, there was no allusion to agriculture, I think the subjects are, applied mechanics, the construction and erection of machinery, analytical, industrial, agricultural chemistry, civil engineering, natural philosophy, metallurgy, mineralogy, geology, and mining?—No, that is not quite correct, the sub-divisions which I gave are the sub-divisions which are recognised, there are four great sub-divisions first come the mechanicians, but that is not applied mechanics, that means teaching mechanical engineering, then there are the constructors, I think that corresponds more nearly to what we should call builders, it is a kind of second-rate architectural instruction; those architects are not architects in the sense which would be recognised at the *Ecole des Beaux Arts*

2536. Then come the metallurgists?—And then come the chemists Now, in the course of teaching these four distinct divisions, several of the subjects which you name are taught, but they are not the sub-divisions of the school itself

2537 With regard to the results of the teaching at the *Ecole Centrale*, I have a return here which you will probably be able to verify. "Amongst 2,000 young men who have left this school the career of 1,394 has been recently traced, and the issue was this 247 had died, while of the others 480 were engineers or superior officers of railways; 54 were mechanical engineers, 124 iron masters, 280 manufactures of considerable eminence, 55 were architects; 35 contractors for public works, and 42 professors of the applied sciences. The rest filled honourable posts in trade or in the service of the French and foreign Governments" It then goes on to say, "The names of some of the engineers and manufacturers are widely known." Do you not think these results seem to be exceedingly satisfactory?—Exceedingly.

2538 So that the *Ecole Centrale* has really done its work, and done it well?—Admirably.

2539 With regard to provincial technical schools, you were saying something, I think, about the *Ecole des Arts et Métiers* at Chalons, Aix, and Angers, did I understand you not to express a very favourable opinion of these schools?—The teaching is very well done there, but the expenses is great for the results obtained. The school at Chalons costs the Government 8,000 l. a-year, and I think it takes about 100 pupils annually, of whom only a small proportion enter works of any kind A considerable number becoming draughtsmen and engravers, and following such trades and businesses as, I think, do not in anyway need Government support, and even with regard to those who do

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go into positions in works, I think we have no data to show what proportion of them become foremen, or whether they become valuable foremen.

2540 Do you know anything about the Mulhouse School?—I know nothing about it.

2541 Or of the school at Lyons?—It is a school of the same kind as the *Ecole Centrale* in Paris, and, perhaps, a little inferior, being a provincial school, at which they would not be able to command the same professors

2542. Do you know anything of the school at Chemnitz?—No

2543 You expressed an opinion that scientific instruction to artisans was of very little use to them, I think?—I think such education as they could possibly get in the time they could devote to it would be of very little use

2544. You made an exception in favour of night classes, did you not?—Yes.

2545 You are doubtless aware that in the North of England there are many instances of evening classes being carried out in connection with day schools?—Yes I should like to see night classes very largely extended I know there is a very large number of adults among artisans who would gladly take advantage of them. When I said that artisans, as a body, could not require much scientific knowledge at school, I was speaking of artisans as a class, but no doubt a certain limited number of them could attain such an amount of scientific knowledge as would entitle them to receive advancement as foremen, and that instruction they would probably get in night classes, or even in Sunday classes, if our English ideas permitted Sunday instruction in science

2546 I think you stated that adults objected to being classified with juniors?—Yes

2547 Are you aware that that difficulty is got rid of at the working men's college at Halifax, by dividing the students into two classes, those of ages between 13 and 18, forming the junior division, and those above 18 years of age forming the senior division, that would obviate the difficulty you speak of?—No doubt.

2548. Take the case of a workman who acts as foreman in a dyeing establishment, do not you think there are instances where men of that class attending chemical classes in the evening, attain such an amount of scientific knowledge as must be of great value to them, and enable them to take higher posts in such works?—I should like to hear the opinion of the managers of the works upon that point. It seems to me very doubtful whether such a man could attain a knowledge of chemistry as would make him more valuable

2549. *Chairman.*] You would, however, consider a man who was attending evening classes for the purpose of obtaining scientific knowledge likely to be a more intelligent and tractable man than the man who was not?—Yes, for purposes of education, I should like to see such men attending evening classes.

2550 And would you not attract such men most readily by placing in their power the means of learning things that bore on their trade?—Probably.

2551. *Mr Akroyd.*] Take the case of a mason, who wishes to learn stone carving, or of the joiner, who wishes to learn wood carving, such a man would derive great advantage from a course of study in the art schools?—Yes, probably art is in a different position from science.

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2552. Mr.

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2552. Mr Bruce] Does your large continental experience enable you to indorse the popular opinion that the English race have naturally an amount of practical ability greater than that of the continental nations?—It is a wide question; but I think that in practical ability they are not inferior to any race abroad.

2553. Do you think them decidedly superior to any race abroad?—I am prejudiced enough to think so.

2554. Would you think that, to some extent, that may enable them to dispense with as complete a scientific education as would be required by the inhabitants of other countries?—If scientific education is required for the other countries, it would be required for this country.

2555. You think that there is no reason why, having naturally a great deal of practical ability, we should not give to that practical ability the utmost assistance that can be derived from scientific instruction?—Certainly not.

2556. And, generally, you consider that the scientific instruction given in this country is inferior to that which is given in Switzerland, Prussia, and France?—I do not think that the highest kind of scientific instruction received by the few in this country is inferior, for we have professors equal to the best men to be found abroad, but I think that the general scientific instruction received in this country is very inferior indeed to the general scientific instruction abroad.

2557. You have stated that in your belief there can be no very great improvement secured in these respects without greatly improving the character of our secondary schools?—That is my opinion, and I think that it cannot be done without creating quite a new class of secondary schools. I entirely agree with the majority of the recommendations of the School Inquiry Commission, but there is one point which I should like to have seen more strongly insisted on, namely, the creation of a new class of schools in which classics should form a small part of the course, and scientific instruction a large part of the education there given, in fact a school in which science and classics, as they are now taught, should change places. I have a very strong desire to see those schools, when established, become first class schools, that they should not be merely second class schools intended to teach useful information, which boys can immediately employ in the counting-house, we want to put scientific education on the same high footing in this country as classical education now is. I do not wish to diminish classical education, but, looking to the number of people who are to be taught, I think there is plenty of room for pupils to fill numerous scientific, leaving the classical schools as well filled as they are now.

2558. The Germans have applied themselves very specially to the improvement of their scientific schools?—Yes, but there the Real-Schulen, or modern schools, stand on a somewhat inferior footing to the *Gymnasien*.

2559. But can the kind of school to which you are pointing be the creation of any Government, must not it depend entirely on the people themselves?—Not entirely, I think that by the application of the endowments which it will shortly have in its hands, the Government can facilitate the establishment of those schools.

2560. In Germany has any particular preference been shown to the *Gymnasien* over the

Real-Schulen, except that shown by the parents themselves?—The Government have established both in Germany.

2561. And the *Gymnasien* have flourished more than the Real-Schulen?—Yes.

2562. In consequence of the preference shown by the parents?—Yes.

2563. Then how has the efficiency of those schools in Germany been gradually improved and raised to its present high level?—By the Government preference.

2564. How has that Government preference been exercised?—Through the Minister.

2565. But, after all, has not the chief thing been in the raising the entrance examination at all their universities?—I think it has; or rather, perhaps, by the departing examination, which, in Germany, is equivalent to the matriculation examination in England.

2566. You have in your own department, I think, raised your entrance examination, or at least you desire to do so?—We have created one.

2567. How long has that been in force?—The chair was founded this year in Edinburgh, and the examination has been set up as a barrier; but it is only just begun.

2568. And you expect as the result of that, an improvement in the education of the secondary schools, so as to fit their scholars to enter into your classes?—Hardly in Edinburgh, because the examination which would prevent men from attending my class, is the same as would prevent men attending courses in medicine, or taking their degree as masters of arts. Therefore, I am only applying to one more profession an examination which already exists; but I hope we shall improve the education of the engineer by this means.

2569. On the whole, you look to the raising of the entrance examination at the higher places of education as the main instrument by which our secondary schools should be improved?—Very much, but there is this difference between England and Germany. On the continent successful education tested by examination, is essential to a man's career either in appointments under Government, or in any recognised profession; whereas in England those examinations and that education are not equally essential, and we wish to make them so in engineering.

2570. But in all those countries abroad the Government plays a much larger part, and exercises a more direct influence on the middle classes than in England?—Yes, and I should be sorry to see the state of things in that respect different from what it now is in this country.

2571. The Government in England could not exercise anything like the same influence on education in that way as it had exercised in Germany or France?—It can do something, however.

2572. It can set a good example?—Yes, if the Government shows that it does attach a real value to methodical instruction, then engineers will be more ready to believe that they cannot do without it.

2573. *Chairman*] Abroad, say, in Germany, more especially, even where the law does not require diplomas, custom will call for them; is not that the case?—Yes, there is no other entrance into the profession, that is how the schools are filled, but if you created those schools in England, the result would not at first be the same, because there is no such custom. Still I do hope that there will be some additional colleges, such

as Owens' College, established in other towns in the north of England, though I trust they will be rather schools and colleges for science, than technical schools

2574. With regard to agriculture, are you aware of the condition of the holding of land in Germany, that estates are much more frequently in the hands of the proprietors than they are in this country?—The conditions of tenure are no doubt very different, but I know very little about that subject

2575 Mr. Bruce] With regard to the more purely scientific schools which you would like to establish, in which science should have a great share, and classics a less share, I do not understand you to say that you would exclude classical learning?—No, I have already said that I should merely like to see science and the classics change places.

2576 When you say the classics, would you have both Latin and Greek taught in those schools?—It would depend on the arrangement of the studies in each school, I believe those languages could be learnt in such a short time compared with that which is now spent in learning them, that you might have Greek

2577 Is not this the general experience, that where a school can afford sufficient time for it, a good classical education is a very great aid to a good scientific education?—It is.

2578. Therefore, it is a question of time, is it not?—It is a question of time

2579 Mr Acland] Did I understand you to say you thought it desirable that there should be special science schools, and that some arrangement for that purpose should be made by the Government, should you think it a satisfactory arrangement, if local or provincial or county boards were entrusted with the duty of looking over all the foundations in a district, and deciding which should be general schools, and which should be science schools?—I think that would be a most excellent plan

2580. Is not that the plan recommended by the Schools Inquiry Commissioners?—It is the plan recommended by the Schools Inquiry Commissioners, and I saw it with great pleasure I should be very sorry to see special-science colleges or schools, such as are demanded by some of the chambers of commerce established as Government schools, unless the Government is prepared to conduct the whole education of the country, they ought not to compete with private enterprise, and they have not the requisite machinery.

2581. Provided Parliament entrusted a competent local authority, under the supervision of some central authority, along with a reference to Parliament, with the duty of selecting according to the wants of a district, which should be classical schools, and which should be science schools, that plan would carry out your views?—Yes, provided they were really first-class science schools.

2582. You think that the distinction should apply not only to secondary schools, but to first-rate schools, in which boys will remain until 18 years of age, and which were socially on a level with other important schools?—Yes, I think manufacturers and others attach so much value to social superiority in England, that if there were supposed to be the slightest inferiority of social rank attaching to the science schools, they would continue to send their children to the old classical schools, though they preferred the teaching in the others.

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2583. And if those things were recommended by the Schools Inquiry Commissioners, then those commissioners recommend exactly what you wish?—Yes. I, perhaps, missed seeing that their recommendations extended to the very first grade of endowed schools.

2584 We recommended, with regard to the first grade of schools, in the case of Birmingham particularly, that there should be three departments one classical, one mathematical, and one scientific, and that those three departments should all form part of one school?—That, then, I do not approve of

2585 Suppose that in the case of an important institution in a great town, it were thought desirable not to separate or to break up a great institution into separate schools (one for the classics, and one for science, and one for mathematics), but to carry on all three subjects together in the same institution, allowing the pupils opportunities to give a preference to either subject, should you see any objection to such a plan?—There might be local circumstances which would make that desirable in particular places, but I think experience abroad has shown that where two classes of education are carried on side by side, the merit of the professors, or some other accidental circumstance, tends to give an injurious superiority to one department over another

2586. When that occurs in England does it not arise very much from the fact that the universities at present give nearly all their rewards to classics and mathematics, and do not take science in the same way?—That may be the cause in England, but abroad, when the ministers attempted to divide the schools into departments, one for classics and one for science, it was found that a large proportion of the inferior students were sent to the science departments.

2587 The French system of bifurcation has been altered because it failed?—Yes.

2588 But may it not be true that, to draw a strong line of separation between two subjects in the same school, and yet to work both departments successfully, is a matter of detail rather than principle?—No doubt that may be said, but I think that subdivision should be avoided as much as possible.

2589 Do you not think there is some danger that if a portion of the grammar schools in England were made into science schools, as distinguished from classical schools, they might come to take an inferior social position in spite of anything the Government could do for them?—I think not, if the endowments and the professors were equal in the two cases.

2590 Chairman] Has it not been the case that in France various successive attempts have been made to give scientific and literary instruction as two different branches in the same schools, and that those attempts have all failed, so that ultimately it has been decided to separate the two branches and establish them as far as possible in different localities?—I believe so.

2591 Mr Acland] I understand you not to recommend bifurcation or divarication, but rather that the schools should be left freely to take that course which the interest or the intellect of the country requires?—Certainly, but I think you might have two classes of schools which should stand on the same footing of social equality, and which should be contrasted in character as Oxford and Cambridge are contrasted.

2592. Have you considered the question how far

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far our old universities are capable of giving scientific instruction to a higher class of science teachers?—No, never having been at either of the old universities, I know but little of them.

2593. What do you think can be done in England as it now is to improve the scientific knowledge of the upper class of workmen who might desire to become foremen and managers?—I think that might be done by the establishment of night classes in connection with our higher schools in which teaching is given, not by second-rate men, but by the very best men, or under their immediate inspection, and I think one of the conditions of endowments of new science colleges might be, that a certain number of such classes should be taught by such professors

2594. I understood you to say just now that in the primary schools in which the sons of workmen must of course ordinarily be educated you would not think that much science could be taught, and I thought you said especially not physics, do I understand you to include under that head the ordinary mechanical powers, and the laws of nature?—Yes, I would rather not see any attempt made to teach mechanics, or physics, or chemistry

2595. But do you include under the term "physics" the ordinary laws of matter and motion and the mechanical powers?—Certainly, I do

2596. Are you aware that the late Dean of Hereford, in the village of King Somborne, threw new life into a common village school by introducing very simple elementary teaching in physics, and if that could be done should you think it objectionable?—A very clever man lecturing about anything may infuse new life into a school, but I think any general attempt to teach these things in such schools would be likely to degenerate into child's play

2597. But suppose that the teachers in our training schools were taught how to teach such things, do I understand you to say you think intelligent teaching of the common laws of nature is impossible for boys staying at school till they are 12 years old?—I think if those boys follow courses in English reading, for instance, they may get a good deal of general information out of an intelligent teacher who takes advantage of each occasion as it arises to communicate such information on the every-day facts of life; he might have occasion to refer to physical laws, and the lads might gain general knowledge in that way, but I think an attempt to teach a class of boys in such school physical science, I mean, for instance, the laws of gravitation, the compression of gases, or anything connected with the flow of water, I say, I think any general attempt of that kind must fail, at present the class of schools to which I allude, turn out men who cannot as a rule read well; after they have been apprenticed for a certain time, we find that they cannot express themselves grammatically, and cannot take notes in after life if they attend night classes; they can calculate only with great slowness and difficulty.

2598. Are you not aware that some very able men, having had a literary education themselves, have lately expressed the opinion that one reason

of the literary deficiencies of our upper middle classes is the absence of real knowledge combined with verbal knowledge, and do you not think that there may be some danger that in the education of the working classes a similar mistake should be made by paying too much attention to dogmatic teaching and mere words without things?—The teaching given in Germany and in Scotland seems to me to be the right thing; that is to say, combining general information with the literary teaching, but not giving special courses of instruction in elementary science.

2599. Passing on, then, to the higher classes, we will suppose that a boy goes into a workshop, and, having had a good elementary education, wishes to keep on improving himself in the hope of rising ultimately to become a partner or superior foreman, do you think it would be possible to make arrangements with an eminent manufacturer carrying on real business for the presence of an instructor of his pupils and his workmen, so that their attention might be directed to the most important points of the theory of the work they were engaged in?—No, I think that would be quite impossible for the pupils, I think the professor could not be present in the works; the whole system is antagonistic to it, a pupil while in the works is treated as a workman, and it is essential that he should be so treated

2600. Do you think, then, that if establishments for teaching science were placed in the great centres of industry it would be quite hopeless to carry the professor into the workshop in any form at all?—A professor and a class can come and visit the workshop before the pupils are articulated, and then the pupils can write essays upon what they have seen, but it is impossible when the pupil has once entered the workshop to let the professor interfere. I do not think, in fact, that you could let the professor from the outside interfere with the articulated pupil in the works.

2601. Do you think it is important for the advance of scientific instruction with a view to the progress of English industry, that establishments for the teaching of science should be closely connected with the great centres of industry, or do you think that the pupils might be removed from manufacturing towns to other places for the purpose of receiving the education in question?—I think it is very desirable that new schools should be opened in the manufacturing towns.

2602. Do I understand you to say that in point of delicacy and finish there is no superiority whatever, either by natural constitution or by habit, in the foreign workman?—Certainly not in my own trade.

2603. Do you think that the advantage which I understand you to believe exists in English work in point of finish, is at all events not likely to be injured by any higher education which may be given?—Certainly not injured.

2604. *Chairman.*] Is not the highest class of finish in engineering work given by tools, and not by hand at all?—I have seen the best work done by hand, surfacing is hand work, and the best possible fitting is done by hand.

Monday, 18th May 1868.

MEMBERS PRESENT :

Mr Acland.
Mr Akroyd.
Mr Bazley.
Mr Dixon.
Mr Gregory
Sir Charles Lanyon
Mr McLagan.

Mr. William Lowther.
Lord Robert Montagu
Mr Edmund Potter.
Mr Powell.
Mr. Read
Mr Samuelson.

BERNHARD SAMUELSON, Esq., IN THE CHAIR

Professor ROBERT BELLAMY CLIFTON, called in; and Examined

2605. *Chairman*] You are Professor of Experimental Philosophy at the University of Oxford, I believe?—I am

2606 You were previously, I believe, Professor at Owens' College, Manchester?—Yes.

2607 You were educated at the University of Cambridge, were you not?—Yes.

2608 You are, consequently, well acquainted with the teaching at Cambridge, at Oxford, and at Owens' College, with regard to science?—I do not know much about the teaching with regard to science at Cambridge. I took my degree in mathematics. I had nothing whatever to do with science there, except so far as it was included in the mathematical course.

2609 You had nothing to do with experimental science?—Nothing whatever. I may correct that by saying that I attended some experimental lectures, which were, however, of an essentially mathematical character. Professor Stokes lectured to us entirely from a mathematical point of view, he illustrated his lectures by experiments, but the main point was the mathematical theory.

2610. Mr. Acland] You have considered, no doubt, what is wanting in England for the education of young persons of different classes connected with the industry of the country?—Yes, as far as my means have enabled me to do so.

2611 You would arrange those classes under certain heads, would you not?—Yes.

2612 Will you state them?—I think, in the large manufactories or workshops, we must recognise four classes, or perhaps five, but two of them are virtually the same; labourers, artisans (the more skilled men), foremen, and masters, a sort of sub-class would consist of the pupils, whose object is to become foremen or masters.

2613 What do you consider are the educational requirements of each class, speaking with reference to the objects of this Committee?—With regard to labourers, it would be very difficult to recommend any scientific instruction, it would have to be so very elementary, that I am doubtful whether anything could be attempted with success. They should be provided with a good primary education, reading, writing, and arithmetic; and if any science is added, it must be of the most popular kind, rather to attract their attention than for the purpose of education. With artisans, I think something like a scientific education is possible, but there again it must be of a very elementary character, and should bear dis-

tinctly on the line of business they are going to take in life. There are two subjects which would be most generally required, viz., elementary mechanics and elementary chemistry.

2614 What should you say were the requirements of foremen?—The same, only carried further, a good general education, with a better knowledge of mechanics and chemistry, which would be possible in their case, owing to their better knowledge of mathematics.

2615. What should you state is the science instruction required for masters and manufacturers?—For a master I should recommend the best education a man can get in all ways; of course, as much knowledge of science as he can possibly obtain, with special reference to his future career.

2616. Have you considered the present condition of the secondary schools of England, especially with regard to their mathematical instruction, do you consider that to be in a satisfactory state?—No, far from it.

2617. Will you kindly state your opinion on that subject more fully?—I can only judge from the pupils who have come to me at Owens' College or at the university, and I must say a great number of these were simply unprepared, their knowledge of arithmetic, even, was the least possible, they professed to have learned the whole, but their knowledge was very small indeed, to the simplest question, which is a little out of the usual course, it seems impossible for them to give a correct answer.

2618. At what age have you usually received pupils of the class of which you are now speaking, I mean those who come to you from secondary schools at Manchester or (since you have been at Oxford) at Oxford?—It would be difficult to say, at Owens' College we could admit them at 14, and there was no superior limit, but there were very few so young as 14. At Owens' College the average (taking out the few exceptional cases of men) would be about 17, and 18 or 19 would be the average at Oxford.

2619 Speaking generally, you consider one of the first requirements is to improve the arithmetical and mathematical teaching in the secondary schools?—Yes, certainly, for anything like accuracy in science that is essential.

2620 Are you prepared to state any class of subjects which you think specially required for all those who are to be engaged in manufactures?—

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Professor R. B. Clifton. Mechanics and chemistry for artisans, and I should like to add drawing for all.

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2621. Now, with regard to the means of supplying the education which is necessary, will you state in what kind of schools you think the requisite education can be given?—Schools would differ according to the class to be educated, labourers, I suppose, could not generally go beyond national schools. I suppose a national school would represent their wants

2622 Up to the age of 12?—Yes, or a little beyond that age

2623. Have you considered the question of trade schools?—Those are the schools which are most required at the present time

2624. Do you know the trade school at Bristol?—Only by what I have seen in the papers.

2625. As far as you know it, that is the kind of school that you believe you require?—Yes, but I meant especially to refer to schools which would be founded by a particular trade, where general education would be given, and the technical part of the one particular trade

2626 Do you mean the science which underlies the trade, or do you mean the skill required?—In this case I mean the manual skill, that a boy, if intended for a carpenter, for instance, should be taught (besides his general education) the rudiments of that trade

2627 In the school?—In the school.

2628. Have you any experience on that subject?—No

2629 As I understand you, for the class above that of which we have just spoken, you would rely on the general introduction of science as a branch of general education in secondary schools?—Yes

2630. Do you think it would be possible to establish local colleges of a more special kind, and, if so, of what kind?—I think local colleges in the great centres are absolutely essential to anything like general scientific education of a high order

2631. Can you give any instance of such a college?—Owens' College is an instance, and there are others, I believe

2632 Mr *Potter*] You were once professor, were you not, at Owens' College?—Yes, from 1860 to 1866. I was elected to Oxford in 1865; but I remained at Owens' College for another half-year

2633 Mr. *Acland*] Passing from the local colleges to the universities, will you kindly explain your view of what a university can do?—A university can give the most thorough scientific education, as far as the theory goes, but I do not think it is at all desirable to make an attempt to give any instruction in the technical part.

2634 What classes of persons do you think the universities could reach?—Teachers in local colleges and schools, master manufacturers, and the best foremen perhaps.

2635 Do you think it possible that foremen, under existing circumstances, could find their way to a university?—No I speak now simply of young men, the sons of foremen.

2636 *Chairman*] When you say foremen, I suppose you mean superior managers of works?—Yes, managers of works

2637. Mr. *Acland*.] Will you now state what are the opportunities offered by the University of Oxford (with which you are specially connected) for science instruction?—The opportunities are

now such that a man can get a thorough knowledge of mathematics, theoretical mechanics, astronomy, physiology, anatomy, physics, chemistry, geology, botany, zoology, and, in fact, I may say, of all the branches of science which are not purely professional. Every opportunity is afforded to students of these branches which the time at the disposal of the very limited number of teachers will permit.

2638 Taking your own department, will you kindly state what are the appliances either in existence, or now preparing, for that purpose; is there, for example, any large apparatus or museum?—We have in the museum a considerable amount of physical apparatus, and we have a fund, not a very large one, but a fund available every year, a kind of annuity, which we spend on apparatus

2639. Are you engaged in building or preparing a large establishment entirely for physics?—Not a very large one, but a building

2640. What will be the cost of that building?—£. 10,000.

2641. And the funds for that purpose you have available?—I believe so.

2642. Will you now state what changes you deem desirable in the existing arrangements of the university in order to make the study of science more generally available?—One thing which I think will be a very great step in advance will be the admission of persons who are not members of colleges or halls; the thorough opening up of the university to any men who like to come up under the disadvantage (at first at all events) of not belonging to a college or hall. Such students would, of course, have to depend almost entirely on the professors for their instruction

2643. Do you think the present requirements of the universities in the prolongation of classical study stand in the way of admitting such persons as you now speak of?—I think so.

2644 What do you think should be done in that respect?—Every student has at present to pass two examinations of a mixed character (classics and mathematics); one is Responsions, which is generally passed by a well-prepared student almost as soon as he comes into residence, namely, in the first term; then there is Moderations, a mixed examination of classics and mathematics, mathematics holding a very minor place, this is passed, or may be passed, at present in the eighth term of residence.

2645. That is to say, at the end of two years?—In the second year. I am speaking now of the academical year, the long vacation being left out, so that it would be a year and nine months

2646 *Chairman*] If you were speaking of the years of a man's life, how long would it be?—If a student entered in October, as would usually be the case, he would be able to pass Moderations in May term of the next year but one.

2647. Mr. *Acland*] That is the earliest time at which he could pass Moderations?—That is the earliest time.

2648. And earlier than usual, is it not?—I have been at Oxford so short a time that I cannot speak to that.

2649 Under the existing arrangement, is it necessary to carry classics beyond that point?—It is not necessary for a classman; but in giving this

this evidence I must distinguish between classroom and passmen.

2650 Do you consider that practically men who are pursuing their studies with any degree of earnestness are almost obliged to carry on their classics to a later period?—Men who are carrying on science with any real purpose would undoubtedly take honours in the natural science school

2651 Then I understand your opinion to be that your classical requirements at Oxford under the existing state of things stand in the way of such a person as a manufacturer's son availing himself of the opportunities which the university now offers for the learning of science?—It is my opinion that the time during which a man must continue his classical studies is at present too long, I may add in justice to Oxford that certain propositions are now before the governing body of the university, which, if carried, would to a great extent remove this objection.

2652 Do you think it desirable that any special scientific faculty with degrees in science should exist?—I do

2653 In order to the giving of those degrees, do you think it desirable that there should be any alteration in the mode of conducting the examinations?—I think there should be a board of scientific studies some recognised persons who should arrange what the studies are to be, and have the whole of the scientific examinations under their control, subject, of course, to the approval of the governing body.

2654. There are such boards of studies in Cambridge, but there are none in Oxford, are there?—None

2655 Should you think that point of very great importance?—I should I should think also an extension of the scientific professoriate will be absolutely necessary

2656. You mean that in the event of any considerable increase of students having trade or industry in view, the staff at Oxford, though it is now a very powerful staff, is not large enough?—I doubt whether it is even now large enough, in some departments I am sure it is not large enough.

2657. *Chairman*] You stated that you consider the function of the Universities with regard to scientific instruction is to educate masters or proprietors, and possibly superior managers, and also to educate teachers for schools and colleges?—Yes, but of course when I say masters, I do not mean men actually engaged in business, but those who are to be masters, or foremen, in after-life. I do not think adults could ever come up to Oxford in this way.

2658 I suppose there are two considerations which would limit the activity of the Universities to those two classes, the first of which is the long time which is necessarily occupied, and the second, the expense of an education at the University. Now, with regard to the teachers, would not the latter consideration in some measure be a permanent bar to their receiving their education at the Universities?—I think not in the case of the better teachers; in the case of the better teachers, who would require the very best training they could get, and who must have a good general education, I do not think they could get it quicker than they can at the old universities.

2659. But my question referred rather to the

matter of expense?—A good student will always get considerable assistance from endowments

2660. You contemplate that a state of circumstances will arise, if it has not already arisen, in which there would be a demand for teachers of a class who could afford a university education?—I do contemplate that, it is difficult even now to supply the demand.

2661 You have stated with regard to boys in training for mechanical pursuits, that for the lower grade of those boys you would be glad to see trade schools established in which they should acquire some knowledge of manipulation?—Yes

2662 Would it not also be desirable that the class whom you designate as masters should acquire some knowledge of technology?—Certainly, that is my opinion.

2663 Then would it not be desirable that there should be some provision at the Universities for teaching technology, civil engineering, for example?—The theoretical part of civil engineering certainly, but it would be impossible to carry out any practical study of the subject

2664 What do you mean by the theoretical part?—The mathematical basis; the application of mathematics and science generally to that special branch

2665 But do I understand you to say, that you would have no professorships of practical construction; that you would not teach, for example, the construction of hydraulic works historically, and in relation to examples of works executed?—So far as it could be done in the lecture room, I would, but I would not attempt anything like teaching them actually to do the thing itself.

2666 That is to say, you would not allow them to construct models of steam engines, but you would have them draw steam engines, and you would teach them what had been approved of and condemned in the construction of steam engines?—Certainly

2667. And so with all other mechanical works?—Yes

2668 With regard to chemical technology, you would pursue a somewhat similar course, I suppose?—Yes, as far as that could possibly be managed without going into actual processes of chemical manufacture, for these can only be learnt properly in the manufactories themselves.

2669. Taking, for example, the manufacture of sugar, would you endeavour in a technical course to instruct the young man in what had been done, and what was being done in the application of chemistry to the refining of sugar?—I am afraid on the subject of chemistry I have had no experience at all that can qualify me to answer the question, but what I should propose to teach in chemistry would, I may say in general terms, be the thorough knowledge of that which could be applied to any point in practice when it arose, whether the technology of chemistry should be taught specially is a question which I think a chemist ought to decide

2670. But with regard to mechanical engineering, of which you have some knowledge, you would consider that technological courses would be desirable, I suppose?—I should in the sense I have already stated.

2671. And you would consider them desirable as much for the teacher, I suppose, as for the class whom you have designated as masters?—Certainly; I think we ought to be able to train teachers who could represent those particular lines of study in the local colleges.

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2672. You

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2672. You would think it desirable that those teachers at some time or other should become practically acquainted with the applications of their sciences?—Yes.

2673. Can you suggest how that could best be done?—I do not think the manipulatory part of the work can be learnt anywhere but in the workshop, or in the office, or in the manufactory, as the case may be.

2674. Would you suggest that the teacher after having completed his theoretical education at Oxford, should endeavour to acquire some practice in some large mechanical or engineering works before he actually began to instruct pupils in the local colleges, or elsewhere?—I think that would be very desirable, it would perhaps not be necessary for him to acquire so much knowledge of the practice as the man who had to be engaged in it for the purpose of obtaining a living, but some knowledge of that kind would be very desirable.

2675. You would say that he ought to possess a general oversight, such as he could scarcely get from books alone?—That is my opinion.

2676. Is it your opinion that some theoretical knowledge should be required of all pupils entering upon business, which may be described as professional?—Yes, in all cases I think the theoretical knowledge which must necessarily underlie the proper working of their own business should be required.

2677. And that it should be acquired at school?—Partly at school, and partly at either the local college or the university, it would be impossible for schools to have a complete scientific curriculum.

2678. In speaking of schools, I referred in my question to teaching establishments, no matter what their rank might be, and I understand you to say, that you would demand a certain amount of theoretical knowledge, and that you would perhaps rely on the pupil's continuing his theoretical courses at some local evening classes?—Yes, I should rely very much on that.

2679. You have said you thought that some popular science might be taught in primary schools, have you any actual acquaintance with primary schools?—None whatever; I simply wish to give it as my opinion, that anything like science, properly so called, could not be taught in primary schools, anything of the kind that was attempted must be of the most popular nature. I do not undertake to say that even that could be done; but if anything is done, it must be, as I have already said, of the most popular nature.

2680. Have you any opinion with regard to drawing in particular?—It is most desirable that it should be taught in primary schools, if it be possible.

2681. Do you think it is possible?—I have no experience at all, or scarcely any, of primary schools.

2682. Have you any experience of evening classes?—Yes, I had some experience of evening classes at Owens' College for six years, in every one of those years I had an evening class.

2683. Were those classes, properly so called, or were they lectures?—They were lectures in every respect the same as those delivered to the day classes, as far as the way of carrying them out was concerned, although somewhat different in the matter.

2684. But was there any opportunity for individual instruction?—In the chemical laboratory

I presume it would be individual instruction to a great extent, in my department there was no individual instruction; I gave simply a course of lectures.

2685. What was your department?—Natural philosophy.

2686. There was no opportunity given for the pupils to ask questions, was there?—Yes, there was ample opportunity given for that, after the lectures the pupils might ask any questions they thought proper, but there was no appointed time at which they could come and ask questions, or perform experiments for themselves.

2687. You did not look over anything which they prepared between the lectures?—No, except in some very rare cases.

2688. It was not part of the general scheme?—Not in my department.

2689. But still the students had an opportunity of conferring with you on any point of difficulty which might arise in the course of the lectures which you delivered?—Yes, and on any point which occurred in their own reading. I always encouraged them to read the books which I recommended to them, and I also encouraged them to ask questions upon them afterwards. My lectures were for an hour, and I very rarely had the room cleared again under two hours, the extra hour being spent in answering questions, from, perhaps, only a few students who stayed behind for that purpose, though all might have done so if they had pleased.

2690. What kind of persons were they who attended those lectures?—I am afraid I can scarcely answer that question. I do not know whether any questions of that kind were ever asked on the entering of the students, but if so, the principal of the college was the only person who obtained the information. Many, I believe, were clerks, others were engaged in mechanical works, some were in railway works, and some were in business.

2691. But generally would you consider they were of a superior grade to the class of artisans?—Yes; I should say that in very few cases only could they be called artisans, in any sense of the word.

2692. Can you trace at all the after-career of many of those young men; did many of them go up for examination at the matriculation of the University of London?—Some did; but I should say not very many, most of them being engaged in some occupation.

2693. But you have reason to believe, and perhaps to know, that the teaching which they received there made a permanent impression on them?—I certainly think so, the evening classes always gave me the greatest possible satisfaction. The way in which the questions were asked was the only means I had of testing whether the attendants at the lectures had thought upon the subject, but judging from these I was well satisfied.

2694. Your classes, then, must have been somewhat limited in number?—They were comparatively small, as far as I can recollect, I advertised every year two courses (one to be experimental), by that I mean a course of lectures, in which the premises of the arguments were put forward mainly depending on experiment, and then the consequences of these premises were deduced as accurately as possible, and in most cases with the same accuracy as could be attained in the mathematical study of the subject, the only difference

difference being that in one case the premises would be deduced from general hypotheses, while in the other experiments would be used in illustration of those premises. The deductions, however, in the experimental course, though not going so far, would be stated as distinctly and as accurately as in the mathematical course. The other course was mathematical, and I professed to give lectures on mechanics and hydrostatics as far as they could be carried with the mathematical knowledge which the students possessed, but I am sorry to say that in only one case was the class formed, we were not compelled to hold any class, unless a sufficient number of students presented themselves, and unless they were properly prepared. I never had the requisite number of candidates; but on one occasion I thought it desirable that the class should be formed, because I fancied the students had sufficient mathematical knowledge, so I carried on that class. In all other cases I was quite sure, from the answers to questions which I asked of the few students who presented themselves, that their mathematical knowledge would have been quite insufficient, and have made the class a mere class of elementary mathematics if I had held it.

2695 What number attended that one class?—In the mathematical class that year there were six students. In the experimental class there were, in the session of 1861-2, 21 students; in the session 1862-3, 22 students, in the session 1863-4, 14 students, in the session 1864-5, 14 students (that was during the cotton distress); and in the session 1865-6 there were 26 students. Of the first session during which I was at Owens' College, namely, 1860-1, I have no record. I may mention, also, that this experimental course was not always on the same subject. The subjects in the first session, 1861-2, were Optics, Heat, and Electricity, all taken in a very elementary form, and all included in the twenty lectures, the next year, Heat and Electricity, the next year, Optics, including Geometrical and Physical Optics, in 1864-5, Acoustics, in 1865-6, Statics and Dynamics; so that in those years I had taken as complete a course as I could give in the day classes. In the first session (1860-61) the subject was Elementary Mechanics.

2696 Did many of your pupils follow the complete series of courses from beginning to end?—Not many, but some did.

2697. Do you know whether any of those went up for the examinations in connection with the Science and Art Department?—I do not know that, but I feel sure that some went up for matriculation in the London University.

2698 And now from Manchester you have removed to Oxford?—Yes.

2699. What number of pupils have you attending your lectures at Oxford?—My lectures at Oxford must be divided into two classes, the simple lectures, which are very much the same as the Owens' College lectures, with the exception of the Mathematical Lectures, which are given at Oxford by another professor. The other is a thoroughly practical course. The students in that class do the experiments for themselves. Each man has a certain amount of work given him to do; apparatus is placed before him, and he has to use it. He is instructed in the use of that apparatus, and has to use it for himself. This class is, necessarily, small. Our arrangements for it are very deficient; but the new building which Mr. Acland referred to is designed expressly to enable the students to join

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that class in larger numbers. The lecture class has gradually increased in the two years that I have been at Oxford, and the last number of attendants was 40 to 50; in the other class I have, at present, eight students. I have been obliged to decline six applicants in consequence of not having room for them.

2700 Are the attendants of the experimental class regular in their attendance?—They are very fairly regular but they are not always so regular as I could wish.

2701. But they are as regular as the attendance would be upon college tutors?—I think a college tutor has more control over his men than we could have, out of the lecture-room we have none.

2702 They come to you only after they have passed moderations, do they?—No, many of them come before passing moderations, and, in many cases, the men have come as soon as they came into residence, but, of course, they must pay attention also to the classical and mathematical part which is necessary for passing moderations.

2703 Have you any idea of what the objects in life of the majority of those pupils are, do they belong to either of the classes for whom you have specially proposed university education in science?—I know scarcely anything about the lecture class. As to the other class, that is a new class. We were never able to have such classes at Owens' College, for there was not room for them there, but I think I should not be wrong in saying that the majority have teaching for their object, at all events, a great many of them have teaching for their object.

2704 Do you know whether that also applies to the chemical laboratory?—Many of the attendants there have teaching for their object, and they are the same persons who attend my class; the students in the physical laboratory are all more or less mathematicians. I insist upon considerable previous knowledge, both of mathematics and of science, before I allow them to handle the apparatus. It would naturally be a costly class to keep up with unprepared pupils.

2705. Then you would say that the attendance on the teaching of science at Oxford is decidedly on the increase?—The attendance on the teaching of science at Oxford is decidedly on the increase. There has been a very greatly increased attendance for every term that I have been there.

2706. Then you have no fear whatever of the large sum which is to be expended upon the laboratory being thrown away?—None whatever.

2707. You think that the more accommodation you provide, and the more encouragement you give to science, the more the study of science will be taken up at Oxford?—Certainly; it is absolutely necessary in science that the appliances should come before the students.

2708 But you do not think you are going too fast?—Perhaps the facts I have mentioned will speak for themselves. I have had 14 applicants, and of those I have only been able to take eight students, for the May term of 1869 four names are already entered in order to secure places.

2709. Have you any practical acquaintance with the classes in connection with the Science and Art Department?—No.

2710 Nor, perhaps, with what is done in Jermyn-street?—Only the most general acquaintance possible.

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2711 Lord Robert Montagu] I think you stated that the lads of 17, who came up for your teaching at Owens' College, Manchester, have scarcely any knowledge of arithmetic?—A very imperfect knowledge, indeed.

2712 And that precluded them from receiving readily a good scientific education?—Certainly, their knowledge of arithmetic was bad, and their knowledge of geometry was equally bad, and a good knowledge of both is essential; it is impossible to take even the first steps in mechanics without a knowledge of arithmetic, and without some knowledge of geometry.

2713 Were those lads the sons of labourers, or were they lads of the middle classes?—They were lads of the middle classes.

2714 To what do you attribute their ignorance of arithmetic?—I can only attribute it to the very bad teaching of arithmetic and mathematics in the middle class schools, the same lads I found could afterwards pass very excellent examinations. I found them often most satisfactory students.

2715 Then do you suppose the teaching which those lads had received was bad, or that their parents had neglected to send them to school?—In all cases these lads had come from school.

2716 Then you conclude that the teaching of arithmetic and mathematics in those schools was bad?—That is the only way in which I can account for the ignorance displayed.

2717 I think you stated that the sons of labourers could hardly go beyond national or parochial schools?—That is my opinion.

2718 Why do you think they could not?—On account of the expense, I do not see how they could attend even a middle-class school of the third grade.

2719 Perhaps the claims of labour would take the son of a labourer from his school early?—Probably such a child would require to go to work young, but I do not know whether the parents could be expected in any case to afford to give him a good education.

2720 Would there be anything to prevent such young people going to an evening school after the day's labour was over?—Certainly not.

2721 Then, if those evening schools were attended, their education might be continued in that way?—Yes, I intended to include that class under another head, the instruction of persons already engaged in business during the day, which is a very important matter.

2722. Do you think also that in mechanics' institutions they might be taught gradually by lectures, and such means?—Certainly.

2723. Means like those would all be available for the sons of labourers, although they were engaged in labour during the day?—Certainly, if they were not made too expensive.

2724. Would you give them the instruction gratuitously, or would you make them pay some small fees?—I think that they should pay very low fees, to make them pay a small fee is better than to give them instruction gratuitously.

2725. Then if the fees were low there would be nothing to prevent the sons of labourers continuing their education in the evening?—I can see none.

2726. In a number of cases, I suppose the lecturers would have to receive some payment from the State, in order to induce them to give those lectures?—They must certainly receive assistance from some source or other.

2727. The fees being part of their income, and this assistance making up the rest?—Yes, whether it should come from the State direct, or in some other way, is a matter on which I cannot give an opinion.

2728. You said you thought each child should be taught the rudiments of its probable future trade in school, for instance, that the son of a carpenter should be taught the rudiments of carpentry?—That is my opinion if he is intended to follow the trade.

2729. Were you speaking merely of manual ability or the teaching of certain geometrical properties of bodies, say, for instance, as applied to bevelling?—I was referring to the actual use of tools. I think the child should be taught the use of tools.

2730. You would teach to the son of every labourer the manual part of the trade which he was intended to follow?—To some extent I would do so, though to what extent I can hardly say.

2731. Would you not be compelled to have in every national school special masters for each trade, shoemakers, carpenters, and blacksmiths?—I scarcely contemplated this being done in national schools. I was thinking of such schools as could be got up by trades unions; for instance, if each trades union would support a school for its own particular trade.

2732. You were thinking of certain secondary schools which should be got up by the workmen among themselves?—Yes, rather for the lower artisans than for simple labourers.

2733. You were not contemplating any State aid?—Not at all.

2734. If you had the special masters with tools and materials, it would be done entirely by the people themselves?—Yes, the tools would be supplied by the workmen themselves; as to the teaching, it is a point for statesmen to decide whether even that should receive aid or not. I did not, however, contemplate that.

2735. You would not apply that to the national schools generally throughout the country?—Certainly not.

2736. You propose that a man should be allowed to come up to Oxford or Cambridge for his scientific education without belonging to any college or hall?—Yes.

2737. You mean that he should be allowed to attend the lectures of the professors on scientific subjects?—Yes.

2738. When you made that suggestion, were you speaking of the working classes or of the middle classes?—Of the middle classes I would exclude none, but I fear a great many people would be excluded by the circumstances of the case.

2739. They would have to pay fees to the professors?—Yes.

2740. And to find their own board and lodging?—Yes.

2741. Would you allow them to enter into competition with those who were studying in the colleges or halls?—I would have them, as far as degrees are concerned, in every respect the same as members of colleges.

2742. Would you let them go in for scholarships or fellowships?—Certainly. I would admit them for all. The whole subject is now being discussed in the Universities, and I am simply expressing my own opinion. The subject is before the governing body at this time; and the principle of admitting out-college students has been passed by

by one of the governing bodies, the Congregation; and the details of the scheme will come before the Congregation in a few days

2743. Is it your object to make intelligent manufacturers, or to educate these people into becoming learned professors?—The object is simply to cheapen the University course. The education they would get would be precisely the same as the college men, as far as the professors are concerned. They would attend the same lectures, and I presume they would take degrees in the same way, the object is merely to enable men who will be economical to get through the University at a reduced expense, if they can.

2744 Mr *Louther*] With regard to the effective teaching of arithmetic, do you know anything of the teaching of arithmetic in England generally?—Only by results

2745. You do not know whether that teaching is generally good or bad?—Judging by the results, again, I should say that it is bad; but I should not like to express any general opinion I should not, perhaps, say that the majority of my pupils came up in that way, but a very great many of them came up shockingly ill prepared.

2746. But was that a result of the system of teaching, or of a want of ability on the part of the persons themselves?—From the experience which I have had of the ability shown by these pupils afterwards, I should certainly say it was not from any want of capacity on their part.

2747 You think there is a general deficiency in the education which middle-class boys receive in arithmetic?—I can only explain the facts in that way.

2748 Sir *Charles Lanyon*] With regard to teaching trades in elementary schools, you referred to instruction in civil engineering, and you said that it was not possible to give practical instruction of that kind, but do you not think that the same objection applies to every other subject You admit, do you not, that it is impossible to give practical instruction in civil engineering?—At the Universities, yes

2749 But do you not think that the same objection would apply to the possibility of giving practical instruction in every other branch?—At the universities, certainly.

2750. But in the primary schools, and in every way?—I do not see that there is any objection to teaching the use of tools; my opinion, however, is not based at all upon experience, only I cannot see any objection to enabling a boy to learn the use of a tool which he is likely to use in after-life.

2751 Do you think it would be possible to carry that out?—I do not at this moment see any difficulty in it, there would no doubt be a difficulty in carrying it out in all branches in one school.

2752 Mr. *Bazley*] I presume that you referred to Owens' College, in stating that the young men presenting themselves were found defective in arithmetical attainment?—I was speaking of the whole of my own experience, both at Owens' College and at Oxford

2753 Had you any instances of considerable mental attainment at Owens' College being shown by students when they entered?—Some of the students appeared to me to be very well prepared, but I should be justified in saying that a large proportion gave me the impression of being very ill prepared.

2754. Have you any knowledge with regard to

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their preparation in chemistry, history, and other matters?—I have no experience at all.

2755 How many students are there usually resident in Cambridge?—I can scarcely answer the question, it is nine years since I left Cambridge.

2756 Could you venture to say that there were as many as 3,000 students at Cambridge at one time?—I should certainly say that the number of undergraduates was under 2,000

2757 Have you any knowledge of the extent of the degrees given annually at Cambridge?—I have not, they are given in so many different departments, and though no doubt the total number could be arrived at, I have never known it

2758. Do you recollect the number of young men who have taken degrees in scientific attainments as well as in mathematics?—In science, very few indeed, when I was at Cambridge.

2759 Was there anything like 50 in the year?—Certainly not, I should say.

2760 Should you say as many as that took those degrees at Oxford?—Certainly not 50 in the year took degrees in science, unless mathematics be included under this term, the degree conferred being the B. A. degree

2761. At neither of the universities would you say that there were as many as 50?—Certainly not at Oxford, and I think not at Cambridge

2762 You would say at all events that not more than 100 took degrees in science at the universities in the course of the year?—Certainly not 100

2763 The steam-engine having been improved by James Watt three-quarters of a century ago, are you aware whether any new principles have been added to the steam-engine beyond those which he discovered as to the expansion of steam, for instance?—No new principle of that magnitude has been discovered, but there has been a great number of new applications.

2764 Are you aware whether first-class engineers have discovered anything fresh in relation to the application of steam to the stationary engine since the time of Watt?—It is a question I cannot answer, but I should imagine there have been great changes in the working of it.

2765 But I am now speaking of a great discovery like the application of steam to the stationary engine?—No doubt the great principle of the expansion of the gas remains precisely the same.

2766 Are you aware whether any more economical applications of steam have been made up to the present day than James Watt himself applied three-quarters of a century ago?—I have no absolute experience of the working of the steam-engine, but I imagine great improvements have been made, and probably from an economical point of view.

2767 During the last three quarters of a century, a great many men have passed through the universities, who were eminent no doubt in mathematical attainment and scientific attainment generally, can you point out, during that time, any signal improvement in the steam-engine which has been made by any single individual of either university?—I have no evidence upon that point.

2768 But is not the inquiry of this Committee supposed to be leading us to the expectation that the sons of artizans, if instructed in science, may do what men of the school and of the highest education

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education in our country have not achieved?— I do not think we are hoping that by educating the working classes, or even the masters, we shall to any great extent discover new general principles, but that we shall be able to improve the working of machinery, and to economise motive power, and generally to keep pace with our neighbours, in the character of the articles manufactured, I think we have reason to hope that that result will be achieved.

2769 But taking the highest schools in this country, are you able to give me any instances of any benefit derived in experimental philosophy or experimental science, to the industry of the country, from persons trained in those schools?—In experimental science, I could mention very eminent men from the universities, but with regard to the steam-engine especially, I cannot, perhaps I need only mention Sir William Thomson, who was a Cambridge man; he has certainly increased our scientific knowledge very greatly.

2770. You might have mentioned the late Master of Trinity, I presume?—Yes, undoubtedly, and Professor Stokes, and many others.

2771 Could you point out any industry of this country which has been created, or largely improved, by any such discoveries as I am now referring to?—Sir William Thomson's researches have added enormously to the industrial working of the telegraph, I should imagine.

2772 But they have not led to any improvement of any great magnitude in any given industry, have they?—I should think they have.

2773 Can you point out any instance like that in which Mr Marshall of Leeds has introduced an improved system of flax-spinning, which has been of immense benefit to England, Ireland, and Scotland. Can you mention any person scientifically trained in either of our great universities who has made any such improvement or discovery?—I am afraid it is a question that I can scarcely go into off-hand.

2774 *Chairman.*] With respect to James Watt, is it not a fact that he received his education at the University of Glasgow?—Yes.

2775 He was a philosophical instrument maker at Glasgow, was he not?—I dare say he was, but I have forgotten the circumstances.

2776 *Lord Robert Montagu.*] With respect to any benefit to be conferred on the industrial classes, which would be the greatest benefit to those classes, to give them additional work, which would improve their means of livelihood, or to improve their minds?—To improve their minds, undoubtedly.

2777 And perhaps scientific education would have that effect on the working classes?—Undoubtedly.

2778. Therefore, although no new engines were invented, or no new industries created, to give them scientific education would be a great benefit?—Certainly, and I do not see how the benefit can be measured by its results in mechanical improvements.

2779. *Mr. Atwood.*] Your experience has been chiefly confined to the scientific education of the middle and upper classes, has it not?—Yes.

2780 At Owens' College you had evening classes which included a certain number of foremen, and people of that stamp, but still the students were chiefly of the middle class?—I suppose they would be called of the middle class.

2781. You have had no practical experience yourself of teaching the working classes, have

you?—They were all taught together, so that it did not come to my knowledge what station of life they occupied. They may have been artisans, but I had no means of coming to any knowledge of the fact.

2782. In speaking of the particular education which you state was required for the four different classes, your own experience is limited to only one of these classes, namely, the middle class?—Certainly.

2783 You speak theoretically, and not practically, of the education required by the industrial classes?—Yes.

2784 At Owens' College had you any workshop attached to the college?—No.

2785 Had you a chemical laboratory?—Yes.

2786. But no joiner's or carpenter's shop, or any place where people may learn the use of tools?—No, nothing of the kind; and I will add that, as one of the professors, I should have opposed any attempt to introduce such a thing.

2787. Am I right in understanding that you recommended for schools generally what you would not have admitted at Owens' College, that is to say, a workshop?—I was speaking simply of boys who were going early into some trade, and I thought it would be an advantage if, before they commenced their apprenticeship, they had already learned the use of simple tools, not to be skilled workmen, but to be useful. I would not attempt to introduce that plan in the case of foremen. In the case of foremen the technical training required can only be gained in the real workshop.

2788. You would teach the applied sciences in these schools and colleges, but you would reserve particular technical education for the actual workshop?—Yes, for the actual workshop. I believe that thorough technical education in the use of tools cannot be obtained in any other way, and that it would be useless to try to do it in classes.

2789 You are aware that Mr Whitworth has assigned eight exhibitions to Owens' College, and three to Oxford; and you would naturally think, I presume, that he must be a particularly good judge of the value of scientific education generally?—Yes.

2790 You are aware that one condition of his scholarships is, that the candidates shall have acquired the use of tools?—Yes.

2791 And that they must have acquired that use of tools not in school or college, but as a separate thing?—I presume that such a knowledge as he requires could be acquired in any workshop where the tools are used.

2792. Would you not think the opinion of a man like Mr. Whitworth almost conclusive as to the value of scientific education in these respects?—Certainly.

2793. You were speaking also of the education required for foremen and masters; that is to say, masters, manufacturers, and so on?—Yes.

2794. Do you know anything of agricultural chemistry?—No; I have not been engaged in chemistry at all.

2795 Would you extend the same remarks to large farmers and landowners with regard to the necessity of scientific training?—Yes.

2796. *Chairman.*] With regard to those local colleges you contemplate that the universities should furnish professors for those colleges, do you not?—I do.

2797. Do

2797 Do you think those professors would be content to be paid in great measure by the results of the examinations of their pupils, or that they would expect an endowment in some shape?—I think they would expect endowments in some shape

2798 Do you think they would be justified in that expectation?—Certainly, for this reason, the teachers from the universities would probably represent the highest class of teachers, they would teach branches of knowledge which, although very important to a certain number of people, would be important to a comparatively small number of people, and consequently such fees as they would be paid must be a very insufficient remuneration. In order to keep the fees at all moderate it would be necessary to supplement that source of income either by private endowment or from some public source, such as a rate

2799 With regard to scientific instruction as applied in the cases of manufacturers and proprietors of large industrial undertakings, I suppose you would expect that such knowledge being superadded to their practical knowledge would be highly beneficial to them in an industrial point of view?—Yes

2800 And that the reason why so few industrial results have been arrived at by scientific men up to this time is because they have not combined science with practice?—I should say that is the reason. In all industrial pursuits that combination is absolutely essential. It would be a mere accident if a man simply acquainted with the theory made great practical applications, for he would only have half the problem before him.

2801 You consider that we have gone on very well, as a practical people so far, but that we should go on a great deal better if we had now theory in combination with practice?—Decidedly, that is my opinion.

2802 Is there anything that you would like to add to your evidence?—I was going to suggest that there should be evening classes and local colleges in all the large centres of industry; but I do not contemplate that they should be confined to evening classes. They might be a part of the general educational resources of the country, by day classes, and the evening classes would be for those who wanted to continue their studies after entering business

2803 If the State gave aid, you would rather that that aid should be given to the evening classes, which should be attended by persons of every grade, than to the day classes, which would be attended only by those whose means were superior to those of the artisan class?—Yes, but at the same time I think that in the case of many of the professorships, at all events, aid would be necessary, even for the day classes on account of the small number of people who would attend them.

2804 You mean in those cases where it is probable that evening classes could not be conducted beneficially along with the day classes?—I do not know that there would be any such cases, I think evening classes would be possible in all cases.

2805 You think that under nearly all circumstances, if there were day classes, the Government endowment should be made to depend on evening classes being also held by the professors who received a stipend from the State?—Yes; I think, certainly, that in all those colleges the

professors should hold evening classes. I may go on to say, I think it would be desirable, when pupils are admitted to a workshop, or to a manufactory, some theoretical knowledge should be required, specially referring to their future career, for instance, that a person in a mechanical workshop should be required to know something of mathematics, mechanics, metallurgy, and the principles of machinery. I think the masters should also endeavour as much as possible to induce their pupils to continue their studies in the higher evening classes of the local colleges

2806. But you would not attempt, I suppose, to enforce those requirements by the authority of the State?—No, I think that would not be possible. I was also going to suggest, that it might be possible, in the case of those students who have shown themselves thoroughly well prepared, to shorten the course which is at present required in the workshop. A man who is well prepared theoretically will learn the practice much quicker than a man not so prepared, from what I have seen of students, that appears to me to be undoubtedly true. If this plan were adopted, the whole of the course which a man would have to go through in order to obtain an adequate knowledge of his profession would not be materially lengthened by insisting on the theoretical knowledge. Let us take an instance. If five years are required, as I think is now the case, for a person to learn an engineering or a machine business, I think that might be divided into at least two years for the theory and three for the practice, or three for the theory and two for the practice, as practical men may decide.

2807. You think that a little experience might lead both the friends of the pupil and the master to concur in an arrangement of that kind, as being beneficial to both alike?—I am not quite sure about the master, because the fees are somewhat large, I believe; but I am sure we should gain a superior class of masters by giving this theoretical instruction first.

2808. Would not the pupil be of greater value to the master during the period of his pupilage if he had received some scientific training before he began it, than if he went there as ignorant as many boys now do go into engineers' offices?—Certainly, he would be of very much greater use, and perhaps from the very first

2809. And in that way his superior value would be a set-off against the shorter time of his pupilage?—Certainly.

2810. Is there anything else that you would like to add?—At Oxford, at the present time, the scientific school for a class-man stands almost on a par with the classical school, the only difference being that, for a man to obtain his degree by taking honours in science (as in mathematics or law), it is necessary for him to take in one extra classical book in Moderations, that is the only difference between the classical and the other schools.

2811. Would you think it desirable to limit the amount of his classical knowledge to any point below what is now required?—Not below what is now required, but to do away with the difference of requiring from the pupils in one school more than is required from the pupils in another school, to have, in fact, free trade throughout the whole of the schools, not to protect the classics

2812. At whatever point the bifurcation took place, you would require no more classics for a man who went on with his science than for a man

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who continued his classics?—Up to that point I think we ought to have what is required for a good general education, demanding that from all alike and leaving specialities to take care of themselves. I am now restricting myself to the case of class-men.

2813 Mr. *Acland*.] Is it not the fact that a considerable number of persons in Oxford are very desirous that men should be allowed to pass their examination in classics as early as they please, and even on entrance, and that they should be free to devote the whole of their time of residence in Oxford to science?—There are many who entertain that opinion; and the opinion that a student should be allowed to pass Moderations in the fifth term instead of the eighth is very general; indeed, I have great hope that this change will be carried out almost immediately.

2814 Is it not also the wish of a large number of persons, expressed by a meeting which took place not long ago in Oxford, that young men possessing eminent scientific capabilities should be admitted into Oxford on the ground of those eminent scientific capabilities alone, without entering into the question of his classical knowledge; in fact, is not that opinion entertained by some of the scientific professors in Oxford?—I do not know that I could distinctly say that, I think the opinion is general that, in the event of a matriculation examination being instituted, science should hold an equal, or at all events a considerable position in it, but whether it is the opinion that students should be admitted for science only, I do not know.

2815. Is it not the fact at the present time that the requirement of a certain amount of classical education, such as is often obtained in the public schools and grammar schools, does really stop the way of a great many men coming up to the University who might otherwise do so, and might even learn their classics afterwards, those men being met at once by the little-go?—They would have very little time to learn their classics afterwards, if the scientific studies were to be carried to such an extent as we hope to carry them in the University.

2816. But the fact is, that supposing science should be accepted as a suitable basis of general education in England, the way at the University

is stopped by the amount of classical knowledge which is necessary for benefiting by the studies of the place?—I do not think that any one would wish to diminish any part of the general education there; we are all of opinion that a good general education is absolutely necessary in every case.

2817 Mr. *Akroyd*] Do I understand you to say that you would shorten the time of apprenticeship to every trade in the case of science students?—That is what I intended, I meant that the previous technical education should be taken into account in calculating the term of the apprenticeship.

2818. The term of apprenticeship in usually from five to seven years, is it not?—It is five in the trades that I know most about.

2819. So that in the event of the term of apprenticeship being seven years, you would shorten it to five years, and in the event of its being five years, you would shorten it to three years?—Practical men must decide on the exact proportions; I do not know how long it would take to instruct a person thoroughly in the practical part of any particular trade.

2820 Most apprentices are at liberty, are they not, in the evening, to attend evening classes?—Yes.

2821. Then, if we adhered to the term of apprenticeship, they might still attend those evening science classes, and prepare themselves to acquire the necessary knowledge of the trade in a short time?—That is what I look forward to from the formation of evening classes in the local colleges.

2822 But that is a matter which I suppose you would leave to the employers themselves, or would you make some special provisions for it?—I must leave it to more practical men to give an opinion upon that point; but I think theoretical knowledge is certain to enable a person to learn the practical part of his work much quicker, how much the time would be shortened I cannot say.

2823 Assuming that an employer was desirous to promote a clever young man, and also to avail himself of his improved services, it would be natural for him to put him forward and shorten the term of his apprenticeship, would it not?—No doubt.

SIR ROBERT KANE, called; and Examined

Sir R. Kane. 2824-5 *Chairmen*] You are a Fellow of the Royal Society, I believe?—I am.

2826. And President of Queen's College, Cork?—Yes.

2827 And Dean of the Faculty in the College of Science in Dublin?—Yes.

2828 Before the establishment of the College of Science in Dublin, you were Professor of Natural Philosophy and Chemistry in Dublin, were you not?—Yes, I had been.

2829 You have paid great attention to the subject of scientific industrial education for a very considerable time, I believe?—For a very long time indeed; I may say that I was among the first in these countries in calling public attention to the necessity for its diffusion among our artisans and the industrial classes.

2830. Before the establishment of the College of Science in Dublin, scientific instruction was

given in Ireland in some shape, was it not?—It was; by an institution termed the Royal Dublin Society, an institution of very old foundation in Dublin, and to which, from the commencement, there had been certain professorships attached, of natural philosophy, chemistry, botany, geology, and mineralogy, and public courses of lectures were delivered by those professors in Dublin, which were very numerously attended, and which produced a very useful result in diffusing among the middle and lower classes a considerable amount of taste for scientific instruction.

2831. Was any attempt made to test the knowledge acquired at those lectures?—There were examinations held in later years. I do not think that originally there was any system of examination; but more lately there were prizes instituted, for which persons attending the lectures might compete; that competition was, however,

however, entirely voluntary, and the courses were public.

2832. Upon the whole, that instruction, I believe, was deemed to be insufficient, and after the subject had been investigated before a Select Committee of the House of Commons, a Commission was appointed, of which you were a Member?—The Commission of which I had the honour to be a Member was appointed by the Science and Art Department about three or four years back, but prior to that a change had taken place in the arrangements for scientific instruction in Dublin by the transfer of those professors, and the instruction which they carried on, from the Royal Dublin Society to another institution, which had in the meantime been founded, and where the instruction was made of a more systematic character, and more directly educational. Instead of the gratuitous lectures which had originally existed, there was an arrangement made for courses of lectures, to which admission was obtained by the payment of small fees, so as to test the reality of the desire for instruction, to make the class a really student class, and not a class of mere loungers, as they were frequently represented to be under the old system. That plan of courses of educational lectures of a certain popular character, that is to say, not of a nature requiring any great amount of previous preparation to understand them, was in action from about 1854 to 1867, those classes were attended in moderate numbers by the artisan class, and by those persons of the middle class that were interested in getting scientific instruction.

2833. Was any attempt made to test the results of that instruction?—Yes, there were examinations, and prizes were awarded at the termination of each course of lectures, but there was, of course, no means of compelling every member of a class to go in for examination, it was only those who wished to compete for prizes that presented themselves for examination.

2834. By whom were those prizes given?—They were given by the Department of Science and Art on the recommendation of the professors who conducted the examination.

2835. That is to say, the examinations did not form a part of the general testing examination in connection with the Science and Art Department throughout the country?—No, they were in operation before the institution of the general system of National examinations by the Science and Art Department.

2836. But all this has been superseded by the Royal College of Science, which is now established in Dublin for Ireland?—Yes.

2837. That college has only been at work a short time?—This is its first session, and, in fact, I may say it is scarcely as yet in operation; owing to unavoidable delays it was not brought into work until a large portion of even this session had passed over. The work of this session is scarcely more than tentative, scarcely more than sufficient to guide the professors in the organisation of the system for the coming session, in which I hope the plan of instruction will be fully brought into action.

2838. But, of course, the scheme of study which is being pursued in the College of Science in Dublin was carefully considered by the Royal Commission of which you were a member?—Yes; the Commissioners laid down a general scheme, not going into minute details.

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2839. It was the commission known by the name of Lord Rosse's Commission?—Yes, Lord Rosse acted as Chairman of the Commission, and under his supervision a scheme of studies was prepared which included the different sciences which are more immediately connected with industrial pursuits. During the first year those branches of study were common to all students, in the second and third years the courses branched into the different professional avocations. It was arranged that four diplomas should be given, one in practical mechanics and engineering, one in chemistry and chemical manufactures, one in mining and metallurgy, and one in agriculture.

2840. You have no practical experience yet of the results of this course of study, but I suppose in devising it you took into consideration what exists elsewhere; you concluded upon the whole that this series of courses would be a desirable one in preparation for industrial occupations?—Yes, the gentlemen who co-operated on that occasion in preparing this course were many of them tolerably familiar with the organisation of some of those institutions on the Continent, such as the *Ecole Centrale des Arts et Manufactures* in Paris, and some of the German polytechnic schools and the schools at Liège and Gand, where similar plans are carried out. I believe the arrangement was decided upon after very full consideration, and the courses decided upon in general terms, for every arrangement of the kind is subject to modifications of detail when it comes into actual working in any particular locality.

2841. But upon the whole you based this scheme on experience gained rather in foreign countries than on anything existing in this country?—There did not exist in this country any parallel which could be taken as a model, for the arrangement of such an institution is in this country completely new. So early as the year 1838 I had endeavoured in conjunction with a gentleman who is now well known in the engineering world of London, Mr Robert Mallett, and one or two other gentlemen in Dublin, to organise from our private resources an institution very nearly on the same plan, but we were entirely in advance of our age, we met with no sufficient public support, and it could not be carried out. However, almost immediately afterwards it led to the foundation of a School of Engineering in Trinity College, so that although we did not succeed in what we desired, our efforts were not by any means without result.

2842. Has that school been a successful school?—It has been a very successful school of civil engineering.

2843. Have any of your Irish railway engineers been trained in that school?—The school came into operation too late for any of the men that were in large practice as railway engineers to have been trained in it, the great burst of railway engineering in Ireland was about 1845 and 1846, and the school in Trinity College was only founded in 1840, but Mr. Charles Vignolles and subsequently Sir John McNeill were connected with it. Professor Downing, who is now connected with it, is well known as a scientific engineer, and its character has been very high.

2844. Was Mr. Hemans a pupil of that school?—No, I do not believe that he was ever directly connected with that school.

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Sir R. Kane. 2845 You said that your attempt was in advance of the age, of course you give that opinion only as far as this country is concerned; but do you think the establishment of the School of Science in Ireland at this moment is in advance of the age?—Certainly not. I think this country is considerably behind the actual condition of industrial science with regard to such institutions or means of teaching; if we contrast the position of this country with regard to scientific education with the position of continental countries of Western Europe, I believe our position will be found to be among the lowest.

2846 If for the term, behind the age, I were to substitute the term, in advance of public opinion, what would you say then? Would you say that the establishment of the College of Science in Dublin is in advance of public opinion, or do you think it is probable that it will be really an institution of which the public will avail themselves?—I believe that the institution of the College of Science in Dublin is not at all in advance of educated public opinion, but it is the kind of institution which must grow, and perhaps grow very gradually, into public acceptance. A diploma such as is contemplated to be given by that institution must be some time before the public come to estimate it, or to give lucrative employment upon the strength of it. The very fact of such a diploma issuing from a Government department is itself quite a novelty, and the value of the diploma must be verified by the performances of the students, who will be sent from the institution before you can reckon upon its being accepted as sufficient proof of the professional qualifications of the holder.

2847. But, taking the case of men who are not dependent on others for employment—for instance, the sons of your large manufacturers, we will say men of the class of Messrs Malcomsons, of Waterford—do you expect that the school will be adequately appreciated by men of that class?—I should hope so, after a little time. The College of Science, in its actual form, is so entirely new, that I do not wish to make any very positive assertion with regard to its future, or as to what I believe it may accomplish, but we have had attending the institution which has been transformed into the College of Science, the sons of the working managers of several large manufacturers' establishments, and they have studied the different departments of industrial science in what was then the Industrial Museum, what is now called the Royal College of Science.

2848 Your organisation being now much more complete, you think you ought to anticipate better results even than those which you got under the old system?—I should hope in time that we shall, but the institution has received a considerable amount of shock, if I may use the expression, from the abolition of what was its most popular element in its old form; that is to say, the system of scientific instruction to which pupils were admissible for small nominal fees. Those courses, which were attended by a considerable number of persons, brought a large concourse of the public round the place, and made it generally known, and gave it a very considerable amount of local popularity. Then the museum, having been organised on a large scale, and I may say in a very perfect form, as illustrating all the more important branches of industry, gave to the institution a very large amount of popular interest. In its changed form that popular ele-

ment has been almost entirely eliminated; and being reduced to the mere trunk of scientific instruction in a rather dry and narrowed form, it has not now (speaking of this session, at least) been capable of taking before the public the attractive position that it had previously occupied. I have, however, every hope that as it becomes better known, the advantages of the system of education now carried out there will be appreciated as a means of scientific education to a very considerable extent.

2849. You do not mean to say that the museum has ceased to exist?—The museum has not ceased to exist, and none of the objects that had been previously in the museum (at least, none of those of an industrial character) have actually been removed from the institution; but the changes of construction which have been carried out in the institution have necessarily closed up from public inspection or public view a great part of the industrial collections; and then, as far as the professors appear to understand the instructions which they receive from the department, it is contemplated in future that the scope of the museum shall be limited to such objects as are indispensable for the illustration of scientific lectures. Such would be a very much more narrow scope than the museum previously had, which embraced a general and very complete illustration, the details of the processes and the products of all the important industries. My own hope is, that the idea of restricting the function of the museum to the mere dry illustration of scientific lectures will be reconsidered, for I think it would be a great loss, both to the institution and the public, if the industrial character of the museum were not preserved.

2850 I think that question would, perhaps, scarcely come within the purview of this Committee, but you have no reason to believe that as a college of science the Royal College of Dublin will not be appreciated?—I have every reason to believe that it will be in time, but public confidence of that kind is a plant of slow growth, and it will be necessary for those connected with the college to prove that success is deserved. I trust when that is shown, the public will fully appreciate it, and manifest that appreciation.

2851 You have a staff of professors fully competent to give instruction in theoretical and applied science, in view of the industrial position of Ireland, have you not?—We have an excellent staff of professors with the exception that there are a couple of chairs still remaining to be filled up; chairs of subjects which did not come into play this first session, and the nominations to which, therefore, were not indispensable this year. We trust, however, that they will be filled up by next session, so as to bring the whole of the professors into full action.

2852 What are those chairs?—Mining and mineralogy, and also, probably, political economy.

2853 But those chairs are included in the original scheme as settled by Lord Rosse's commission?—Yes.

2854 On the whole you would consider that that scheme, as so settled, might serve as a model for any similar institution to be established in the sister island?—I may say, in general terms, that it is modelled on the *Ecole Centrale des Arts et Manufactures* in Paris, but in the adaptation of such a scheme to any particular locality or particular institution, it might require modifications in detail.

2855. As applied to a great central school in London would you say that this scheme might be followed with advantage?—I think in general terms it certainly might in London, but from the great magnitude to which such an institution might naturally be developed here a still further degree of speciality might be found necessary: as a commencement and in general terms, however, I think nothing better could be suggested.

2856. But if you were establishing a local college in Belfast or Limerick, or in Manchester, or in Birmingham, you would then make some modifications?—Yes, it is always desirable in such institutions to give the most development to the teaching of those branches of industry which are most cultivated in the particular place; for instance, in Belfast, it would be most natural to give greater development to practical mechanics and mechanism, the industries there being principally connected with machinery. In another district, which was the site of chemical manufactures, on the other hand, the development of the chemical sciences, would be more natural, a division of that kind actually takes place in Belgium, where in Ghent, which is the seat of the great cotton manufactures, they have a school of civil and mechanical engineering. In Liège, which is in the centre of a great coal-field, and the seat of chemical manufactures, they take mining, metallurgy, and metal manufactures, as the principal subjects of the industrial college which is there.

2857. In all these cases, however, you would require a certain amount of theoretical knowledge in certain subjects, I suppose?—You must base industrial teaching entirely upon previously acquired education in theoretical science; you cannot teach the applications of science to industry, until you have first taught the principles of science itself.

2858. But you would teach future chemists a certain amount of mechanics, and you would teach future mechanics a certain amount of chemistry?—Yes, those sciences are so interwoven with one another, in their general principles, that a man would be very imperfectly educated if he were a mechanic without any knowledge of the nature of the materials he was making use of, and, on the other hand, a chemist would be a very imperfect man of science if he was not acquainted with the fundamental principles of mechanics.

2859. After having taught every man intended for an industrial occupation the elements and principles of certain sciences, you would then develop the instruction in the direction of the pursuit which he was to follow?—Yes; I believe the elementary education in science would be better obtained (by better, I mean more conveniently, not better as to quality,) in a different institution, so that a person going into an industrial college, such as that founded in Dublin, should matriculate, as it were, or pass through an entrance course, and should have learnt some elementary mathematics, perhaps some elementary mechanics, such as a knowledge of the mechanical powers, as they are termed, and by that means be enabled at once to enter on the courses of the professors, and to follow them, without troubling the professors to occupy themselves with teaching the mere elements, which fritters away a great deal of time, and for which the services of men of very high rank in science are not quite necessary.

2860. You would carry that general scientific instruction several steps further in your colleges,
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and afterwards develop it specially, according to the department of industry which the pupil intended to follow in after-life?—Yes; I think a complete education in industrial science would consist, in a manner, of these three stages: first, the primary education in science which could be gotten at a primary scientific school, and where the first elements of geometry up to three or four books of Euclid, some elementary algebra up to simple equations and arithmetic with decimal and vulgar fractions; those things as a basis would enable the student to enter a college of industrial science in a state in which he could at once commence to attend lectures of professors of chemical and physical science with real advantage to himself, and then having spent one or two years in those studies which may be considered as common to all departments of industry, he could specialise himself for one or two years more in those particular branches which were to be his subsequent profession or business.

2861. Those studies you would develop more in one locality than another, according to the difference of the localities?—I think that would be the more natural and more advantageous course to pursue, it is not absolutely necessary, but for practical purposes it would, I think, be more desirable.

2862. Then you assume a certain amount of preparatory scientific knowledge?—Yes; a student ought to possess such before entering an institution such as the College of Science in Dublin.

2863. Now, do you find that amount of preparatory scientific knowledge really exists?—We have not been able to require that at present; the means of obtaining such preparatory scientific knowledge is not generally diffused, and although the question of having an entrance examination has been discussed by the council of professors, they have not thought themselves warranted in recommending that it should be imposed; we have, therefore, at present no entrance examination, but it would be, no doubt, very desirable that it should be introduced as soon as it is found practically possible.

2864. Have you any preparatory course in connection with the college which may be taken as a substitute for the instruction which ought to have been received elsewhere?—Not in the institution, or in immediate connection with the institution, but to some extent with a certain class of pupils, such preparation is secured by the fact of the Science and Art Department having founded a number of exhibitions in connection with the College of Science in Dublin, which exhibitions are conferred upon the persons who give the best answers at the May examinations which are held by the department all over the country; a person getting one of these exhibitions by success in these examinations has already proved himself to be in possession of a certain amount of preliminary scientific knowledge, which, to some extent, may be considered as representing an entrance examination for that class of students.

2865. You consider that the amount of knowledge which is attested by getting one of these exhibitions is sufficient to enable a pupil to pursue his studies satisfactorily at your college?—It certainly should be. The professors and officers of the college have no direct cognizance of the standard which is assumed by the department in conferring these exhibitions, but we consider it almost certain that they would take a standard for conferring

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Sir R. Kane, conferring a reward of that kind, which should be quite high enough to correspond to any entrance examination which we would think of imposing.

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2866 Have you received any such exhibitors?—Yes, we have, at present, in connection with the college, nine students of that kind.

2867 I suppose, without any formal matriculation examination, you have had some opportunity of judging what the acquirements of these young men were when they entered?—As far as I have been enabled to judge from my official opportunities what their progress has been, I believe them, in all cases, to be students above the average of qualification, and quite sufficiently well informed for our purposes.

2868. Do you know where these young men came from?—There are two or three who come from London; many of them are from different parts of Ireland, and I should say that they were a very good representation of all parts of the United Kingdom.

2869. Are they generally boys?—No; I should say they were young men of from 16 to 18, or 19, just about the age when young men would ordinarily enter a university.

2870 And you believe that the instruction which they have got has been chiefly obtained in the classes in connection with the Science and Art Department?—I could not undertake to answer that question of my own knowledge. We in Dublin have no cognizance of the arrangements of the department in London. These students are sent to us from the department as exhibitors.

2871 In fact, you have not inquired into their previous history?—It is not our business to inquire into their previous history, and we have not done so.

2872 With regard to the Queen's colleges, can you tell us what amount of scientific instruction is given in those colleges; taking, for example, Cork, with which you are intimately connected?—We have introduced in the curriculum, for degrees in the Arts Faculty, in the Queen's colleges, a very considerable amount of instruction in mathematics, physics, chemistry, and the natural sciences. Every student on entrance into the Faculty of Arts, passes a matriculation examination, which consists of a certain amount of classics and in mathematics, some geometry, algebra, and arithmetic, then, for the first year of the arts course, all the students attend to classics, mathematics, and French, one modern language being required, which practically is always French. At the end of the first year they are allowed to bifurcate into what we term the classical side on the one hand, or the science side on the other hand.

2873. At what age does that generally take place?—The average age of entrance is about 16½.

2874. And at what age does the bifurcation take place?—At between 17 and 18 years of age; in round numbers, I should say 18, then if the student is going for his degree in arts on the literary side, he devotes himself to classics in his second year, and he takes up probably metaphysics, logic, ethics, and political economy; but if he adopts the science side, he takes in the senior year's mathematics, natural philosophy, chemistry, natural history, and political economy. Consequently the student who gets his A. B. degree, and prefers a course of scientific study, has two years of mathematics, a year of chemistry, a year of natural philosophy, and a course of political

economy, which lasts about three months, and in addition to that he learns a modern language, which is usually French.

2875 How would you compare the science course of one of the Queen's Colleges with the instruction given in the College of Industrial Science in Dublin?—In the Queen's Colleges each science is taught in a purely abstract and general point of view without any reference to special application. Of course special references to the use of certain materials or processes in the arts are not omitted if they come in the natural order of the lectures, and the professors do not go out of their way to avoid them, but they are not a principal subject, the sciences being there taught simply as sciences, as illustrations of methods and of logical trains of investigation, and as embodying a vast accumulation of facts, but without any reference to their immediate practical application in the arts. I am speaking of the Faculty of Arts, where science is considered solely for its own sake, and not as applied to any directly professional purpose. In the Faculty of Medicine and in the Department of Engineering, of course every one of the sciences receives directly practical treatment.

2876. Have you a department of practical engineering in each of the Queen's Colleges?—Yes.

2877 That school would resemble in some respects, I suppose, the engineering division of your School of Industrial Science in Dublin?—In the organisation of the College of Science in Dublin, we do not as yet entirely know the extent to which it may be contemplated by the department to push the study of civil engineering. The only professor whom we have in the department of engineering, or immediately connected with engineering, has for his title professor of descriptive geometry, and the diploma given is mechanics and engineering; but I do not think the matter has been at all put in a definite or formal shape as yet, in all probability the commission did not see its way clearly with regard to Government's giving a diploma in civil engineering, such as is already given by both universities in Ireland.

2878. Then the Queen's colleges cannot be considered in any respect as being ancillary to the College of Industrial Science in Dublin?—No, they occupy rather a different ground; the only practical schools which they have in connection with them, are the schools of medicine, and the schools of civil engineering, neither of which is substantially or properly represented in the industrial college.

2879. You have, then, no secondary schools at all in Ireland which would serve as a preparation for the courses of an industrial college?—We have no secondary science schools, properly so called, or which could serve that purpose, because in our secondary schools, owing to the peculiar character of the older universities for which they educate, their training is almost exclusively classical; but we have in the superior primary schools, in what are termed the model schools of the national board in Ireland, and in some of the schools which are under the management of certain of the religious orders in Ireland, scientific education which is brought to a very creditable, and indeed, I may say, a very high point, and which would abundantly serve for the purpose of preparing students for the entrance course in the College of Science.

2880. By the term model schools, do you mean normal

normal schools?—They correspond to what would here be termed normal schools, they serve the purpose of normal schools in training pupil-teachers and monitors, but the title they usually have in Ireland is that of model schools, because there is in every case connected with them an ordinary primary school, which is worked by the persons who are in training to be masters, that primary school being considered to be carried out in a most perfect manner, it is usually termed a model school.

2881. Then, a model school is a superior primary school and a normal school for teachers at the same time?—Yes, the constitution of the schools which we have in Ireland under the National Board combines the characters of a model primary school and a normal school for the education of teachers

2882 Then, do the same teachers who teach the monitors or men in training as schoolmasters also teach the children?—Yes, the teaching of the children in the primary schools becomes part of the training of the pupil-teachers and the future masters themselves, it is part of their own education

2883. But the persons who teach the pupil-teachers also teach in the primary schools, do they not?—Yes; there are the superior masters, who are actually the masters of the primary school, and then the pupil-teachers, who, in addition to getting special instruction of a higher order, themselves become the junior masters, they serve as assistants in the school, and learn the art and mechanism of the teaching which they are to carry out in their future duties when they are appointed masters in other schools.

2884. These model schools are generally disseminated all over the country, are they not?—I do not recollect the number; but there is one usually in every large town

2885. That is additional to the schools connected with certain religious orders, is it not?—Yes.

2886 Some of which also are superior to what one usually understands by the title "primary school"?—Yes, particularly those of the order known by the name of the Christian Brothers, they have some schools of a very superior description, in which mathematics, geometrical drawing, free-hand drawing, and arithmetic, are taught in a very excellent manner.

2887. They are of the same religious order that conduct the Ecole St. Nicholas at Paris, are they not?—Yes.

2888 Do they teach trades, as they do in the Ecole St. Nicholas?—They do not push industrial teaching to the same point. The Ecole St. Nicholas includes what is called secondary education.

2889. Are the Brothers who teach in these schools generally Irishmen, or are they from abroad?—I believe they are all Irishmen. I cannot speak with any authority on the subject; but I understand that the body of Christian Brothers in this country and in Ireland, except in name, have nothing in common with the French body; they are an independent organisation.

2890. But the object of the organisation is the same, namely, the giving of instruction?—Yes; and I believe their regulations are the same

2891 Lord Robert Montagu.] You spoke of the suppression of the popular element of scientific instruction at the College of Science at Dublin, did you not?—I referred to its cessation.

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2892 Did you ever represent to the department that there was any disadvantage arising from the suppression of the popular element of scientific instruction at the College of Science at Dublin?—I do not think that there was ever any formal representation made to the department, it was rather a cessation by the professors through the creation of a new set of duties; a set of duties so entirely absorbing all the time and the energies of the professors that the popular courses dropped of their own accord, because the professors could not do both

2893 There was no representation made by you or by any other professor of any disadvantage that would be likely to accrue from the loss of that popular element of scientific instruction, was there?—There was no official representation made with regard to it, but the professors found themselves in such a position that they had not merely to continue the amount of duties which they previously had to perform, but even to enter upon the performance of an increased amount of duties in the special proper courses of the institution, and their giving in addition the popular courses which had previously been their entire duty, was out of the question.

2894 Was there then any unofficial representation made concerning this matter?—I cannot undertake to say. The matter was very much canvassed and talked about among the professors, but I am not aware that any formal representation was made to the department on the subject.

2895 In fact, I should be right in saying that with respect to the department, no representation, official or unofficial, was made on the subject?—You would be right in saying that, but I should be anxious, in speaking on the part of the professors who are not themselves here, to make it understood, that the cessation of what we may term the popular lectures became an inevitable consequence of their entering on the duties of the courses of lectures in the college, which lectures being more laborious and greater in number, and occupying more time than the whole of their duties previously had been, left them no time to think of continuing all their former duties.

2896 I believe the report of Lord Rosse's commission was opposed to the continuance of that popular element of scientific instruction, was it not?—The report recommended the establishment of the systematic course of professional study, which has now been brought into operation, that being the only subject referred to the commission. The abandonment of the original system of popular lectures had been long before decided by the department, and did not come before Lord Rosse's commission at all

2897: And you concurred in that report, did you not?—Yes, fully

2898 Lord Rosse's commission recommended that fees should be paid for the lectures, did it not?—Yes.

2899. Will you state to the Committee, what the fees are at this college of science?—The scale of fees, I believe, is calculated in this manner for a student entering and paying at once for the whole course of study; the amount is 25 l.

2900. For a studentship of three years?—Yes; and for a single year the payment is 10 l.

2901. And the payment admits the student to all the courses of lectures for the year?—Yes, and for a single course, 1 l.

2902. So that the fees are in fact very low indeed?

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deed?—The fees measured by the college standard, are very low.

2903. Now, if popular lectures were given in the day-time, they would, in fact, be attended only by the middle classes?—One of the disadvantages of the popular courses which were formerly delivered in the day-time, at the time when they were entirely gratuitous, was, that they were attended by a class who it was considered were in a position to pay for any instruction they received, and had no right to expect it free from the State.

2904. You think that the middle classes should pay adequate fees for the instruction they receive?—I think they might reasonably be expected to pay moderate fees.

2905. And if the lectures were given during the day time, it would be practically only the middle classes who would attend?—Yes; artisans could not attend in the day time.

2906. Is there anything to prevent the professors giving evening lectures in the College of Science now, just as the professors give evening lectures in the Jermyn-street Museum?—The subject of giving evening lectures has been discussed among the professors, and several of them are anxious that it should be done, but the professors are not unanimous on the subject; and it was considered that for this session, as the arrangements of the session are necessarily imperfectly carried out, and as there could not be an arrangement for all the professors giving those lectures, we should not propose to give any of them, but I would hope that next session there should be a system of evening lectures, which would, however, be a gratuitous offering on the part of the professors, and a thing not considered to form any part of their official duties.

2907. There is nothing to prevent the professors giving those evening lectures to artisans, except an objection on the part of the professors themselves, is there?—No, I trust the department would not throw any obstacle in the way of the lectures being delivered, but it is difficult to expect gentlemen who are occupied with very heavy courses of lectures delivered on subjects which require a great deal of care and preparation, to occupy themselves again in the evening of the same days, perhaps, in delivering courses of lectures to artisans without receiving any additional remuneration, and without any positive encouragement from the department. That the department would acquiesce in it, I am quite sure, but I think the professors would, perhaps, expect more than simple acquiescence.

2908. You spoke of the loss of the Industrial Museum, or the exhibitional department, did you not?—I did.

2909. That was handed over to the Royal Dublin Society, was it not?—Yes, there was a collection of natural history, birds, fishes, mollusks, and some mammals which had originally been collected by officers of the Ordnance survey, and which had always been considered as merely deposited provisionally in the museum.

2910. The principle proposed to be carried out by Lord Rosse's Commission, of which you were a distinguished member, was that the College of Science should be purely instructional, and that the Royal Dublin Society should be exhibitional in its character?—Yes, that was the general principle.

2911. In accordance with that you handed over some stuffed birds and fishes to the Royal Dublin Society?—Yes.

2912. But there has been no other loss which you have incurred, has there?—None, with regard to the removal of objects; but practically owing to the changes in the interior, the building for the museum has been reduced in the space available for its purposes in a very considerable degree, and for a great part of the session it was entirely closed to the public, within the last few weeks a portion has been arranged so as to allow of its being visited.

2913. The gravamen of the case is this, that there is not room enough in the building?—The building will be too small for the objects if the museum is an industrial museum, in the manner in which it had originally been; I believe, however, that by a different arrangement of the new constructions a much less interference with the objects of the museum might have been produced.

2914. It was the intention to give an instructional character to the College of Science, and nothing has been removed which was necessary to those instructional operations, has there?—We have always regarded the museum, so far as industrial education was concerned, as one of the most important elements of the instruction.

2915. And of that you have lost very little, but there is not room enough for the museum, because so much space is devoted to instructional operation, namely, lectures and so on; is not that the case?—It is the case to this extent, that by the new arrangements which have been carried out in the construction of the laboratories, and some other parts of the building, the instructional arrangement of the museum has been, I may say, remodelled, and therefore it is true that the space that has been taken from the museum has been applied to the purposes of instruction, but still, owing to those circumstances, the museum has not been available as a means of illustration and of popularising the instruction during the past session, and unless the building is profoundly modified again, I do not see how the museum can be laid out as it was before, or in any similarly useful manner.

2916. The science classes in Ireland have greatly increased in number, have they not?—I am not minutely acquainted with the number; there are, I believe, some in the north of Ireland.

2917. *Chairman*] With reference to industrial museums; you are acquainted with Owen's College at Manchester, are you not?—I have never been in it.

2918. But you know it is a very successful school of applied science, do you not?—Yes.

2919. You are aware, are you not, that it has no museum whatever?—I am not aware of that, but if so, I think that they ought to obtain one.

2920. *Mr. M'Lagan*] I believe you are Dean of Faculty at the Royal College of Science in Dublin?—I hold the office which is termed that of Dean of Faculty, my function is merely to preside at meetings of the council of professors as chairman; I have no other responsibility, and no other position.

2921. There are lectures delivered on agriculture in that college, are there not?—There are; the gentleman who held the office of Professor of Agriculture in the Royal Dublin Society was transferred to the Royal College of Science with the other Professors.

2922. Do many pupils attend that class?—No; the chairs of agriculture throughout Ireland altogether, both in the Royal Dublin Society and the Queen's Colleges, have been failures.

2923. Do

2923. Do you know from what cause that has arisen?—They were intended for pupils derived from the class of landed proprietors and the ordinary middle class, and not for farm bailiffs or stewards, unfortunately that class in Ireland has shown an entire indifference to scientific instruction in agriculture; the professorships of agriculture in the Queen's Colleges, which we originally founded, have been abolished in consequence of there being no classes

2924. But has there not been in Ireland a great improvement in agriculture of late years?—Very great.

2925. In spite of the indifference which you say has been shown to scientific knowledge in agriculture?—The improvements have followed in the wake of the improvements in agriculture in this country, it is not from the special education of the proprietary agricultural class in Ireland, but simply from the introduction of the same methods of improved agriculture of which this country set the example

2926. Are there any pupils at all attending the agricultural class in Dublin?—There is one pupil only.

2927. Are you aware whether that pupil is prosecuting any other studies in the college, such as chemistry, or botany, or geology?—I believe I may answer that he is not.

2928. Do you know what is his object in attending that class, is he a landed proprietor, or does he intend to become a factor?—He is not a landed proprietor, I believe, but what his particular object may be I do not know; he entered for and is attending Professor Davy's course of lectures

2929. And does the professor deliver his lecture every day to that single pupil?—Yes, the professor has lectured to him regularly in the ordinary way.

2930. Mr. Read.] And no one else ever attends?—I never heard of any one else.

2931. Mr. M'Lagan.] Do you know anything about the agricultural schools which are established in Ireland?—There are a great many of the agricultural schools in Ireland under the management of the National Board of Education.

2932. What classes are taught in those schools?—I am not a member of the National Board of Education, and have therefore no right to speak with regard to their arrangements, but I believe I may say that the agricultural school is in every case a primary school, in addition to being an agricultural school, they have two classes of agricultural schools; they have the ordinary agricultural schools, and the model agricultural schools; to the great majority of those schools farms are attached, which are worked by the agricultural teachers in the schools, and from what I have heard, I believe with considerable success. The pupils in the ordinary national schools are taught the general elementary principles of agriculture, the nature of soils, the nature of rotations, and the value of drainage, those general ideas may serve to make them know something more of the general principles of agriculture when they become farmers themselves. In the model agricultural schools, they go through a course which I have reason to believe is a very effective course of elementary mathematics, land surveying, elementary chemistry, elementary mechanics, so that they know the general nature of agricultural implements, and qualify themselves, which I believe

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is a very useful object, for situations such as those of bailiffs to landed proprietors.

2933. You would say that those agricultural schools have been of far more use than the chairs of agriculture in the colleges of Cork and Dublin?—The chairs of agriculture both in the Queen's College, and in Dublin, have entirely failed

2934. Do the students who attend those schools pay fees?—There is a very small amount of school fees paid in the national agricultural schools in Ireland.

2935. Are you aware whether the farms connected with these schools are profitable?—That is a point upon which I have no personal knowledge, and on which I have heard very opposite statements, but the officers of the National Board positively state that the balance sheet shows that the farms are worked to a profit

2936. As far as you know, you would say that those schools which are supported mainly by grants from the Consolidated Fund are a benefit to Ireland?—I would say a benefit in the very highest degree to Ireland; the agricultural instruction of the National Board is one of its most valuable departments, and I should be very sorry to see any interference with it.

2937. Are the whole of the pupils in those schools from the agricultural classes, or from other classes?—I believe they are entirely from the class of small agricultural farmers in Ireland. Of course, there may be an exceptional case of a person of a higher class going to Glasnevin, which is the head quarters, and where the Albert Agricultural Institution is. There is an occasional instance of a person of a superior class going there, but it is rare

2938. You think it would be attended with bad results to Ireland if those schools were done away with?—I think it would be very undesirable indeed, and a great loss to the country.

2939. Is it the fact that some years ago there sprang up a very important industry in Ireland in the conversion of bog into oil, paraffin candles, and other things of that character?—No industry sprang up, but there was a proposition to that effect

2940. Do you know who proposed that, whether the proposition came from scientific men or from merely practical men?—It arose very naturally; every vegetable substance, such as woody fibre, or coal, or turf, yields upon distillation a certain amount of paraffin, and the only question debateable was, whether the amount which issued from any particular material was such as to make it profitable to distil it, from certain varieties of coal it has been found very profitable

2941. Sir Charles Lanyon.] I think you are of opinion that the Queen's Colleges and model schools, as at present organised, are very useful in disseminating scientific knowledge throughout Ireland?—I believe so.

2942. Can you suggest any mode by which the Queen's Colleges, whether by additional science professors, or otherwise, could be made more useful?—I believe it might be found very useful to develop in the Queen's Colleges somewhat more of the practical element than they have at present. At present the only chair of a specially practical character is that of engineering. The Professorship of Natural Philosophy which we have, is one that even as it stands is too heavy for one professor; he has to deliver three heavy

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courses, a course of lectures on experimental physics, a course of lectures on applied practical mechanics, and a course of lectures on mathematical physics, any person who is conversant with those departments of science will know that these three courses are too much for one individual even as they stand, and I think it would be a very excellent arrangement if the present Professors of Natural Philosophy in the Queen's Colleges were relieved of the course of practical mechanics, and that a separate chair for practical mechanics were created, which would embrace such things as steam machinery, the detailed theory of machines, prime movers, and matters of that kind. That would of itself form an enormous field for the energies of professors of a very high order. Then we have at present in each of the Queen's Colleges only one Professor of Chemistry, who is to teach the science which, in an institution of that class, must be taught on a very large scope, giving its full theoretical development, and he has also to conduct practical classes, but practically he is compelled to devolve the management of the practical classes upon an assistant, I think it would be very desirable if a chair of practical and applied chemistry was constituted, which would relieve the Professor of General Chemistry of a certain amount of labour, and leave the applications of chemistry to the arts to be developed by the other professor, in a manner which the college cannot now attempt. If we had those three practical chairs, technical chemistry, practical mechanics, and mechanical construction, and civil engineering (which last we now have), each Queen's College would contain the elements of a very useful School of Industrial Science.

2943. That is to say, if you had two additional professors?—Two additional professors, not meaning the addition of any absolutely new subject, but giving a greater development of divisions already existing.

2944. With regard to the model schools, have you any suggestion by which you think they could be better applied to the promotion of scientific education?—I think we could scarcely wish for more than what the model schools, wherever they exist, are now quite capable of supplying, they give to their pupils a very excellent preparatory course of mathematics, elementary mechanics, and in some of those that I visited elementary chemistry, that would furnish everything necessary for the entrance course to an industrial college, and it would only require the model schools to be in a completely recognised and established position to enable them to become the centres of very useful scientific education.

2945. The result of your opinion is this, that with the model schools, as at present constituted, and with two additional professors in each of the Queen's Colleges, we should have a very efficient system for the dissemination of science in Ireland?—I think, coupled with the completion in a satisfactory form of the Central College of Science in Dublin, that is so.

2946. Along with the improvements which you suggested for that college, you think we should have very efficient establishments in Ireland for instruction in science?—Yes, I think we should then have for Ireland the means of affording scientific instruction of a very high order, institutions capable, I think, of ranking with some of the best on the Continent.

2947. Mr. Read.] Did the Industrial Museum

at Dublin contain any specimens of agricultural produce or machinery?—No, it did not; the department of agriculture has been always in Dublin under the control and management of the Royal Dublin Society, that society was originally founded for the purpose of encouraging husbandry, and therefore the persons connected with the industrial museum have been careful never in any way whatever to trench upon the agricultural department. With regard to the professor of agriculture, who was sent to us a short time ago, we objected decidedly to his being transferred to us, for he had really no connection with our proper objects, but as the department had ruled that all the instruction was to be in our institution and all the exhibition in the Royal Dublin Society, the professor was transferred to the College of Science, although we did not at all consider his department as ranking among our own proper objects.

2948. He was transferred without any good results, I suppose?—He has got one pupil.

2949. Do you consider an industrial museum a useful means of instruction, independently of the assistance it affords to courses of lectures?—I believe it to be very useful, I would not be prepared to say that the instruction necessarily afforded would be very great, because persons casually passing along in a museum gallery and merely seeing a number of objects which are not very attractive in themselves might not give the attention necessary to appreciate them, but with the professors directing the attention of the students to the substances, with a good system of labelling, such as we had fully carried out in the museum, we have found that there is great use in such a museum, presenting a series of objects which take in the materials of manufacture on the one hand and illustrations on the other of the more important stages in the treatment through which materials pass, in that case, in addition to the instruction which is given to the eye, a basis for thought and reasoning is given than which I know nothing more practically valuable in the same order of helps to knowledge, I believe that a system of industrial teaching without a collection of that kind would be very imperfect.

2950. Specimens of that kind assist the eye very considerably in understanding lectures, do they not?—Yes, they give a realisation to the instruction which a mere lecture could not possibly afford to the mind, the assistance which can be given to a lecture by a well conceived descriptive museum illustration is very great.

2951. Did the popular lectures of which you have spoken contain any instruction about the cultivation of flax, or a description of its manufacture?—Not the lectures at the museum, they contained nothing with regard to its cultivation; but in the lectures on botany there were 8 or 10 specially on the elements of botany, in which the professor pointed out the most important plants giving fibre, and, of course, as flax in Ireland was the most interesting, flax was included, and then afterwards the plants yielding the dyes used in the arts, but we did not enter at all into the agricultural treatment of flax, because there we should be branching off to the agricultural department from which we had carefully kept ourselves aloof.

2952. Who are the teachers in the farm schools throughout Ireland, and where do they receive their own instruction?—Speaking from merely general knowledge, I believe they have practically been all taught in the Central Institution at Glasnevin;

Glasnevin, the gentleman who is at the head of the whole of the Agricultural Department was himself trained under the late Dr. Kirkpatrick in the Albert Institution

2953 Mr *Powell*] You stated that you kept yourselves apart, with some care, from agriculture, with regard to instruction in that department, from what cause did that careful abstinence arise?—From a wish not to interfere with the objects of another institution whose speciality agriculture is.

2954. Do you think that that entire abstinence is beneficial?—I think it is, when in the same city there are two institutions, each of which has a special line or object of its own to work or cultivate, I think it is prudent, and for the public good, that they should not trench on one another's objects, any interference of the kind might stimulate little rivalries which it is better to avoid

2955 But does not that restrain your pupils from gaining information, which, although not complete, and not embracing the whole subject, would still be interesting and suggestive, and therefore valuable?—If one of our students wished to get agricultural information it would not be difficult for him to go and get it in the Dublin Society; we are not very far apart

2956 But is it not your theory that you yourselves afford the pupil sufficient occupation for such faculties of time and mind as he may have at command?—We could not undertake to teach everything. The matter was not originally of our arranging, the matter was arranged by the Governmental authority under whom both institutions are placed; it was originally arranged that the institution with which I am connected should not in any way interfere with the Royal Dublin Society with respect to agriculture

2957. And you think that complete separation is convenient?—I think so, of course all these institutions have a certain unity, and, in a purely theoretical point of view, the subjects would be better taught in concert, but we have sometimes to sacrifice a little completeness in theory, in order to work with institutions and people in a practical way; the arrangement was that the Dublin Society should keep to itself entirely everything belonging to agriculture, but, as I have already mentioned, that arrangement was broken through by handing over the professor of agriculture to the College of Science

2958. Do you find that those who are about to become owners of land in Ireland acquire the scientific knowledge of agriculture by which they will know how to plough their own property without being dependent on an agent?—I think they do in the way in which a man of that class gets general information in society by reading, and so on, but I believe that such a thing as a landed proprietor, or as the son of a landed proprietor, setting himself to actually learning the science of agriculture is very rare.

2959. Should you not think the existence of such knowledge among the class of landowners would be highly beneficial in a country where agriculture is backward?—Yes, I should say it was very desirable indeed, and so we thought at the time of the first organisation of the Queen's Colleges. We were very sanguine that the class of landed proprietors, particularly as at that time they had suffered so terribly from the potato famine, and were compelled to exert themselves to recover their position, would at once adopt the

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means of having their younger sons taught scientific agriculture, but we were disappointed, they did not come, the chairs of agriculture became nearly useless after a time

2960. Do you find that those who are the sons of large farmers, or other men likely to become large farmers, in their turn, and naturally expect to follow their father's profession, are desirous to get a knowledge of scientific agriculture in Ireland?—Not by availing themselves of the Queen's Colleges, they go to the national or the model schools, in some instances they go to Glasnevin or to Scotland.

2961. But speaking of them as a class, do you think there is that desire?—I think the desire is growing, but it does not exist to any great extent as yet.

2962 You spoke of certain schools as being schools of primary education, but primary education does not ordinarily embrace in its application agriculture, will you be kind enough to explain that?—Usually, primary education would be confined to reading, writing, and arithmetic, with perhaps some geography and history.

2963 Then in what sense are these schools of agriculture schools of primary education?—It is rather that, certain schools of primary education have a little farm, and superadd some agricultural instruction, but the basis of the primary education remains the same in every school

2964. It is an ordinary school of primary education, with some slight subordinate portion of elementary agriculture introduced?—With some agriculture superadded.

2965. Is that taught from text-books or from operations in the open air?—Generally both, in every school that bears the name of an agricultural school, there is a small farm attached, most of the farms in Ireland of that class are very small, but there is enough in each case to give the schoolmaster an opportunity of showing the nature of rotations and so on

2966. Are they taught the value of deep diaming, for example?—I have no doubt they are, but I would not undertake to say that of every school.

2967. Have they the machines in those schools which would be necessary to show such things?—Not in the primary schools, they could not go to that expense.

2968 I think you stated that you desired the multiplication of professors and the subdivision of their provinces, but is the attainment of the pupils such as to give scope for the energies and abilities of a high class of professoriate in the Queen's Colleges?—The standard of proficiency among the students of the senior classes, I think, may very fairly be measured with some of the best in this country.

2969 Are there any professors whom you could dispense with, so that the staff might remain the same in number, and the same in the courses given, but with a greater development given to each branch?—Certainly not now. There is no professor that is not absolutely required.

2970. How many pupils are there in the agricultural schools, taking first the ordinary schools, and secondly the model schools?—As I am not a member of the National Board, I do not think it would be proper for me to attempt to answer that question.

2971. Mr. *Akroyd*.] I think you were stating that there was a difficulty on the part of the

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professors connected with the Dublin School of Science in giving evening lectures, which you thought might be removed by some increased grant, but are you aware that in Jermyn-street the professors give those evening courses without charging any fee whatever?—I do not think the difficulty in the case of the professors in Dublin is so much a monetary one, but that they have a good deal of additional duty imposed upon them by the department; and I believe they consider that they do not receive the countenance or sympathy of the department in the way in which they thought they deserved. It is a point on which I would really ask the Committee to pardon my not going into detail. I should not hesitate to state my own personal opinions to any extent, but I should feel embarrassed in saying, on behalf of other gentlemen, what are their grounds of action.

2972 At all events, this is not, you say, a money question?—I believe not merely.

2973 Have you reason to believe that the difficulties, whatever they are, may be removed?—I believe they might be removed by action of a conciliatory kind on the part of the department.

2974 With regard to the scholarships at the Dublin School, there are 10, I believe, are there not?—There are nine exhibitions and two prizes, which are put on a different foundation, and which are called scholarships.

2975. Are those all filled up?—The scholarships have not come into play yet, they will be examined for next month.

2976. The candidates must submit to three years' training, must they not?—The scholarships will be for two years, and they will be given to students who have been already in the institution, the exhibitions are given to students before they go to the institution.

2977. There are nine exhibitions, you say?—Yes.

2978 And how many of those are filled up?—I believe they are all filled up.

2979 Mr Dixon] How many students have you in connection with your School of Science altogether?—I have not the numbers by me now, I shall have the return laid before the Committee.

2980 Chairman] Is there any improvement which you think could be made in the general arrangements of your college which you would wish to bring under the notice of the Committee?—In general terms, I would venture to say this, that the professors feel that the teaching body, which, in a college of that kind, should exercise a certain degree of influence, and possess a certain amount of consideration, has been too much subordinated to the mere administration which is vested in an officer entirely independent of the professorial body, and who represents the department here in London.

2981 Mr Gregory] Do you refer to the secretary?—I do.

2982. But does the Department of Science and Art exercise any control over the professorial body by means of the action of this secretary?—The whole administration of the institution and the arrangements of the service; in fact, everything in the whole government of the institution, except the mere form of delivering the lectures and sitting in council on questions of routine, of the hours, and so forth, is vested in the secretary, under the direction and instruction of the department here in London. I believe that a great deal of the difficulties that have arisen in the work of the

professors, the frictions which have occurred connected with the non-delivery of those spontaneous lectures, depends upon the professors thinking that the department does not concede to them their due position. A college is necessarily different from a mere Government office, in which a clerk to do the correspondence is everything. In a college, which should contain men of reputation in science, and some of them of considerable distinction, professors do not like being subordinated to a secretary, and I trust that, even without any immediate action, a little experience of the working of the institution will induce the department to acquiesce in the professors and the professorial council being placed in their proper position as the real governing body of the institution, an educational institution will never satisfactorily be worked otherwise.

2983 Surely you do not mean to convey to the Committee that the professors are subordinated to the action of their own secretary?—Practically they are. I do not mean to say that if you examined the minutes you would find in so many words that the professors were subordinated to the action of their own secretary, but substantially in the working of the arrangements and in the practical conduct of the whole business, the department governs the college through the secretary, who is entirely independent of the professors. This secretary is also one of the inspectors of science schools for the department, and is frequently absent on that duty. At this moment, for example, he is away in the north of Ireland examining schools without any communication with or authority from the professors, so that the college is left in Dublin without any official representative.

2984 Is there no minute defining exactly the functions of the secretary?—I never saw one; he represents the department; the function of the professor is to teach, but the secretary represents the department, and as the department is absolute, the secretary exercises their authority.

2985 No doubt the department is absolute, but do I really understand you to say that your secretary is not, as it were, the servant of the board of professors, that he keeps together all the correspondence, that he acts upon the representations of the board of professors, and that he is, as it were, the intermediary of communication between the board and the department?—He attends the meetings of the college council.

2986. He takes no part in them, does he?—Yes, he discusses every subject that comes before the council; but he retains in his own hands all administrative business, that is all the real government of the college, as the representative of the department.

2987 He has no vote, has he?—No, he has no vote.

2988 But is he considered to be entitled to have a voice, except so far as he may state those views of the department which he may have been commissioned to impart to the Board?—I would say the point is, that his position at the council of professors is more a moral position derived from his being taught to feel himself the organ of the department; it is more a moral position than a position which you could define by any actual written description.

2989 Does the secretary interfere in the working of your Board, except upon those points on which he has received previous instructions from

from the department?—I believe that he would consider himself entitled to interfere and speak on any matter which was under the consideration of the council

2990. *Chairman.*] You stated with regard to this question, that you spoke with some hesitation, because you were anxious not to appear to represent the views of others as well as your own, now, would it not be desirable that the views of the professors at large should be stated on this question in some authoritative form?—I think that would be very important, nothing is of more pressing necessity for the success, or even the chance of success, of this industrial education in Dublin, than that the professors should work, not merely as passive official agents, but as thoroughly and heartily co-operating and assisting in the action of the Science and Art Department, and unless that strong moral principle of co-operation is secured, I do not think the institution has a chance of going on well, I think, therefore, for the purpose of enabling the opinions of the pro-

fessors to be made known to this Committee, it would be very desirable that one or more of those professors, who have been long attached to the institution, and are thoroughly acquainted with all its working, should be examined by the Committee.

2991 Will you undertake, in the first instance, to represent to the board of professors that the Committee would be glad to receive an exposition of their views on this subject, in order that they may judge whether it would afterwards be desirable to summon one or more of them to attend before this Committee?—I will do so I will have a meeting of the college council for that purpose when I return to Ireland

2992. *Mr Gregory*] Does the secretary interfere in matters of arrangement connected with the museum?—We have succeeded in preserving to the professors a good deal of control over the arrangements of the museum and the library, by forming museum and library committees

Sir R. Kane,
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Thursday, 21st May 1868.

MEMBERS PRESENT

Mr Acland
Mr Bagnall.
Mr Bazley.
Mr Dixon
Mr Graves.

Mr. Lowther.
Mr M'Lagan.
Mr. Read.
Mr Samuelson.

BERNHARD SAMUELSON, Esq., IN THE CHAIR

The Rev Dr JOSEPH WOOLLEY, called in; and Examined.

Rev. Dr.
J. Woolley.
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2993 *Chairman*] You are Director of Education for the Admiralty?—I am.

2994 And Inspector General of the School of Naval Architecture?—Yes.

2995. And I believe you were a Fellow of St. John's College, Cambridge?—Yes

2996 And third Wrangler in Mathematics?—Yes

2997 How long have you been connected with education?—I have been connected with education all my life

2998 You were not a tutor at Cambridge, were you?—I was a private tutor at Cambridge; but the two mathematical tutors on my side at St. John's remained for 10 or 12 years; there was no change for all that time, and I never had an opportunity of becoming college tutor

2999. But yours was mathematical tuition?—Yes

3000. How long have you been connected with the public service?—For 20 years.

3001 In what capacity did you enter the Government service?—I entered the Government service as the principal of the School of Mathematics and Naval Construction at Portsmouth, it was intended to be a kind of school of naval architecture

3002 Is that school in existence?—No; it lasted only five years, it began in 1848 and was discontinued in August 1853.

3003. Was the curriculum there tolerably large?—Yes, it was very considerable, it was as high as I could carry it at the time, considering what the preparation of the pupils was.

3004. What staff had you there?—Myself only for the theoretical instruction For three days in the week I did the whole of the teaching The remaining three days the pupils were taught by a draughtsman under the directions of the master shipwright.

3005 Who were your pupils?—Apprentices selected from the dockyard school, on account of their knowledge of mathematics.

3006 Were they of the class of artisans?—Yes; they had originally been so, most of them, the same class that all the apprentices are of

3007 And they were still apprentices at the time they were placed under your care?—Yes, they were apprentices when they were placed under my care.

3008 They would be boys from 18 to 20 years of age, I suppose?—Yes; from 18 to 21.

3009. Why was that school abandoned?—

There was found to be a difficulty in those days in providing places for the young men afterwards, or at least a difficulty was made I think it had never been established with any very great desire for its success on the part of the department of the Surveyor of the Navy.

3010 By whom was the establishment of that school suggested?—It was suggested by the present First Lord of the Admiralty, Mr Corry and Mr. Herbert were the persons who were most concerned in the establishment of that school. It was carried on afterwards with the same zeal by their successors in the Admiralty of which Lord Auckland was the First Lord.

3011. But it met with a kind of passing resistance from the permanent officials?—I always thought it did. The pupils, on going out of the school, were promised certain positions in the dockyard, but when they went out all those places were found to have been filled up.

3012 What was the nature of those positions?—Very low positions, leading men, the very best possible position for their future success. It is the lowest grade of mechanical officer; though, indeed, it is hardly that of an officer, it occupies a place between the working men and the mechanical officers

3013 It is scarcely even a foreman, is it?—It is below the foremen There is another class between them and the foremen, namely, the inspectors It is below the third-class draughtsmen, and is, in fact, quite the lowest grade.

3014. Were none of those young people appointed leading men on quitting the school?—They were all appointed supernumerary third-class draughtsmen at first; but afterwards one or two of those who were the latest students before its abandonment obtained the position

3015 What kind of men did they turn out?—Very good indeed, the present staff of the Constructor's Department at the Admiralty consists entirely of those who were brought up in that school, and the only engineer student there obtained the position of assistant inspector of machinery at Keyham, after a competitive examination, having been up to that time employed as a draughtsman in the Chief Engineer's Office at Portsmouth.

3016. They have since risen in grade?—Yes, certainly.

3017 That school, you say, was discontinued in 1853?—It was.

3018. When

3018. When was the present school of naval architecture established?—In 1864

3019 After an interval of 11 years?—Yes

3020 During that interval, I believe, the want of scientifically trained men was very much felt in the dockyards?—Very much indeed, there were none in the dockyards between the pupils of the former school of naval architecture and those who were brought up by me who could be looked upon as specially educated in the science of their duties

3021 Do you know whether in the commercial ship-building establishments there are any young men who have received a similar education to that which you gave at Portsmouth?—I do not think so, there were not any in former times, to my knowledge.

3022 With regard to your present school at South Kensington, is that visited extensively by persons hoping to get private appointments?—No, there were 18 students at the end of last session who were seeking employment in the private service

3023 Were most of them natives of this country?—There were six foreigners, and 11 natives of this country.

3024 Is there anything analogous to this school in Europe?—There is a school in Paris which has been in existence for some time in connection with the marine of France, it is called the Ecole d'Application du Génie Maritime, but that differs from our school in this way, that the students are entirely selected for the dockyards from among the best of those who have been at the Polytechnic School At this school du Génie Maritime they study for three years entirely practical, or rather professional subjects

3025 Have they any professional duties at that school?—They are taught in Paris for six months of the year, and then, for the other six months of the year, they go out to practical work in the dockyards, and that course continues for three years

3026. Have you any Frenchmen in your school at the present time?—None.

3027. What was the course of instruction in the abandoned school of naval construction at Portsmouth?—It began at the stage to which the education had been carried in the dockyard school, which implied a fair knowledge of algebra, and of the first six books of Euclid, together with a little trigonometry, in fact, they came to the school with a knowledge of algebra, as far as quadratic equations, four books of Euclid were *de rigueur*, but most of them knew a little more than that, and they had besides a fair knowledge of plane trigonometry.

3028 And those were working apprentices?—They had been working apprentices

3029 But they had been educated in the dockyard schools?—They had been educated in the dockyard school for four years.

3030 To what grade of society did they belong?—Some of them were the sons of mechanical officers in the dockyards, one was the son of a master shipwright.

3031 They were not mere ordinary apprentices then?—Some of them were.

3032 At what time did they leave the school?—They came to me at about 18 years of age, and remained three years.

3033. But between the time of their leaving the dockyard school and their coming to you at that age, were they at work?—They were chiefly

at work, and at the dockyard schools for about two afternoons and three evenings in the week.

3034 They were in the school at the same time that they were serving their apprenticeship?—Yes, just as apprentices in the dockyards are now

3035 Having previously been at some primary school?—Yes.

3036 What was the course of instruction in this school of naval architecture at Portsmouth?—It included a very fair knowledge of algebra, and geometry, with descriptive geometry, plane co-ordinate geometry, or conic sections, with some knowledge of solid geometry, the differential and integral calculus, and some differential equations We did not go much further than that, although we took, perhaps, a few propositions in the calculus of variations, and finite differences

3037 Will you be kind enough to state what you understand by descriptive geometry?—Descriptive geometry is that which teaches a knowledge of solid geometry by projections, it teaches how to construct from them the proper shape of different solid bodies, and their sections, it is a science well known in France, and, in fact, some knowledge of it is absolutely necessary for admission to the Polytechnic School.

3038. That course of instruction is not generally followed, I think, is it?—No, it was not followed before it was introduced into the school at Portsmouth, but it has been introduced into King's College.

3039. Had you any special reason for introducing it into your course?—Yes, I found that it had a very important bearing on everything that took place in the mould-loft floor. A person who knew the principles of descriptive geometry would have no difficulty in getting in a short space of time an intelligent knowledge of everything that took place in the mould-loft floor.

3040 Will you continue your account of the course of instruction in that school?—There were mechanics, of course, with the strength of materials and constructions, with the applications as far as possible to the theory of the steam-engine and naval architecture That is the course which we attempted to carry out.

3041 You taught the construction of the steam-engine and of vessels, as far as they could be taught in a school?—Yes, the theory

3042. Did you teach chemistry?—Chemistry was taught; there was a chemist in the dockyard who gave lectures on chemistry

3043 What was the number of your pupils?—I think at one time it was 20.

3044. And those pupils had some difficulty in getting employment at first, but they were ultimately employed, and they are now valuable servants of the State?—Yes, almost all of them.

3045. That school was closed you say in 1853?—Yes.

3046. What was your occupation in connection with the public service from 1853 until the establishment of the school of naval architecture in South Kensington?—In 1853 I became inspector of schools for the Admiralty, and I remained in that capacity till 1858, when I became one of her Majesty's inspectors of schools.

3047. What was the nature of the schools which you inspected for the Admiralty?—They were the dockyard school, the schools connected with the divisions of marines, and the schools on board ship.

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3048 Schools for boys of from 13 to 17 or 18 years of age?—Yes.

3049 Mr. Acland] Have you anything to do with the education of the cadets?—Matters connected with them are referred to me, if the Admiralty please; there is something of the kind before the Admiralty at this moment; and I have been consulted by them during the past year

3050 Are you the inspector of their education?—No, I have not been so hitherto, except on a special visit made by me by order of the Admiralty last November

3051 Then what is the nature of your connection with them?—I have none, except that I give the Admiralty advice when they ask me for it.

3052. *Chairman*] You simply act as referee when you are consulted?—Yes

3053 From the year 1858 till 1864 you were Her Majesty's Inspector of Schools?—Yes; during which time I still inspected the Admiralty schools, the inspection of which was then under the control of the Committee of Council.

3054 Did you find that many of the men who had been under your instruction left the Government service in order to enter the service of private establishments?—I know of none at present. One became a Wesleyan preacher

3055 In 1864 the school of naval architecture at South Kensington was founded, was it not?—Yes

3056 Will you kindly state what is your course of instruction there?—As far as mathematics are concerned, it is very much the same as that which before existed in Portsmouth, only that things have progressed since then, and we use now two books of Professor Rankin, of Glasgow, on applied mechanics and the steam engine

3057. What are your books for teaching geometry?—Euclid, and a book which I published on descriptive geometry myself. Then we have also the books which are generally in use at Cambridge for conic sections and solid geometry

3058 Mr. Acland] You are aware that some persons have latterly expressed an opinion in favour of the expediency of departing from the old English method of beginning the teaching of geometry with Euclid?—Yes

3059 Have you considered that question?—Yes

3060 What is your opinion upon that point?—My opinion is that it would tend to remove many difficulties in the way of beginners, if a different book were employed, and if geometry were taught more in the French method, as it is taught in the books of Legendre

3061 Is there any book in English which could take a place similar to that occupied by Legendre in France?—No, if there had been any English book fit for the purpose, I should have recommended it for the use of the dockyard school long ago.

3062 *Chairman*] In what way is this book of Legendre to be distinguished from Euclid?—It deals with the subject in a more systematic way, and does not take the student at once into such difficult propositions. Everybody knows the fifth proposition, it is found very difficult by most boys, and a good many never get over it at all, who, if they were studying mathematics on the plan of Legendre, would, perhaps, succeed in getting a fair knowledge of geometry

3063 Mr. Acland] Do you think that it is desirable, before a boy begins the study of abstract

geometry, that he should be familiarised with some of its practical applications?—Certainly. I think that a very important point.

3064. *Chairman*.] Do you teach practical geometry?—Practical geometry is taught, the principal of the school of naval architecture begins his course with a few lessons on practical geometry.

3065. Mr. Acland] Do you consider that the books now existing on practical geometry in the English language are sufficient for the purposes of such teaching as yours?—I think they might be improved, and that we might have something more systematic.

3066. *Chairman*] What other subjects are taught at the Naval School?—Besides mathematics there is chemistry, with chemical manipulation and analysis, and the properties of metals, and there are lectures on physics, more especially magnetism, and its effect on the compasses of ships.

3067 In what way is chemical manipulation taught?—There is a small laboratory connected with the school

3068 Are all the pupils taught chemical manipulation?—Yes, every one is taught chemical manipulation for three or three and a half hours a week.

3069 Is there a metallurgical laboratory as well as a chemical laboratory?—No; the time will not suffice for that. Dr. Percy gives lectures on metallurgy, and I need not say that he is the great authority on that subject.

3070. Metallurgy is only taught in that way then?—Yes, Dr. Percy gives lectures.

3071. And those pupils who choose may, I suppose, avail themselves of the instruction of Dr. Percy at the Jermyn-street laboratory?—No; the time would not permit that, and the distance from Jermyn-street is too great

3072 Will you now continue your sketch of the course of study?—It includes mechanics, both practical and theoretical, practical mechanics as much as possible; then there are some higher dynamics, and hydrostatics, and hydro-dynamics.

3073 Are hydrostatics and hydro-dynamics taught by the professor of mathematics, or are they a separate course?—They are taught principally by the vice-president, who is a fellow of Trinity College, Cambridge. I endeavour to get given to these studies as practical a direction as I possibly can consistently with that thorough knowledge of principles which I consider most essential for persons who are going to occupy the positions which is supposed these persons will ultimately do.

3074 That is to say, to a certain extent the instruction is made technical?—Yes, as much as possible.

3075. You have in view the applications to shipbuilding in teaching hydrostatics and hydro-dynamics?—Yes; all the problems connected with shipbuilding are carefully brought before them

3076 Mr. Acland] With regard to the floating of ships, there are very important questions which would come under those heads, are there not?—Yes; those questions are brought before the pupils; they are not treated all in any one book, but the matter is culled out of different books.

3077. *Chairman*.] The strength of materials is included in your course, no doubt?—Yes; the strength of materials is included; and the newest authority

authority for that is Professor Rankin, and we have also the benefit of his help as examiner upon that subject.

3078. He has given you a special course, has he not?—Yes, he gives us a few lectures in the course of the year, but, unfortunately, he is engaged in his duties at Glasgow at about the same time as our school at Kensington is going on. He gives us, however, a few days in April. Then there are the strictly professional subjects of ship engineering and drawing. Physics are not taught so extensively as we could wish. The want of time is one reason, and the great expense is another, I mean the great expense which would be required to obtain very good teaching for us where we are so far away, but if ever the School of Mines should be brought into junction with us, I think we might benefit each other considerably.

3079. What are the strictly professional subjects which you teach?—Ship and engine drawing—what is technically called laying off, the making of the moulds on paper for the different parts of the ship, and for the engines, and all the usual calculations and designs, those form a large part of the course.

3080. I suppose the steam-engine is taught principally in reference to marine engineering?—Yes.

3081. But you have no course relating to engineering or workshop tools, have you?—No, that is supposed to be acquired, and is, in fact, acquired by the students in the dockyards.

3082. You have mechanical construction, of course?—Yes, we have mechanics, the principles of machinery, the theory, and also a practical course of instruction. Every year we have a course by Mr. Anderson, the well known machinist of Woolwich.

3083. Then taking your course, which I believe is for six months of the year during three years, together with the courses of lectures delivered at Jermyn-street, you would say, I suppose, that these two courses combined would pretty well cover the ground of Polytechnic instruction?—Yes, I should say it would.

3084. Are there any exceptions to that?—With regard to mathematical instruction, there would be a divergence after a certain point according to the different profession which the student intended to follow. For some the instruction would point specially to the theory of naval architecture, while for others it would point to engineering, and so forth. Some would not require so extensive a knowledge of mathematics as are required for those two subjects, but there would still be a great deal which would be in common for them all.

3085. You would say the two establishments together would cover the ground?—I should say so for almost all technical subjects.

3086. Although some of the courses might possibly require to receive a different development?—Different developments according to the different professions of the students.

3087. What number of professors have you in that naval school?—Permanently there are the principal, and the vice-principal, and there is a gentleman who was brought up as an engineer, and in fact was a wrangler at Cambridge, who teaches the strength of materials and engineering, and subjects of that class.

3088. What do you mean by engineering; do you mean mechanical construction?—Yes; but

he is not at present a permanent member of the staff. Then we have the assistance of a gentleman connected with the Admiralty, who teaches ship-drawing, and the professional subjects relating to shipbuilding. There is another gentleman who comes twice a week to teach engine-drawing, and there is one amongst the constructors of the Navy who comes once a fortnight, and who gives a course on the design of ships.

3089. How do your young men employ themselves during the other six months of the year?—They are sent down to the dockyards and factories, and employed under the immediate supervision of Mr. Reed, and Mr. Lloyd, the Chief Constructor of the Navy, and the Chief Engineer of the Navy.

3090. Do you find then that this half time system works well?—Yes. The only point is, that there is hardly time now in the three years for doing all we want to do, because, although we speak of the six months of instruction being theoretical, there are so many practical matters mixed up with it, that the theory cannot be considered to occupy much more than half the time.

3091. What practical matters are you now referring to?—Ship-drawing, chemistry, and things of that kind.

3092. In what state of preparation do the young men ordinarily come to you?—Those that come from the Admiralty come very well prepared indeed.

3093. They have been prepared in the dockyard schools, of which you have been speaking?—Yes, in the dockyard schools which are under my inspection.

3094. How do the others usually come prepared?—The others have hitherto come up very indifferently prepared in mathematics, which has caused a very great deal of difficulty with regard to those students.

3095. I presume that they are rather a drag on those who come from the Admiralty?—No, it is not that, but they do not get the same amount of benefit for themselves out of the course of instruction.

3096. But must not the course of instruction for the more prepared students be rather retarded, in order to suit the inferior state of preparation of those pupils who come to you from private schools?—No, those who come in a less advanced state of preparation are put into a class by themselves, they are taught in that class according to their state of preparation, and they are not allowed to interfere with the progress of the others who are more advanced.

3097. Can you give us any statistics with regard to the number of the pupils?—Yes, in the first year I think the number of the pupils was 20, there were 16 sent by the Admiralty, and four private pupils.

3098. What are the numbers for last year?—Last year there have been 42, of whom 24 were from the Admiralty, while 18 were private pupils.

3099. In fact, the number of the scholars has doubled during the three or four years of the existence of the school?—Yes, quite.

3100. Do a large number of those private pupils go through the entire course of three years, or do many of them abandon the school?—More than one-half of them do not go beyond one or two of the courses, but there is one who has left us now, who began at the very beginning, and has been there four years.

Rev. Dr.
J. Woolley.
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Rev Dr.
J. Woolley.

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3101. Do you give any diplomas?—Diplomas are given

3102 What is the expense of instruction?—I can hardly say, but altogether with the lectures, and one thing and another, the expense would be about 3,000 *l* a year, as nearly as possible.

3103 That is the budget, but what are the fees?—The private pupils are only charged 25 *l* a year, and if they enter for the three years, it is 60 *l* for those three years

3104. Are they allowed to visit the dockyards and arsenals in the same way as the Government pupils?—Yes, the Admiralty have always permitted that

3105. It is understood that it will not be refused, I suppose?—Yes, it is understood, but there has never been any difficulty even before that definite understanding had been come to.

3106. Do those pupils who are sent by the Admiralty pay any fees at all?—No, the Admiralty pays fees for them, it is a mere matter of account.

3107 But they do not receive any scholarships?—They receive none, they are paid by the Admiralty something extra for their maintenance in London. They receive besides their wages a guinea a week during the time they are at school.

3108 How are they selected?—They are selected by an examination, the theoretical part is carried on by myself, and the practical part by the department of the Comptroller of the Navy.

3109 How many naval schools are there?—There are seven.

3110 In what localities?—In each of the seven dockyards

3111 Mr. *Bagnall*] What is your opinion of the desirability of having workshops connected

with scientific schools, in order that pupils may be taught the use of tools?—There would be no time for anything like that in our school

3112. But supposing there were time, do you think it desirable?—Our pupils come up with a sufficient knowledge of the use of tools.

3113 My question was referring to the existence of workshops in connection with schools as a general thing?—My own opinion is that it would be better to give theoretical instruction and instruction in workshops separately; I mean that workshops connected with educational establishments are liable to become mere playthings unless they are employed in remunerative labour.

3114 Mr. *Lowther*] How many hours are the students occupied in your school?—In the school of naval architecture they are employed from nine to 12 o'clock every day in the week, and on four days in the week from two to five o'clock, and in the evening from seven till nine; besides that on two other days of the week they attend lectures from five to six. In fact, on two days of the week they have eight and a half hours at the day school, and on the two other days they have about eight hours, while on the other two days they have three hours.

3115 You stated that there were some foreigners in your school, did you not?—Yes.

3116 What are those foreigners?—There were four Russians; we had one lieutenant from the Swedish navy there and a Hollander.

3117. Do you find that the foreigners come up better grounded in the knowledge which would be useful to them than the English students?—No; a great deal worse; the Russians were very ignorant indeed -

3118 *Chairman*] Is there anything you wish to add to your evidence?—No.

EDWARD J REED, Esq, called, and Examined.

E. J. Reed,
Esq.

3119 *Chairman*] You are Chief Constructor of the Navy?—Yes.

3120 Have you heard the evidence which has been given by Dr Woolley?—A great part of it.

3121 The Committee would be glad to know from you what is the bearing of the instruction given in the school of naval architecture on your department, and on naval construction generally?—Taking, in the first place, the calculations involved in the work of obtaining the displacement and centre of buoyancy of a ship, from the drawings, and the preparation of the curves of displacement, tons per inch immersion, and area of mid-ship section, including the calculation of plane areas, the volumes of solids, and the determination of the centres of gravity of surfaces and solids.—to enable the students to master these, we require to train them in geometry, including conic sections and solid geometry, trigonometry, the differential and integral calculus, the calculus of finite differences, mechanics and hydrostatics, the special geometry, mechanics, and calculations of shipbuilding. Then we come, in the second place, to the calculations of statical and dynamical stability, by both the ordinary and the more exact methods; the determination of the heights of the transverse and longitudinal metacentres, and the preparations of curves, showing the locus of the metacentre, and the variations of stability at different angles of inclination, and different draughts of water, with the estimation of the

probable trim of a ship, and of the variations of trim produced by putting additional weights on board, by shifting weights, or by taking out weights—to enable him to master all these questions, it is necessary that the student should be trained in all the subjects enumerated in section 1, together with differential equations, calculus of variations, dynamics of a rigid body, treatises (such as Atwood's and Dupin's) on the statical stability of floating bodies, and those of Professor Moseley, and others, on dynamical stability; together with the special applications of these principles to ships. Then arises, thirdly, the question of the behaviour of ships, including rolling and pitching in smooth water and among waves, and the changes produced in the character of these motions by alterations in the form of a ship, or the disposition of the weights; the sailing properties, and the considerations essential to a proper arrangement of the sails, in order to secure handiness, and to have a due regard to stability under canvas, theoretical investigations of the best modes of setting the sails, &c; the investigation of the steering qualities of a ship, and the relation between the power applied to the steering apparatus and the effect produced on the ship; and other particulars necessary to a prediction of the probable qualities of ships for these purposes:—it is necessary to study the subjects enumerated in section 1, together with differential equations, dynamics of a rigid body, hydrostatics, particularly the investigations connected with the oscillations

lations of floating bodies, treatises on the practice and theory of masting, rigging, and steering ships, theories of wave-forms and motions, and their applications to the designing of ships. I should like to make an observation or two here, it is the more important to train young men thoroughly in those questions, because unless they know the laws of waves as well as the laws of the motion of a ship in still water, it is impossible for them to calculate the qualities of a ship satisfactorily. It is well known to those who have studied the subject that a ship which will roll but little in ordinary waves will, because of the very quality which induces her to roll but little in ordinary waves, roll very much in extraordinary waves, the very quality which makes a ship steady under one set of circumstances will make the same ship extremely unsteady under a different set of circumstances.

3122 By extraordinary waves you would, I presume, mean not only waves of greater length or height, but waves of less height or length than the vessel was built for?—Yes; if you take a ship in still water and set her oscillating there by inclining her, then, if she has a long period of oscillation, it indicates but little stability, and she will be reluctant to depart from the upright in ordinary short waves, but if such a ship encounters waves resembling her own in length, the effect of those waves will be to accumulate motion in the ship and to produce extreme degrees of oscillation; it sometimes happens that a ship which to-day distinguishes herself by rolling more than any other ship in the squadron, because there is a relation between her period of oscillation and that of the waves, to-morrow equally distinguishes herself by rolling but little in comparison with the other vessels of the squadron, because the waves of to-morrow have the same relation to the periods of oscillation of the other ships that the waves of yesterday had to her own.

3123 She may be comparatively steadier in a heavier sea?—Yes, it is therefore in a high degree necessary that students should understand the laws of waves as well as the laws of floating bodies. Fourthly, we come to the calculations connected with resistances and propulsion, including estimates of the horse-power required to drive ships at certain speeds, and the effect of the ship's form upon the speed, the design of engines and boilers and the calculations of their efficiency, thus necessitating an acquaintance with the theory of heat in its dynamical relations, and investigations of the principles of combustion, evaporation, draught of furnaces, &c., the consideration of the mechanical principles of the action of propellers, and their efficiency. For these purposes we require all the subjects which have gone before, or a great part of those which have gone before, together with hydrodynamics in general, and fluid resistances in particular; special treatises on the application of theories of fluid resistance to the calculation of probable horse-power and speed (those theories being numerous and very important), and the determination of the forms of ships, mechanism in its general aspects, and the construction and theory of the steam-engine; thermodynamics, and treatises on marine locomotion. Then, fifthly, we come to the preparation of the working drawings of a design for a ship, for which we require mechanical drawing, descriptive geometry, theory of naval architecture, and an acquaintance with

the subjects enumerated in sections 1 and 2. Then, sixthly, the arrangement of structural details, including the consideration of the strains to which a ship is subjected when afloat and ashore, the determination of the dimensions of the various parts, in order to safely resist these strains, the proper arrangement of the connections between the different parts of the hull, a knowledge of the systems of construction advocated by various builders, the arrangement of the details of the structure, so as to secure proper ventilation, light and general accommodation. For these purposes we require the mathematical theory of the strength of materials, and its application to ship construction, the records of experimental researches into the strengths and physical properties of the various materials used in shipbuilding, the published accounts of methods of shipbuilding, and plans for ventilation. To illustrate the importance of these things, I should like to refer here to one or two points. In the case of the "Warrior," the first iron-clad ship, the hull was very carefully designed at that time, and it was from 300 to 400 tons more in weight than all the armour, the backing, the engines, the coal, the masts and the spars, and in fact, all the other weights on board the ship. The hull, which carried these things, exceeded by 300 to 400 tons the weight of the things carried.

3124. *Chairman.*] The armour would be a portion of the weight carried?—Yes. Now, in the Invincible class of ships, although the Invincible is a much smaller class of ship than the Warrior, by dint of studying the value of each portion of the material introduced into the ship, and by getting rid of material wherever it could be done without a reduction of strength, we have brought about this result, that the hull of the Invincible weighs from 500 to 600 tons less than weights which are carried by the ship, so that by improvements of that nature you are, in the first place, able materially to reduce the size and cost of the ship in the aggregate, and at the same time very materially to increase the power, offensive and defensive, in relation to what may be called the deadweight of the structure. I may offer to the Committee one other illustration. I have lately been working out along with my assistants the question of riveting, and by careful investigation we find that the most authoritative works upon iron structures would induce, and have induced shipbuilders to employ an excessive amount both of labour and of material in putting those structures together, it has been quite a common thing to treble the rivets at the butts of certain plating in the ship, in the places where we now find that it is quite unnecessary to treble the rivets, and where you really obtain no increase of strength or value, it is simply an additional weight, involving additional labour.

3125 You give these as two instances in which theoretical investigations have come very considerably in aid of practice and experiment?—Yes; and without employing trained persons in work of this kind it is quite impossible to expect such very important improvements in construction as I have been referring to. We now come, seventhly, to the selection of materials, including a general acquaintance with the properties of various kinds of timber, and the modes of extracting and working metals, together with a knowledge of the proper modes of testing the qualities. For this we require treatises on

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timber and metallurgy. In the eighth place, we come to the proper combination of the materials used in shipbuilding in order to avoid galvanic and chemical action; the modes of sheathing ship proposed and practised, compass deviations, and corrections. For this we require physics in general, and particularly electricity, magnetism, and inorganic chemistry

3126 Now this school has been established since 1864, has it not?—Yes.

3127. Is it the case that before the establishment of that school you found a very great dearth of trained assistants?—Undoubtedly

3128 Although the school has only been established for a short time, have you already found it is to be of considerable value to the department?—We have.

3129 Will you state in what way?—In the first place, it has enabled us to increase the number of persons in our department who are competent to deal with questions of the nature which I have been describing, not mere rule of thumb draughtsmen, but persons who can conduct calculations for us which could not have been made except by a very limited number of persons who had been trained in the old school at Portsmouth, the three assistant constructors of the navy; for example, all of whom were quite competent to conduct these investigations. But apart from this we could not reinforce the designing strength of our office by calling in men from the dockyards, because there were not trained and competent men to call in. And consequently we had to do certain things, because they had been done before, although they were things the propriety or necessity of doing which we very much questioned, and which we knew were expensive.

We were placed in this position solely because we had not the proper persons to put on the necessary investigations, which are very often extremely complicated. Then there is a second point to be referred to. We employ some of those students of this school in the dockyards and private firms, where ships are being built for the Admiralty, to record the mode in which all the details of the work are done—those details which are not included in the original drawing and specification of the ship. Then in the office we calculate those matters, and in future designs we employ the best, simplest, and cheapest.

3130. Is the want of such men felt in the private yards?—I should say very much.

3131 There is no other source at present from which you can supply that want except this school?—None whatever

3132 Is it the case that in that school men are now being trained as practical shipbuilders, intending to devote themselves to shipbuilding, as a trade?—Yes, a few, that is to say, apart from the Admiralty students

3133 Do those men, generally speaking, propose to become marine engineers or shipbuilders?—Yes

3134. When you say that that want is felt in private dock-yards, do you mean that it is felt by the Government or by the owners and constructors of those yards?—I think it is most felt, by the purchasers of ships.

3135. You think it is more felt by them than by the constructors?—Yes.

3136. You would say, I suppose, that the constructors are not as yet fully aware of their deficiency with regard to theoretical instruction?—Just so. Many ships are produced which do not

correspond either to the original intentions of the designer or the original wishes of the purchaser.

3137. Now with regard to the art of naval architecture, going back, we will say, for 25 years, how would you compare that art in this country with its condition, say in France or the United States of America?—I can hardly answer that question.

3138. Would you say that 25 years ago the French and Americans were more or less advanced than we were at that time?—I am scarcely prepared to go back so far as 25 years.

3139 Then will you kindly go back to 15 years, and answer the question with reference to what is within your own knowledge?—If I were to form a judgment with reference to the Americans, for instance, from the shipbuilding literature of America, I should say that there never was a period when the condition of America was comparable to that of England, but at the same time the Americans have frequently produced vessels which were certainly superior to any vessels existing in England at the time of their production

3140. What would you say with regard to France and the French navy?—My own impression has been, that the state of naval architecture in France has indicated not so much an excess of theoretical training as a deficiency of practical training. It is most important that, whatever theoretical training should be given to students of naval architecture, their practical training should be of the best and most thorough kind.

3141. So far as you are acquainted with technical subjects, would you say, speaking generally, that the defect of the foreign system has been in the practice while our defect has been in the theory?—I think so, and I will give an illustration: there was a system of sheathing ships shown in the French Exhibition; I mean the sheathing of iron armour plates to protect them from fouling and injury; this was done by means of mastic placed upon the iron plates, and then they were coppered over; now we must take it for granted that the training which the French students of naval architecture have received in chemistry is superior to that which was received in this country up to, at all events, the establishment of the present school of naval architecture, and yet that system of seeking to protect ships from fouling by that sheathing has appeared to me all through a thoroughly unpractical thing, a thing which must entirely fail; and I infer that not so much from any chemical knowledge which I possess as from what I should call the practical application of a small amount of such knowledge; I fancy that the French have taken up a theoretical mode of protecting ships which would, no doubt, be satisfactory, but for certain practical influences the consideration of which they have neglected, but which we have been very much accustomed to regard carefully.

3142. You think thorough practical instruction would enable one to avoid mistakes of that kind?—I think we have avoided them. In this very case I strongly opposed the plan. I think the theoretical training of the French has not been sufficiently supplemented by practical experience

3143. Do you think that practical experience of foreigners in these matters is likely to increase? I should say very much so

3144. Would you say that their practical experience

perence is increasing in a greater ratio than our theoretical instruction?—In so far as the influence of this school extends, I think this subject is in a fairly satisfactory condition. I do not think that there is a prospect of the practical instruction of the French students surpassing the theoretical instruction of the English students at this time.

3145 Do you think that the influence of this school will ever be great on our mercantile marine and on our naval construction by private enterprise so long as there is no other school of the kind, except the school in London?—I have not yet seen any great evidence of this school materially affecting the shipbuilding trade in various parts of the country.

3146 If there were similar schools in the outports of England, do you think that they would be attended by a great many pupils?—I have no doubt of it. I think it would be to the interest of the employers as well as that of the students and the apprentices in the trade. I think they would both feel the value of these schools, and would avail themselves of them.

3147. Mr. Acland.] When you speak of similar schools, do you contemplate the possibility of having schools in one or two of the outports in which mathematical science would be carried to as high a pitch as you now describe?—I think there would be no great difficulty in providing for all the necessary education in four or five of the principal outports of the country.

3148 *Chairman*] In Glasgow, for instance, you would see no difficulty?—None whatever; there would be a difficulty on the Mersey, perhaps.

3149 And some on the Tyne, perhaps?—Yes.

3150 But certainly not in Glasgow?—Just so.

3151 Mr. Acland.] Do you think that in our sea ports it would be possible to carry mathematical education quite far enough for the purpose you contemplate?—Yes.

3152. *Chairman*] Will you kindly tell the Committee what was your own theoretical training?—I was trained solely in the dockyard school at Sheerness, and in the school of mathematics and naval construction at Portsmouth.

3153 How long was that ago?—Sixteen years ago.

3154 Did you work as an apprentice?—Yes; I was four years at work as an apprentice in the dockyard.

3155 In what department?—As a shipwright, receiving in the afternoon and evening of certain days school instruction.

3156. You never served an apprenticeship in any branch of engineering, did you?—No.

3157 But you had opportunities in the dockyard of becoming practically acquainted with the details of the construction of engines?—Yes, and after leaving the Government service 16 years ago I was employed for many years in writing on scientific questions, and made it my business to visit all kinds of shipbuilding and engineering yards.

3158 But with regard to actual manual labour, do you consider it important that every professional shipbuilder should undergo a certain amount of such labour either as a shipbuilder or as a mechanical engineer?—I do not think it is necessary that every one should do that, but I think that wherever a school is established all

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the students should be made to go through a course of practical work, it is only a small percentage of them that can possibly rise with a position where actual manual work or the supervision of actual manual work would not be essential to them.

3159 You would consider it necessary that all those who are to hold the position of superintendents or managers, should have gone through some amount of manual work?—Yes.

3160. Is there any limit of age above which you would consider it undesirable that such persons should go to manual work?—My own impression is, that the sooner they begin practical work the better, for after they have gone through a course of theoretical study, there is a very great reluctance on the part of young gentlemen to take up the tools, and go through the practical drudgery.

3161. You would consider it a good plan to be followed in naval schools, that from the age of 15 to 18 the students should be at school during a portion of the day, and at work during another portion of the day?—I think that is an excellent plan.

3162 And that plan is followed in our naval schools?—Yes.

3163 Mr. Acland.] You think that would be consistent with a thorough course of mathematical study?—Perfectly, and I also think that it has a tendency to keep the pupils in health.

3164 But that almost implies, does it not, that your pupils must separate themselves from the ordinary middle schools of the country, and commence a special training at 15 years of age?—It does so.

3165. How would that influence the nation at large in shutting out a large portion of the middle class from the trade of shipbuilding?—I do not think it would be possible to train in Manchester or Birmingham a youth for shipbuilding, at least while he remained in Manchester or Birmingham. I think we must look for the development of the shipbuilding art primarily in the shipbuilding ports.

3166. *Chairman*] Would you consider shipbuilding as altogether special and apart with reference to this question, or would you consider that, with respect to ordinary engineering, it would be necessary also for a boy to go to his work as early as 15 or 16 years of age?—There is no necessary connection between the construction of engines and the works being situated at an out port. We have Messrs Penn's at Blackheath, and Messrs Maudslay's on the upper Thames, just across the water.

3167 But, with respect to the age at which a boy must leave school in order to become an engineer, how long do you think he may remain at school without losing the opportunity of becoming sufficiently skilled in mere workmanship, assuming that he is to be a manager or a master?—I think, undoubtedly, he ought to begin between 14 and 17 years of age.

3168. Mr. Acland.] You would say that a young man stopping at a first-class scientific school till he was 18 years of age, ran great risk of damaging his prospects as a successful nautical engineer?—Yes, I should, unless he had local opportunities of making himself acquainted with the processes of the workshop.

3169. Is your opinion on that subject, given generally with regard to all classes of manufacture and engineering work as far as they come under

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your observation, or do you give that opinion only with regard to shipbuilding?—I should prefer to confine the opinion to shipbuilding and marine engineering

3170 In your intercourse with naval officers, which has no doubt been very considerable, have you found a great difficulty arising from the want of accurate scientific training in the minds of naval officers, leading them to speak about the form of ships rather by a kind of instinct and guess work than by the application of any accurate knowledge?—I have not the slightest hesitation in saying that I have found that very extensively to be the case

3171 Do you think it a very important element of education not only for the Royal navy, but for the commercial marine, that the commanders of ships should have such accurate knowledge as that to which my question points?—I think, undoubtedly, they should have a certain amount of scientific training

3172. Scientific training with a direct bearing on naval construction?—Yes, and upon the performances of ships under steam and under canvas

3173. *Chairman.*] You are applying that to the mercantile marine just as much as to the navy?—Quite

3174 *Mr Bagnall.*] Are these naval schools intended exclusively for the benefit of young men in the dockyards, or are they available for young men in any part of the country?—The dockyard schools are exclusively confined to dockyard apprentices and students.

3175. The instruction given is not generally available?—No, but the instruction in the school of naval architecture is generally available.

3176 *Chairman.*] Have private pupils ever been admitted into the dockyard schools, I mean pupils who evidently did not intend to devote themselves to the Government service?—No, not in any case

3177 *Mr Bagnall.*] Is there any restraint with respect to their leaving the Government

3178. *Mr. Acland.*] With regard to the possibility of establishing local schools, such as we have been speaking of, do you think there is any great objection to the admission of pupils for private shipbuilding into the public naval school; would there not be great difficulty in having two sets of schools?—The private shipbuilding which goes on in those ports where dockyard schools exist is very limited in amount. With regard to the restraint in relation to the Government service, I should like to add, that the answer I gave does not apply to the pupils at South Kensington; they are now placed under an obligation of the kind, though my advice was given the contrary way, because I believe that an obligation of that kind must usually prove inoperative. I have generally found that those trained people who get enticed from the Government service are people that the Government service can spare. But this is not always the case.

3179. *Chairman.*] That restriction only applies, I suppose, in the case of those who pay no fees, and who in fact receive some remuneration?—Yes, there have been two or three cases in which pupils at South Kensington have left the service after receiving their training at the Government expense, but one of them married a wife with money, and it was evidently useless to try and keep him against his will and hers, another had some inducement in connection with his father to leave, and he was not particularly valuable, or likely to prove so. I thought it undesirable myself to attempt to place these young fellows under a bond, although I know the question is quite open to another view

3180 By paying full fees, students who are not intended for the Government service can attend the school?—Yes.

3181. *Mr. Acland.*] Do you think there would be any great objection to admitting such pupils into dockyard schools, they paying their own expenses?—I should think not; I have not thought much upon the question, but I fancy it might easily be arranged.

Monday, 25th May 1868.

MEMBERS PRESENT

Mr Acland
Mr. Akroyd.
Mr. Bagnall
Mr. Bazley.
Lord Frederick Cavendish.
Mr. Dixon.
Mr. Graves

Mr Gregory.
Sir Charles Lanyon
Mr M'Lagan.
Mr. Potter
Mr Read.
Mr Samuelson

BERNHARD SAMUELSON, Esq., IN THE CHAIR

JOHN WILLIAM CUNNINGHAM, Esq., and Dr WILLIAM ALLEN MILLER, called in, and Examined.

3182. *Chairman (to Mr. Cunningham)*] You are Secretary of King's College, London, I believe?—I am

3183. How long have you held that office?—Since the year 1845

3184. Was that the date of the creation of the college?—No; it was founded in 1824.

3185. But I suppose you are acquainted with the history and statistics of the college generally from a period preceding your appointment?—Yes, I think so

3186. What was the origin of the foundation of that college?—I suppose it was, first of all, set on foot rather in opposition to University College.

3187. At all events, it was set on foot as a college in connection with the Church of England?—In connection with the Church of England

3188. Did it receive any aid from the Government?—It only received from Government a piece of land next to Somerset House

3189. Was that land the property of the Government at the time?—It was the property of the Crown

3190. Was it valuable?—Not that I am aware of; we held it for 1,000 years at a rent of 1 l a-year.

3191. You hold it at a nominal rent?—We hold it at a nominal rent.

3192. Have you any conception of what the value of that land was at the time it was given for the purposes of King's College?—It was of no value whatever, it was utterly waste

3193. But, I suppose, it would be of very considerable value now?—I should say so

3194. Can you form any estimate of its present value?—No, I have no idea.

3195. What is the area?—383 feet in length by 203 feet in width, when they gave us that piece of land we were forced to complete the frontage of Somerset House according to the plan.

3196. That is to say, in erecting your building, you had to conform to the design of Somerset House?—Yes; the wing on that side was incomplete, and we had to complete the wing by conforming our building to the plan for that wing.

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3197. Which involved some cost to you, which otherwise would not have been incurred?

—Yes

3198. Do you know what was the cost of the erection of the new building?—No; but I know what the buildings now stand in, they stand us in about 130,000 l.

3199. That is to say, 130 000 l have been expended on the building?—£ 130,000 have been expended on the buildings, the laboratories, museums, and so on, up to this moment.

3200. You include all the fittings?—Yes

3201. Can you form any estimate of what proportion of that may be attributed to the fittings of the workshop?—A very small portion

3202. What are the fees for students at King's College in the department of the applied sciences?—The fee for students in the department of the applied sciences is now 42 l a year.

3203. Would it be possible to separate the cost of that portion of the building required for the teaching of the applied sciences from the total value?—No, I think not, because our departments are so mixed up, for instance, we have a large number of men learning mathematics, some of whom belong to the applied science department, and some to other departments

3204. The only way to get out an approximation to the cost of the buildings attributable to the applied sciences would be by dividing the total cost of the buildings by the total number of students, and then multiplying the cost per head by the number of students in the applied sciences?—That would be an inadequate way of doing it, because, a large portion of King's College consists of the younger boys in the school; the expenses connected with the school are very much smaller than those connected with the senior students in the college, and some departments, again, are much more expensive than others, the medical department costs perhaps, three or four times as much as the others

3205. What is the total number of students in every department, excluding the school and the evening classes?—There are about 500

3206. Five hundred in all the departments?—Five hundred in all the departments of the college.

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and Dr
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* 3207. What number have you in your evening classes?—About 650.

3208. And how many in your school?—About 375.

3209. What is the number of students of the applied sciences?—About 100.

3210. Is there any special preparation for that course in the school?—Yes, the school is divided into two parts, one for the public school system of mathematics, classics, and so on, and the other, for English, mathematics, French, drawing, and subjects which are distinctly in preparation for the study of the applied sciences.

3211. How many boys have you in the latter department?—About 175; they are not all working for the applied sciences, but they are taking that class of education which would fit them for it.

3212. Mr Gregory.] You may call that the non-classical department?—Yes, we call it the modern division.

3213. Chairman.] Then, in addition to the pupils from your own school, I suppose you receive pupils from other schools into the college?—Yes.

3214. And from private tuition?—Yes.

3215. Is there an entrance examination for the college?—For the applied sciences it is the first two books of Euclid, arithmetic, and algebra, as far as to simple equations.

3216. Is there any examination in natural science?—No.

3217. None whatever?—No, none, that is the only examination.

3218. There is no examination in English?—No examination in English.

3219. Is any record kept of the order of merit in which the pupils stand at their entrance examination?—No, I think not.

3220. Then you have no official means of comparing the acquirements of the pupils from the school with those of pupils coming up from extraneous establishments?—I should think the professor who holds the examination would be able to say how they stood, but we have no official record of it.

3221. What are the fees in the school?—£. 24 a year, including stationery, books, and everything.

3222. Are the applied sciences taught in the school?—Science is to a certain extent taught; every boy in the department that I speak of now has two or three lectures a week in science.

3223. What are the subjects?—The elementary parts of chemistry, and the earlier parts of physics.

3224. At what age do your boys habitually leave that school?—They enter the school at about 11 years of age, and leave it at about 16 years of age.

3225. Have you any classical instruction in that department?—A small portion of Latin only.

3226. Is that obligatory?—Yes.

3227. Is it simply grammatical?—Yes, grammatical, taking some easy book of Latin, Virgil perhaps.

3228. And the cost of instruction is 24 l even for the younger boys?—Yes, for all the boys.

3229. I believe that some of the professors connected with the college have boarding-houses?—Yes, some few.

3230. Is there a large proportion of boarders in the school and in the college?—No, there is

only a small number of boarders either in the school or in the college.

3231. So that, in fact, most of the boys coming up for instruction there board with their parents or friends?—Yes, in town and around London.

3232. Do you know whether many come up from the country who board with their friends?—No, I think not, those who come from the country either reside within the walls of the place itself or with the professors, those, for example, who come up from places like Birmingham and Manchester.

3233. They are in a hostel in connection with the college?—Yes.

3234. How is that conducted?—There are 24 sets of rooms in the college; they are under the principal's care, and all dine in hall together.

3235. Are they allowed to remain out at night as they please?—No, they are obliged to be in by 10 o'clock, except they are out on leave.

3236. What is the course of instruction in the college in the department of the applied sciences?—It includes, mathematics, natural philosophy, chemistry, geology, mineralogy, the arts of construction, and the manufacturing arts, drawing, surveying, and the workshop.

3237. Is any drawing taught in the school?—Yes, to all the boys in the modern department.

3238. In the modern department?—Yes, landscape, freehand, model and architectural to the whole of them, and geometrical drawing to those who are going to be architects or engineers, that being taught in addition to the other.

3239. Is machine drawing taught in the school?—Yes, machine drawing and model drawing.

3240. Are any specimens of drawing presented before matriculation in the college?—No.

3241. Can you state generally to what professions the majority of the pupils in the applied science department of the college propose to devote themselves?—Either to architecture or engineering, engineering, rather than architecture.

3242. But chemistry is extensively taught, is it not?—Yes.

3243. Then with regard to the pupils who are studying chemistry; is that study only subsidiary to their education as architects and engineers, or do many of those propose to devote themselves to some branch of chemical manufacture?—A large number of those are sons of manufacturers in the Midland Counties, they are to go into their father's counting-houses; they come up to learn these very subjects that their fathers want them to take up afterwards; they have special instruction in chemistry if they are going into manufacturing chemistry, eight or 10 students in the laboratory are studying with the express view of afterwards entering manufacturing works.

3244. To Dr Miller.] And you recommend that they should also follow the courses in mathematics and in applied mechanics or mechanical drawing?—Yes, they very often come to myself, and I advise them to take certain courses, according to the object in view.

3245. Young men who are about to become manufacturing chemists are recommended by you to attend the courses in mathematics, geometrical and mechanical drawing, and the allied subjects?—That depends upon circumstances. If, for example, a young man says, "I have no taste for drawing," of course I do not recommend him to spend his time over it, but a large number of the

the students come with the intention of devoting their principal attention to experimental and analytical chemistry, and then I advise them to give a certain portion of their time to other studies, particularly mathematics and modern languages

3246 Do you advise them to avail themselves of the workshop?—That depends entirely on the opportunities which they may have had at home. Many of them are engaged in the pursuit of some particular kind of work at home, so that they have an opportunity of seeing all the operations carried on in their own particular business. Those who come up for chemical studies have usually not time enough for practice in the workshop, but still many of them do go into it.

3247 What is the exact nature of the workshop?—(Mr *Cunningham*) There is a large building set apart for it, where there are different machines, lathes, and so on, and in that building the young men themselves work in iron and wood (Dr *Miller*.) Beginning with carpentering, and gradually going up to iron and brass-work.

3248. *Chairman* (to Mr *Cunningham*)] Are the lathes driven by a steam-engine?—They are driven by a steam-engine. We found that it was rather too hard work for the young men to drive them themselves

3249 They were originally foot lathes?—Yes.

3250. You have now applied power to them?—We have now applied power to them

3251. I suppose the students learn the use of all the ordinary hand tools employed by carpenters, smiths, and fitters?—Yes.

3252 What portion of the week is devoted to workshop instruction?—They are obliged to be there three or four hours in each week, the work is over in the other classes at four o'clock in the day, and those who like can afterwards go to the workshop from four o'clock to six, if they please.

3253. Under whose superintendence is the workshop instruction placed?—Under the superintendence of the workshop master, Mr *Timme*.

3254. Was he originally a working man, or a man who had received scientific instruction?—He was a working man, he was one of the foremen at Messrs. *Holtzapfels*'.

3255 But I suppose he is a man of good scientific acquirements?—Yes, he is a man of good scientific information

3256. And do you find that the young men seem to like this workshop course?—They like it very much indeed

3257 They take great interest in it, do they?—Very great interest indeed. Of course some take more interest than others, and some we have actually to hinder from working too much. Again, others have rather to be compelled to go there. Some like the theory of their education better, and some like the practice better

3258 Have you been able to form any estimate of the value of the instruction given in the workshop during the subsequent careers of these young men?—I do not know that I am able to do that; but we find our young men are greatly valued and sought after for engineering appointments.

3259 You do not at all consider that the instruction you give them in the workshop would dispense with a practical apprenticeship in some commercial works?—No.

3260 You do not contemplate that for a mo-

ment, I suppose?—No, certainly not. We^b rather contemplate that a man should be able to see some of the theory which he has learnt in the lecture-room put in practice in the workshop. For instance, in the arts of construction class, the professor would teach the student how to make a roof, and the student would then go into the workshop and see a roof made, or actually make it himself on a small scale

3261 And you think that greatly facilitates the theoretical instruction?—Yes.

3262. *Chairman* (to Dr *Miller*)] Is that your opinion also?—I have no doubt of it

3263 Do you think the courses are made of greater value by the practical instruction in the workshop?—Yes, it gives them the details of the subject, and interests them very much

3264. *Chairman* (to Mr *Cunningham*)] And you state that these young men are highly appreciated by persons and firms to whom they become pupils?—Yes

3265 And that you say from your own knowledge?—That I say from my own knowledge

3266 You speak from your contact with the pupils after they have left the college?—From contact with the pupils, and also from contact with their employers, we very often hear of them afterwards

3267. Is it found that as workmen those young men save much time in their apprenticeship, that they become good workmen more rapidly than a raw boy taken from school would become one?—Yes, of course, that is so.

3268 With regard to the evening classes, what sort of people are they who usually attend those?—To a very large extent clerks, either clerks in public offices, or clerks in engineers' offices, young men of from 17 up to 30, who want to get on and make themselves more useful in their every day work.

3269. You are still speaking of the evening classes in the applied sciences?—Not exactly of them only, I am speaking of the whole of the evening classes

3270 But, distinguishing the evening classes in applied science from the other evening classes, should you still say the same thing with regard to the class of persons who attend them?—They are young men from engineers' and architects' offices, and so forth, who want to improve themselves in their own profession

3271 What are the subjects which are taught in the evening classes, so far as the applied sciences are concerned?—Chemistry, mechanics, physics, mineralogy, practical chemistry, and mathematics

3272 In the evening instruction in chemistry, will Dr *Miller* state what the students learn?—They learn the elementary portions of the science; perhaps there may be forty lectures in the course of the entire year, and they have besides that, if they choose, practical instruction in the laboratory; they usually work for an hour and a half or two hours in the evening

3273. I suppose you do not find it possible to superintend the laboratory practice both in the day and in the evening without some trained assistant?—I do not take any part in the evening lectures, Professor *Bloxam* gives lectures in the evening, he is professor of practical chemistry in the department, and besides that, he has an assistant.

3274. Mr. *Gregory*] Have you a different staff for the evening classes?—Yes

J W. Cunningham, Esq., and Dr. W. A. Miller.
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3275. *Chairman*] Does Professor Bloxam also superintend the laboratory during the day?—Not much during the winter, because he is occupied at Woolwich, but for three days a week during the summer, he conducts the practical class in a distinct laboratory; a class which lasts for two hours.

3276. And, in addition, he gives evening instruction with the help of competent assistants?—Yes

3277. Are the evening classes in theoretical chemistry given by yourself?—No, those are all given by Mr Bloxam, the only part I take is the day lectures I have the students with me in the laboratory during the day.

3278. I suppose the occupation is so continuous during the day, that the strain would be too great to permit you to give instruction in the evening also?—Yes, I am there for six hours during the day, every day from 10 to four

3279. What is the entire number of the students in all the departments under your instruction, including the medical?—From year to year, the number attending my lectures on chemistry is about 160

3280. The average is about 150 or 160?—Yes

3281. In a smaller institution, say if there were only 20 or 30 students, or perhaps even 40, you would not consider it impossible for the professor to give instructions during the day, and to conduct also some classes in the evening, perhaps?—I do not think that would make much difference, it is not more fatiguing lecturing to a large class than to a small one, and if you have six or eight students in the laboratory during the day, that pretty well occupies the whole energy of a man, so that I think he ought not to be expected to do anything more in the evening

3282. You do not think then, that that would be practicable?—I myself would not undertake it.

3283. What is the extent of your laboratory?—There is more than one laboratory, the principal laboratory is about 30 feet by 40 feet.

3284. How many pupils work in the laboratory?—Of those pupils who work continuously in the laboratory, there are generally from eight to 10. Those who have instruction in a regular course of practical chemistry, perhaps 40 or 50 in the medical department. In the department of applied science, the third year students come in as a part of the course, but they do not take practical chemistry in the earlier part of their studies. There are never so many in the third year as in the first two years, so that there may be perhaps 12 to 14 students in the applied sciences in the laboratory.

3285. But I suppose the eight or ten pupils who work continuously in the laboratory also receive class instruction, or instruction by lectures?—They usually attend the lectures.

3286. Have you any examination for a diploma in King's College?—We award what are called certificates of honour, and certificates of approval, which are given according to the manner in which a man has acquitted himself; those certificates are given by examinations in each class, each professor reporting according to the answers he receives from the students. Then a general meeting takes place of the professors, in which it is considered which of the students may be held deserving of such a mark of approbation.

3287. But is there no intermediate examination?—Yes, there are continual examinations;

there is an examination at the end of each term always. In my class I hold frequent examinations; I hold a written examination twice, perhaps, in a term, and occasionally a *viva voce* examination

3288. Are these examinations taken into account in the certificates which are given, or the giving of the certificate founded only on the final examination?—It is generally speaking given on the whole of the examinations still in the giving of the prizes the term examination is the one which decides the question whether the student shall get the prize, or not. There are what we call special certificates for those who, by their diligence during the course of study, are shown to have been really working.

3289. Is there any literary examination in connection with your diplomas?—Not in the department of applied science.

3290. The examination is exclusively in science—Yes; in applied science.

3291. Do many of your pupils, after they have left King's College, proceed either to Cambridge or to Oxford, or come up for examination at the London University?—Not those who have gone through the scientific course; a good many from the department of general literature go up to Cambridge and take honours.

3292. But not from your applied science classes?—No; almost all of them, when they enter, have a definite object in view.

3293. From your applied science department in fact, very few young men go up either for examination at the London University, or to pursue their studies at either of the two great universities?—Just so, several students from the evening classes go up for the matriculation examination at the University of London.

3294. Does the instruction in your evening classes carry them sufficiently far to enable them to pass that matriculation examination with moderate ease?—They generally do very well in that examination.

3295. As compared with young men who come up from ordinary schools?—Yes, our students do very well, there are a large number who enter themselves as coming up from private study, and those are usually at a greater disadvantage than those who have had the opportunity of regular study in a college.

3296. Taking the young men who attend the evening classes, do they frequently receive any instruction from tutors, or private instruction in addition, before they go up for the matriculation examination?—I do not know (Mr. Cunningham) I should say not.

3297. I suppose they are generally of a class who would be occupied the whole of the day?—They are generally hard at work throughout the day. There are about 60 of these evening students in the applied sciences.

3298. Have you made any estimate at all of the cost of erecting a college for instruction in applied science alone, and the cost of conducting such a college?—I could not venture to offer any estimate. The cost of conducting such a college would, of course, depend on whether it was so placed that there were professors to be had who were occupied in other duties.

3299. In fact, whether the professors had to derive their whole livelihood from giving instruction in that college?—Yes.

3300. Have you had any experience at all in the examinations of the department of science and art?—No.

3301. You

3301. You are not aware whether many of the students in King's College have been previously instructed at those schools?—I have never heard of any of them going up to the examinations of the Department of Science and Art, except some few evening class men in drawing

3302 But my question was rather the converse; are you aware whether many of your students have received their preliminary instruction in classes in connection with the Science and Art Department?—No, I think not

3303 What is the instruction given in drawing, in the Applied Science Department?—The instruction is for four days a week for three hours, namely, from one to four.

3304 What is the nature of the drawing taught there?—It is geometrical drawing, and also engineering and architectural drawing

3305 Is there any machine drawing?—Yes

3306 Drawing in relation to buildings and constructions?—Yes, plans of buildings, and also surveying and plotting

3307 Is that in addition to free hand drawing?—That is optional.

3308 In the school the pupils all have free hand drawing as well?—Yes

3309. Have you any classes for mechanical construction?—We have lectures in the arts of construction

3310 But what does that include?—It includes wooden construction of all kinds, the roofs of buildings generally, architectural specifications, earthwork, and the making of walls

3311. In preparation for the office of a civil engineer or architect?—Yes.

3312 Have you any courses of machine construction, hydraulic works, for instance?—(Dr. Miller.) There is instruction given upon the theoretical parts of that.

3313. Is that carried far?—I am not myself able to speak to that, perhaps the syllabus of the college will give you a better idea than any answer of mine could give (Mr. Cunningham) Part of the class in applied science are taken occasionally to some large workshop, or large manufactory, and there the machines are explained to them, and the different parts pointed out by the professor

3314 Is that confined to London and the neighbourhood?—Yes

3315. With regard to chemical technology, do you give instruction in chemical processes?—(Dr. Miller) Yes, that is a portion of the course of instruction that is given, it is a separate course for the students in applied science.

3316 Do you attach any great value to that course?—It is a very important part indeed. That is to say, the general principles, I do not go into details.

3317 Take, for instance, the subject of the manufacture of soda-ash, would you teach historically and theoretically the processes employed in that manufacture, or in any other?—Yes, as far as I can do it, I illustrate principles by examples in those parts of the subject which are likely to prove interesting, or valuable in business. I can only illustrate general principles, of course, but, in choosing my illustrations I go upon the principle of selecting what will be, probably, useful to the pupils in their after career.

3318 But all that is merely by way of illustration?—Certainly.

3319. You do not, for instance, give a technical course on sugar refining?—By no means, I give 0.72.

principles of chemistry, and illustrate them by their applications to the arts.

3320. Lord *Frederick Cavendish*] What is the age at which students enter the college, and the age at which they leave it?—(Mr. Cunningham.) They enter between 16 and 17, and the greater number stay about two years Three years is the whole course, but it is only a small portion who stay so long

3321 Perhaps they cannot afford to attend the whole course?—I do not know that, but they are taken off into employments of one kind or another At this time we have, out of 100 men, only 16 third-year men

3322 *Chairman*] Do your second-year men take either of the certificates, which Dr. Miller has spoken of, in that year?—At the end of their second year they can do so.

3323 Lord *Frederick Cavendish*] Not at the end of the first year?—Not at the end of the first year

3324 Does the small number of the boarders arise from the accommodation being limited?—Yes

3325 If you had more room, you think you could fill it?—Yes.

3326 Are your numbers increasing?—Since I went to King's College, 23 years ago, the Applied Science Department has largely increased

3327 And does it still show a tendency to increase?—I do not know that it does just now, I think that engineering is rather looking down, for the last three terms we have had about 88 matriculated students

3328 Is it the same also in the chemical department?—(Dr. Miller) There are a good many occasional students in that department, there are 12 or 14 this term

3329 Since you undertook that department, it has increased largely, has it?—It has been increasing steadily for some years, I think

3330 *Chairman*.] You think there is an increased appreciation of the value of theoretical instruction among chemical manufacturers?—I think there is not a doubt about it.

3331 Mr. *Bagnall*] How many students could you accommodate in the Applied Science Department?—(Mr. Cunningham.) We should be sorry to see any large increase with our present accommodation, we should have to add to our space before we could receive them

3332 Should you have a sufficient professional staff?—Quite, some of our rooms are rather confined, the drawing rooms, for instance

3333. Mr. *Gregory*] Can you state a little more precisely of what class your evening students are usually composed?—They are almost all of them clerks, or young men employed in houses of business, or as assistants to engineers

3334 Do the students in the modern department remain a longer or a shorter time, as a general rule, than students in the classical department?—I think a longer time, and almost all of them have a certain object in view

3335 They generally come in with the view of obtaining a special education for some particular object?—For some particular object.

3336 Do you attach very much importance, in an institution such as yours, to there being a workshop, I mean importance with reference to technical instruction?—Yes, most decidedly.

3337 Do you imagine that any of your pupils are likely to compete for Mr. Whitworth's scholarship?—I think so, several of them.

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J W
Cunningham,
Esq., and Dr
W. A. Miller.
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25 May
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3338. I

J. W. Cunningham, Esq., and Dr. W. A. Miller.

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3338 I presume the instruction they would get in your workshop would give them very considerable advantages in that competition?—Most undoubtedly.

3339. *Mr. Bazley.*] To what pursuits in life are your young men mostly drafted off?—A considerable number are drafted off to be engineers, some to be architects, and a large number go into their fathers' establishments in the centre of England.

3340 Do many of your students become builders?—No, they become iron masters, or manufacturers of different kinds, most of our applied science students are the sons of very wealthy men, and they come in to get a training specially for their own future career.

3341 You do not touch mineralogy, do you?—Yes, it is one of our subjects, mineralogy and geology being both included.

3342. When you say "wealthy men," you mean wealthy men engaged in manufactures, or mining, and so forth?—Yes.

3343 *Mr. Bazley*] And the young men, you say, go to the mining or manufacturing establishments of their parents?—Yes, in large numbers.

3344 *Mr. Dixon.*] What are the fees of the night students?—One pound eleven shillings and sixpence for two hours a week, for about 20 weeks, that is the fee for attendance during the winter session for each separate class.

3345 Do the fees charged in those respective schools cover the entire cost?—Yes.

3346 From what sources did you get the 130,000*l* that King's College has cost?—One-half was raised by shares, and one half by donations from private friends.

3347 *Chairman*] The only grant from the Government was the land?—The land.

3348. *Mr. Dixon*] Is the college managed by a council?—Yes.

3349. How is the council elected?—By the shareholders and the donors.

3350 How are the students admitted to the different departments?—By the principal; they apply, in the first instance, to him, and all those who are fitted for it are allowed to come in.

3351 Is there any religious test applied to the students on entering?—Every student is obliged to conform to our laws and rules; we have a short service every morning, upon the opening of the school at 10 o'clock, and we have a divinity lecture once a week, but if any student were to go to the principal and say that he did not wish to attend the religious teaching because he did not approve of it, he would be let off from it. As a rule, however, all the students attend.

3352. Are applicants sometimes refused admittance to your school?—Very seldom; if any young man came up knowing next to nothing, he would be turned back, but that does not often happen.

3353. So that, practically, all who apply are admitted?—Yes, in practice all who apply are admitted.

3354 *Mr. Akroyd*] How is the expense of the workshop borne?—Out of the fees; out of that 42*l* a year.

3355. Have you any idea what the average expense would be, including the materials?—We have a head man in the workshop, who has a salary of 100*l* a year, and 1*l* from each of the young men out of the fees, so that he gets about 200*l* a year; and we have two men there,

one for the ironwork and one for the woodwork, and they get about 30*s*. a week each.

3356 You have a small steam-engine, have you not?—That does not cost much.

3357 So that the expense of the workshop is provided for by the extra fees?—It is all borne by the fees.

3358. *Chairman*] Included in the fees?—Included in the fees.

3359. Is the laboratory instruction also covered by the fees?—Yes, of the practical instruction; the practical instruction in the applied sciences is that which *Dr. Miller* speaks of as given to those who come three times a week in their third year.

3360. But not that of the special students?—No.

3361 What is the average cost of that?—They pay 10*l* 10*s* for three months, 25 guineas for nine months, which is the entire session; and then there is a certain expense for materials, which depends entirely on the nature of the study.

3362 Do the young men also pay fees for instruction in the applied science course?—No, not at the same time.

3363. But they can attend those classes, and pay specially for them?—Yes.

3364 *Mr. Gregory*] Does expertness in the workshop form part of the test of merit, so that it is an ingredient in the getting of that certificate which you spoke of?—Yes (*Dr. Miller*.) There are certain practical subjects in which the processes are given; the making of models is not necessary, but they are required to do the processes in the workshops for themselves.

3365. Would that form an ingredient in the ultimate examination?—No.

3366 That is to say, a boy might leave you with a certificate of approval, and yet have no manual expertness whatever?—Everyone goes through the workshop as a part of his course, if he enters this department, so that he has always a certain amount of familiarity with the workshop processes, though that varies. Of course, he would gain no certificate if he did not do his duty properly in every class to which such certificate refers.

3367. *Mr. Akroyd*] What description of work is done in the workshop?—In the first year there is some instruction in wood-turning, in the second year it is iron and brass, with models of steam-engines.

3368. Do you mean that the articles which they make are chiefly models?—They make almost anything they please; we have a large collection which is always brought up at the summer distribution of prizes.

3369. Do the students take away the articles?—Yes; the fee of 42*l* would not cover the cost of the wood and iron, and the tools, that is extra. We do not allow them to go beyond 4*l* expense without the permission of the parent or guardian.

3370. And provided for in what way?—It is provided for by themselves; they pay for it.

3371. They find their own materials, do they?—No, we find them, and they pay for them.

3372. *Chairman.*] Do they pay for files and chisels?—Yes, they pay for all their tools.

3373. *Mr. Akroyd.*] Is this workshop available for the evening classes?—No, it is only for the day classes.

3374. Do you think there would be any difficulty in making it available for the evening classes?

classes?—No, I think not, it is available for boys also in the modern department of the school, who are to be engineers.

3375. Mr. *Gregory*] Do any of the boys in the classical department ever go into the workshop?—No, I think not

3376 Mr. *Akroyd*] Going back to the workshop in the day, what is the regular course of progression there?—“Students of the first year, on joining the department, are made acquainted with the different tools, and their practical application to the purposes of carpenters’ and joiners’ work, by going through the processes of preparing the wood, setting out and forming the various joints used in constructions of wood, after which they are employed in making models, in which the preceding joints are combined, so as to form trusses for roofs, bridges, girders, and other framings required for buildings and other purposes. Second year students are then enabled to proceed with the construction of models of various sorts in illustration of the different apparatus used in practical mechanics, manufactures, and philosophical experiments, which involve the necessity of turning, for which purpose they are instructed in the use of the tools for turning soft wood, hard wood, ivory, and other substances, and also in the mode of preparing and fixing the work in the lathe, the formation of cycloidal, epicycloidal, and involute teeth, for wheels, pinions, racks, &c, the method of working in sheet metals, and soldering. Third year students commence metal work, the operations of which consist of the various processes of chipping, filing, fitting, turning, boring, screw cutting, and planing, the construction of foundry patterns in wood or metal, core boxes, moulding, and casting in iron and brass, and forging.”

3377. Mr. *Gregory*] You stated that a pupil could go out on a certificate of approval after two years of study?—(Mr. *Cunningham*) Yes.

3378. Therefore the two-year men do not get into the highest branch of the workshop?—Not unless they are unusually advanced

3379. Only very advanced students of the second year go in for the third year subjects?—(Dr. *Miller*) With special permission, on payment of certain fees

3380. *Chairman*.] You have given what is the workshop instruction of the college; will you now state what is the workshop instruction for pupils of the school, is there any regular course for them?—I do not know what the regular course is, but all boys, in the modern department of the school, who want it are allowed to be in the workshop on Wednesdays and Saturday afternoons, paying a small extra fee for it.

3381. It is not obligatory?—It is not obligatory, it is only if they desire it.

3382. How many of the boys do that?—About 25 boys every term.

3383. That is 25 out of the 175?—Yes, it is only on their half-holidays.

3384. It does not form part of the regular school instruction, but it is optional, and they lose their half-holidays?—Yes.

3385. And they have to pay for it?—Yes, they have to pay 1*l.* 1*s.* a term

3386 Mr. *Akroyd*.] It appears that the students in your evening classes are more numerous than those either in the school or in the college. I presume the evening students are chiefly persons who are engaged during the day in some other pursuits?—Yes.

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3387. Are they chiefly of the middle class?—Yes; they are generally the same kind of young men whom you will find engaged as clerks in Somerset House.

3388. Are there any artisans among them?—I think not. We have one or two sappers and miners.

3389. Do you give any lectures which are open to the public?—No, if anybody wants to be there, we are always glad to see him once or twice

3390 Mr. *Acland*] I understand, that in your model workshop nothing is made for sale?—No

3391. In fact, there is nothing to be learnt in that workshop in the nature of real designs, it is all in the nature of models for teaching purposes?—It is all done by young men who are really and practically making the things which they have learnt to make in the lectures

3392. Is it not rather making models in illustration of the lectures they have been listening to than making the actual things which the students will have to make in after life?—(Dr. *Miller*) Of course it varies with the taste of the young men themselves, one of the commonest things which they make is a steam-engine

3393. But would they make a steam-engine such as might have to do actual work?—They would make a working model, but still not on such a scale as would be used for any considerable purpose

3394. *Chairman*.] Have they ever made a steam-engine of more than two-horse power?—No, but they go as far as that.

3395 Mr. *Acland*] We may take it that your workshop is purely an appendage to the teaching department and for teaching purposes?—Yes.

3396. But still I understand you to be of opinion, that the practical results on the teaching department are very satisfactory?—Very. (Mr. *Cunningham*) Yes

3397. Therefore, if an engineer, 20 years ago, expressed the opinion which he did express to me, that though he intended his son to go to King’s College as the best place for his education, yet that had no reference to the workshop, at which he laughed as an absurdity, you would be of opinion that matters are different from what they were at that time, supposing that that opinion was sound?—(Dr. *Miller*) I do not believe that anyone would now laugh at the instruction given in the workshop).

3398. *Chairman*] Would you think that the opinion then expressed was unsound?—Of course that engineer has his own way of thinking

3399. Mr. *Acland*.] But even if that opinion was sound 20 years ago, then you would say that probably there had been since some alteration in the system of the workshop which made the system more suitable for teaching purposes?—It teaches thoroughly well what it professes to teach.

3400. Has there been any alteration of system within the last 20 years, either in the superintendence, or the management of the workshop?—I think it has been made a little more systematic, but I do not know of any material difference; since Mr. Timme has been there, the whole thing has been very satisfactorily managed.

3401. I think that the attention of the professors, and the whole of the staff, at King’s College, has lately been directed to the systematic arrangement of scientific teaching?—Yes.

3402. Will you kindly give the Committee your

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your opinion upon this question—are there any subjects which are of general application to the wants of England at the present time, as a basis for technical education, and if so will you specify them?—I think there are three general subjects of a scientific character, which I may mention in answer to your question, those are mathematics up to a certain point, physics, and chemistry (the elementary branches of the two latter).

3403 Will you kindly tell the Committee how far you would carry mathematics as almost indispensable to technical education?—I should say ordinary geometry and Euclid, or some equivalent, up to the usual point, and trigonometry, though I do not know that that would be absolutely necessary

3404 You would have mechanics taught mathematically?—Yes, so far as simple constructions are concerned.

3405 And physics?—Yes I should include the simpler portions of the study of heat and electricity, and the construction of the ordinary philosophical instruments, and pneumatics

3406 And as to chemistry?—I should say in chemistry, the chemistry of the non-metallic elements, as far as the general principles are concerned.

3407 You would not, then, think any organic chemistry necessary for purposes of general education?—I am strongly of opinion that whatever is learned should be learned thoroughly, and I do not think it is wise to make too broad a scheme I have seen attempts made to give a general idea of organic chemistry, but I believe, generally speaking, they have failed. I have had a great deal to do with boys coming up for the matriculation examination at the University of London, and I think the preparatory teaching in chemistry has been very unsatisfactory.

3408. Then you would say it is desirable that nearly all students preparing for the industry of England should go through an elementary course of those three subjects?—Yes

3409 Assuming that after this general course of scientific instruction, students would direct their education with a view to special industries, do you think it would be necessary that any change should be made in the ordinary conduct of secondary schools, with a view to the qualifying of such students to enter on a scientific course?—My idea is that those subjects should be studied by young men generally, as a part of an ordinary liberal education, not limiting it to those who intend to go into any of the industries.

3410 But my intention in my previous question, was to ask you what, in a college like King's College, you would lay down as a fundamental general scientific course for young men, presuming them to have left school, and to have come to the college, intending afterwards to go into manufactures, or some other branch of English industry?—If your question referred to a collegiate course of instruction, I should carry it further in the same subjects

3411 Then, understanding my question to refer to a course of instruction in a college, will you state what subjects you would think desirable to be followed out by all persons intending to go into any branch of English manufacture or industry?—I think I should still mention those three branches

3412. Then, going back for a moment to the school question, and looking to the existing state of the secondary schools in England, have you any suggestion to make to the Committee with

regard to the introduction of scientific subjects into the school course (bearing in mind the special object of this Committee), with a view to qualifying young men to enter on a scientific course at college, as a basis of technical pursuit?—Yes; I should say that they must certainly have the elementary part of the same subjects, I think that every boy at school ought to have a knowledge of elementary geometry, and he ought to be able to follow ordinary algebraic calculations, say up to simple equations; and there ought to be a certain knowledge of the elementary principles of physics.

3413 Would you introduce chemistry into schools?—Not at an early period; I think physics afford a better training for the early periods; there is more exactness in the processes of investigation

3414 Then, looking to the condition of the secondary schools in England, generally, do you think that the education of which you speak is generally attainable, either in grammar schools or in private schools?—No doubt it could be given, but I do not think that at the present time the teachers are sufficiently prepared to give it, still, if it were once made an object, the demand would create a supply of qualified persons

3415 Do you think it would be desirable rather to look to the leavening of all the secondary schools of England with the requisite amount of scientific training, or should you rather think it desirable that certain special schools should be founded, having science, rather than any other subject, as their basis?—That is a question on which I should have considerable hesitation in giving an opinion

3416 I put the question with reference to the object of this Committee; namely, the providing of scientific instruction for those who are to be engaged in the manufacturing industries of the country?—As far as that goes, I think you might have special scientific instruction, but, with regard to the influence on the improvement of education in the country generally, I think it would be far more advantageous to introduce science into the secondary schools

3417 Do you think it would be desirable to establish special training schools for science teaching, or would you rather trust to a natural supply, from the universities or other places, meeting the demand as it arises?—Yes, I would. I think the demand being once made, the supply will gradually be found to be in proportion to that demand I think persons would naturally seek to qualify themselves for such posts.

3418 *Chairman* (to Mr *Cunningham*)] Is your college now entirely self-supporting from its own resources, or are you still compelled to make occasional appeals to the shareholders?—It is entirely self-supporting

3419. (To Dr. *Miller*) You spoke of mathematics, including geometrical drawing, as a part of the preparatory course of technical education, would you not also include mechanical drawing; that is to say, plan drawing of machinery and buildings, as a preliminary part of the education?—It is necessary that the student should have that kind of facility, no doubt.

3420 But you would not look upon it as so essential as geometrical drawing?—I think not.

3421 You have not stated, I think, how you would afterwards develop that preparatory instruction in a college, with more direct reference to

to special pursuits; can you give the Committee any suggestion with regard to that?—I think the plan would be to have a well-considered scheme, which each college would itself carry out. We have no difficulty ourselves at King's College, we carry on what we consider a good scheme for the purpose of instruction in those branches of applied science which are most generally useful in this country.

3422 Without going into details, you vary that course, with special reference to the after pursuits in life of the student?—Certainly, each student has a course of study put into his hands. If the parent or guardian says I wish this lad to be instructed in such and such branches, because he is to go into some particular pursuit, then a special variation is made to suit that particular case, but in any other case each student is expected to attend that particular curriculum which is laid down in our department of applied science.

3423 Have you had any experience of any of the large continental polytechnic schools?—No.

3424 Then you could draw no comparison between any of those schools and King's College?—I have not sufficient knowledge to do so.

3425. You spoke of universities and other existing institutions supplying trained teachers for secondary schools?—Yes.

3426 I suppose among those institutions you would include the school of mines?—Yes, certainly.

3427. Have you considered the question, whether science could not also be taught in our primary schools, taking the National and British schools, for instance?—I doubt it.

3428 Then, with regard to the evening classes in connection with the science and art department, where would you look for teachers to supply those classes, we are told there is at this moment a great deficiency of teachers, is not that so?—Yes, but at the same time there has been only a recent demand for them, and I think they will be supplied by a natural process when a sufficient length of time has been given for the want to be made known.

3429 But you are aware that the emoluments of those teachers are very limited, so that you could scarcely expect them to receive their education at Oxford or Cambridge, or even at King's College?—No, but at the same time the emoluments for teaching generally are low. I think there would be no more difficulty in getting teachers in those subjects than in getting teachers in other subjects, provided the demand were sufficiently great. Teachers would rise up who would qualify themselves.

3430 But where?—In all these cases it seems to me that young men who are qualified to become, for instance, schoolmasters, would give the same amount of time, and pay the same amount of fees, to qualify themselves as teachers of different branches of science as they now pay for literary training. There is no more difficulty in one case than in the other.

3431. Then, for primary instruction in science, would you think it desirable that the preparation should be made in the training colleges in which schoolmasters are now trained for primary schools?—I certainly think there should be a modification in the mode of instruction there.

3432. It being, in fact, however, the case that there are facilities in some of the training colleges for teaching natural science to the future

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masters of elementary schools, do you think that a very good thing?—Certainly I do.

3433 Did I understand you to say that chemistry was not taught in King's College School?—No, it is taught to the senior boys.

3434 Then that school you would rank with such secondary schools as have been alluded to, I suppose?—Yes.

3435 And there you do teach chemistry?—Yes.

3436 And do you teach chemistry with advantage?—Yes, some of the boys answer remarkably well.

3437 Mr Acland.] The school at King's College, I think, ranked once with the other classical schools, did it not?—Yes, and it does so still.

3438 Has there been any modification of the classical course at King's College, with a view to the introduction of more science?—The boys in the classical school attend lectures on science as well as those in the modern school.

3439 But has there not been more science introduced within the last few years?—Yes, certainly.

3440 You have yourself been connected from very early life with teaching in London, have you not?—Yes.

3441. And you have no doubt observed that great changes are going on in the old Universities of Oxford and Cambridge, in the direction of teaching science, it has been suggested to this Committee, that they might do a great deal by training teachers, though they could not undertake to teach the arts, or to train manufacturers specially for their pursuits. Do you agree with that opinion, or do you think that there are difficulties as to the older universities on account of their being so far from London, or from any other circumstances?—There are advantages in the older universities, no doubt, they have endowments which, if they were to devote them for this purpose, would enable them to effect a good deal, there are certain things which can be very well taught anywhere, and, on the other hand, there are technical operations which can only be properly taught on the spot where they are performed.

3442 Those reasons, which, in the opinion of competent judges, make any attempt to found anything like a medical school in Oxford or Cambridge not very desirable, would lead you to a similar conclusion with regard to technical knowledge in general?—I think so.

3443 But, as in connection with the medical profession, it is held by a great many persons that there are certain subjects which may be pursued with peculiar advantage in the metropolis, do you think, with regard to technical education, a similar course might be taken?—I think so.

3444 Chairman.] Would you expect that a college similar to King's College could be established with success in some of our great manufacturing centres?—I think something might be done in that way if endowments be made, but there is considerable difficulty in doing it unaided. At Birmingham a great effort was made a few years ago (in Queen's College), which was only partially successful. The difficulty is first to find the men who are qualified to teach, and who would be properly paid for the devotion of their time to the teaching. The number of the persons who would be likely to attend

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would probably hardly pay the expenses of an unendowed school. We have considerable difficulty even in London in making those schools pay, and yet it is in a large place like London that the facilities for establishing such a school are the greatest. As the education required is of a high order, the emoluments of the persons who teach must necessarily be something very considerable, or else you cannot get men of the class you want.

3445. I think Mr. Cunningham said it would be impossible for him to give any estimate of the cost of the separate departments of King's College, owing to their being so interwoven with each other?—(Mr. Cunningham.) Yes; I know, of course, what the fees of the applied science department come to every year, and I can tell you how much it costs, but I cannot include in that all the expenses of the building and staff.

3446. What is the entire revenue of your college?—About 34,000 l. a year.

3447. Does that include the school?—It includes everything.

3448. Does it include the income from the endowments?—No, we have really no endowments, except for certain prizes, and it would not include them.

3449. Have you any money in the funds?—None, except a few sums given us as prizes.

3450. And those are not included?—No; we have not a halfpenny in the world except our building, and hence our success.

3451. You are obliged to supply the education which is in demand?—Yes.

3452. What are the income and expenditure of your applied science department?—The income is about 4,000 l. a year from the applied science department, and about 3,000 l. of that goes to the professors; the remaining one-fourth is applicable to all outgoings.

3453. But that 3,000 l. would not be sufficient for the professors if they had not an income from other sources in connection with the college?—Just so.

3454. Mr. Acland.] That also presumes the existence of a building?—Yes.

3455. And it presumes, also, the existence of a staff of general superintendence, such as the principal and secretary, or do you charge that on the 1,000 l. a year?—Any surplus, after payment of the expenses necessary for actual teaching, goes to the general maintenance of the college.

3456. Chairman.] Do you consider that the department pays its way?—Yes, most undoubtedly, we have out of that department from 300 l. to 500 l. a year applicable towards paying clerks and servants, and so on.

3457. That, of course, would be quite insufficient if the applied science department were to stand by itself?—Yes.

3458. Mr. Akroyd.] Do you know of many instances in which day schools are attached to colleges?—(Dr. Miller.) There is one at University College

3459. Are there any in the provinces?—I think not.

3460. Do you think there are advantages in working a college and a school together?—Undoubtedly, we have every year a fresh accession of students from the senior department of the school to the college.

3461. The day school operates as a nursery for the college?—Yes.

3462. And there is also in having the two together, some economy in the teaching department?—Yes, the science teachers of the school have also occupation in the college.

3463. There is, also, economy in the building?—Yes.

3464. Would you, in fact, recommend that course?—Yes, it enables two things to be done for about the same money.

3465. Mr. Acland.] Do I gather from you that, looking at the existing need for scientific instruction in England, and the existing demand for it, you would not recommend the multiplication of colleges in England at present?—Just so.

3466. You would rather look, as I understand you, to the general improvement of our middle class, or secondary education in grammar, proprietary, or private schools throughout the country?—I think that that is the most hopeful course, as it is also the least expensive.

3467. Even in cases like those of Manchester, Liverpool, and Birmingham, you would look more hopefully to the thorough development of the school system than to the foundation of new colleges?—Yes.

3468. Should you go so far as to say that it would be undesirable to aim at the construction of great technical colleges or universities in the West Riding of Yorkshire or the South of Lancashire?—I doubt it very much.

3469. You have indicated to us generally your views of the course of education suitable for those who intend to be manufacturers or otherwise to be engaged in the industry of the country should you have any objection to draw up a short scale of studies having reference both to general scientific instruction and scientific instruction under different heads, with a view to different branches of industry?—I will endeavour to do so.

3470. Mr. Basley.] At what minimum age can a pupil make much proficiency in scientific attainments?—That is a thing which comes gradually that it is difficult to say, some boys have more aptitude than others for scientific attainment, we give them simple principles to begin with, and they move on by degrees.

3471. It being the fact that the great masses of labouring children are employed as early as 10 years of age, do you think that much scientific knowledge could be got into the mind of a child under that age?—No, certainly not; it is quite out of the question.

3472. Chairman.] Is there anything that you would like to add to your evidence?—No.

The Reverend EDWIN ABBOTT ABBOTT, M.A., called in, and Examined.

ev. E. A. 3473. Chairman.] You are the Principal of the City of London School, are you not?—Yes.

3474. I believe that you were educated in the City of London School?—I was.

3475. You proceeded from there to the University of Cambridge, did you not?—I did.

3476. And there you took honours?—I took a first class in classics, and a second in mathematics.

3477. For how long have you been the Principal of the City of London School?—Not quite three years.

3478. I

3478 I think you succeeded Dr. Mortimer?
—I did

3479. Had you been engaged in teaching before you succeeded Dr. Mortimer?—Yes, I had been engaged in teaching classics first for more than two years at King Edward's School in Birmingham, and then for about half a year at Clifton College, Bristol. In both those cases I was doing the work of a regular classical master.

3480. And from there you were translated to the position which you now hold?—Exactly

3481 The City of London School is, I believe, eminently a modern school?—Yes, it is modern both in point of date and in point of the education which is given there

3482 It is an old foundation, is it not, which was remodelled about 30 years ago?—Exactly

3483 Will you kindly state what are now the objects of the City of London School?—The main object of the City of London School is to prepare pupils of the middle class for the life of tradespeople, to give them what is called a commercial education. For this purpose we have what you would call a primary school in which no Latin is taught, and then a secondary or middle school, which takes the commercial education to a higher point. After the middle school the study of Greek commences, and we reach what may be called the highest school, consisting of about three classes of 80 or 90 boys, many of those boys are the sons of professional people; and the school is what may be called a professional or university school, but, as a rule, the great body of the boys leave direct from the middle school, and the object of the school is to give a commercial education

3484. At what age do the boys leave this middle school on an average?—From the age of 15 to 16

3485 When you speak of a commercial education, do you include in that term preparation for the work of a manufacturer, or only preparation for shops and merchants' offices?—I include, to some extent, the preparation for a manufacturing career

3486. The pupils in the middle school are very numerous, are they not?—Yes, there are about 300 boys in the middle school.

3487 Could you state what proportion of those boys would be likely to devote themselves to technical pursuits in after life, to the career of a manufacturer, for instance?—I could not state that, we always include under the head "business," all kinds of trades or manufacturing work, without making any distinction.

3488 Do many of your boys leave you after having gone through the primary school only?—Very few

3489 In fact, your primary school is a preparatory school?—Yes.

3490 What is the number of the boys that you have in that school?—From 200 to 250 boys.

3491 Then the entire number of boys in your school is between 600 and 700?—Yes; the average is about 640 or 650

3492. Are there the same fees throughout the school?—Yes

3493. What are those fees?—£.9 a year, not including drawing and books.

3494 Is drawing not obligatory?—It is not.

3495. But it is taught in all the divisions of the school for those who desire it?—Yes.

3496. At what age do you begin to teach drawing in the primary school?—As soon as ever
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the parents of any boy desire it, he is allowed to learn drawing

3497 At what age do you receive boys?—Theoretically, at the age of seven

3498 But practically, what is the age?—Eight and a half to nine years of age is the average

3499 So that the minimum age would be about eight years?—Yes; I have had boys younger than that, but very few

3500 At what age in practice do you begin to teach them drawing?—I have seen boys who were certainly not older than 10 in the drawing class, practically I should say from 10 to 11 is the lowest age for a boy to commence drawing

3501 What kind of drawing are they taught?—Freehand drawing, drawing from models, and mechanical drawing

3502 Geometrical drawing included, I suppose?—Yes. They are, in fact, definitely prepared for the examinations at South Kensington, if they wish it.

3503 Are your masters certificated masters of the Department of Science and Art?—I cannot say. You speak of "masters" in the plural number, but the master is an artist who has exhibited pictures at the Royal Academy. That master has an assistant appointed by him with the sanction of the committee, and they were both there when I came, but we have only one master

3504 What is your entire staff?—It consists of 12 class masters, and of 11 extra masters

3505 Are these masters devoted to special divisions of the school, or do some or all of them take classes in all the divisions?—Some of them take classes in all the divisions, as, for instance, the three writing-masters

3506. With regard to arithmetic, how is that taught?—Arithmetic is invariably taught by the class masters

3507 What are the acquirements of those masters?—That would be tested by their testimonials, which have not been perused by me, because some of those masters have been there 20 years, but they have not, as a rule, taken degrees, either at Oxford, or Cambridge, or the London University

3508. But, with regard to those 12 masters, are they generally graduates of the universities?—It is to those masters that I have now been alluding, there are only five out of the 12 who have taken degrees at Oxford or Cambridge, and our teacher of natural science is B. A. of the University of London, none of the others have taken degrees

3509 The revenue of the school is, I believe, derived from endowments, and from the fees of the pupils?—It is

3510 You have stated that the fees of the pupils are 9 l a-year, besides the charge for drawing and the cost of books?—Yes

3511. It has been stated that the endowment is of the value of 900 l a-year?—It has

3512 But it has also been stated that the income from the Carpenter bequest is 3,000 l a year?—It has been so stated, and I believe it is the fact.

3513 But is it the case that of the 3,000 l a year, only 900 l is received by the school?—Yes, that is the fact.

3514 But in addition to the 900 l, you have, of course, the use of the building rent free?—Yes, the use of the building and its repairs.

3515. Do you know what the cost of the building

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building was?—It was rather above 20,000 *l*. The endowments had been for a long time in excess of the objects to which they were applied, and the Corporation erected this building.

3516. Do you include the site in the 20,000 *l*?—The site was not included, that was Honey-lane Market, (opposite to Bow Church, in Cheap-side), which was given by the Corporation,

3517. Exclusive of the site, the cost of the building was over 20,000 *l*?—Yes.

3518. Exclusive therefore of the land, the rent of the building alone would be quite 1,000 *l*. a year?—Yes.

3519. And the repairs would be how much?—About 200 *l*. a year.

3520. So that exclusive of the value of the land, you may say that you have an endowment of 2,100 *l*?—Yes.

3521. How many pupils have you?—From 600 to 650.

3522. Then the income from the endowment would be rather over 3 *l* a head?—Considered as an endowment, its value may be reckoned as rather over 3 *l* a head.

3523. One-fourth of the entire cost of the education of the pupils?—Yes.

3524. Can you give the Committee roughly the salaries of the principal masters?—My salary would be dependant on the capitation fees, as long as there were 650 boys in the school it would be 1,000 *l*. a year, the second or mathematical master, now gets 500 *l*. a year, which was altered from 400 *l*. a year three years ago, the third master has 275 *l* a year, and the next master who has been there 27 years, has 300 *l*. a year; the next master who has been there about 21 years, has about 275 *l*. a year.

3525. You are now speaking of the masters holding university degrees, are you?—Yes, the committee occasionally give bonuses to the assistant masters when the state of the school funds admits of it.

3526. Have you given us the emoluments of the science master?—He is a class master, and with reference to his class teaching, he has 220 *l* a year, with reference to his teaching of the sciences, he has a further sum of 200 *l* a year, and 25 *l*. is allowed him for materials and the like, he has also an assistant who is paid 60 *l*. a year.

3527. What are the duties of the science master?—The duties of the science master are to give lectures to the whole of the school in natural science, to see that the written exercises in natural science are done once a week, and to inspect them.

3528. Is there a chemical laboratory?—It may be called a chemical laboratory; it is in the subterranean passage to the lecture theatre, the passage has been utilized in that way, but when the teacher has any experiments which are unusually unpleasant, the necessary preparations have to be made in the lecture theatre itself, because this passage is so close.

3529. I suppose the boys do not practise analysis, do they?—At the top of the school, and, in fact, throughout the school after the lecture is concluded, the more promising and advanced pupils are called round the table, where they witness experiments, and sometimes make the experiments for themselves.

3530. At what age does the instruction in science commence?—At the entrance of the pupil, whatever age that may be.

3531. In the primary school even?—Yes.

3532. To boys of eight or nine years old, what branches of science are taught?—Inorganic chemistry, with such references to the physical sciences as may explain such subjects as atmospheric pressure and the balance of nature between animal and vegetable life, and the laws of chemical combination with regard to air and water, subjects of that kind are taught in the primary school, those are boys who, theoretically, might be as young as eight; many of them are, in fact, as young as nine; and I have every reason to believe that what is taught is well taught, some of the boys would be as old as 14.

3533. You mean to say that boys between nine and 14 years of age, and consequently boys from 10 to 11 years of age, are really deriving considerable benefit from the instruction given in elementary chemistry in that way?—Some benefit, undoubtedly.

3534. And that instruction forms part of a continuous course throughout the whole time of their remaining at school up to and including the highest school?—Yes, just so.

3535. Is the number of hours devoted to science instruction the same throughout the school?—It is.

3536. What is the number of hours?—It is one hour a week.

3537. Then do I understand you to say that the instruction in chemistry in the highest school only occupies one hour a week?—It only occupies one hour a week. I need not say that though we have not a workshop at the schools, yet the boys are accustomed to make workshops of their homes and their doing so is encouraged in every possible way. The entire course, however, as far as lectures are concerned, including all the sciences, is confined to one hour a week.

3538. What is the gradation in which the sciences are taught throughout the school?—There are four divisions. In the fourth or lowest division the instruction given, while necessarily of a very elementary character, is such as to make the pupils thoroughly acquainted with the laws of chemical combination, and thus lay a sound foundation on which to build their after studies. The chemistry lessons (which are confined to the composition and properties of air and water, and those of the compounds produced by the various combinations of their component parts) are accompanied with such simple allusions to the principles of pneumatics, hydrostatics, animal and vegetable physiology, and physical geography, as shall the better explain the atmospheric pressure, laws of diffusion of gases, motion of air and water; the manner in which the atmospheric equilibrium is maintained by the winds, and the mutual action of plants and animals, the importance of good ventilation and the methods by which fresh air may be supplied to diving apparatus, houses, drains, mines, &c. Then we come to the third division, above that. The chemistry in this division, while of a nature to enable the student to understand certain geological formations, &c., is given principally with a view to show its application in the arts and manufactures, as, for instance, manufacture of blue, white, and green vitriol; manufacture of English and German sulphuric acids, manufacture of nitric and hydrochloric acids; manufacture of gunpowder and gun cotton; manufacture of phosphorous, lucifer matches, &c.; and at the same time to place such an amount of chemical knowledge at the disposal of all, that they may readily

readily detect the common metals occurring in any mineral or other specimen. Then we come to the second division. In this division the instruction is of a higher character. It is chiefly devoted to the consideration of the metals proper, the metals of the alkalis and alkaline earth in connection with their application in the manufacture—1st. Earthenware, porcelain, and glass, with the process for colouring, 2nd. Mortars and cement, 3rd. Potassium cyanide and ferro and ferri-cyanide potassium, chromates; 4th. Pigments, 5th. Soaps, and other matters connected with trades and manufacture. This is the division after which most of the boys who are intended for a commercial life leave the school, and they are given an outline of theoretical analysis, and the first principles of heat.

3539 That is the division for boys who ordinarily leave at 16 years of age?—Yes; now we come to the first division. The object in this division is to encourage the students in theoretical speculations as a means of mental discipline. The chemistry (inorganic) is taught in its entirety, while, in the organic chemistry, the attention is principally directed to the nature of ferments, malting, and brewing, the manufacture of wines, spirits, vinegar, the manufacture of dyes, chloroform, &c., saponification, and the manufacture of candles and glycerine, animal chemistry, the principles of agriculture, and so on. Then we have magnetism, frictional and voltaic electricity, special attention being paid to electric telegraphy, and also heat. I think that is all I need give to the Committee.

3540 Even in that higher division, notwithstanding the introduction of physics, only one hour a week is devoted to science?—Only one hour a week is devoted to science.

3541. Who is the present teacher of science in your school?—Mr Thomas Hall, Bachelor of Arts, of the University of London.

3542 How long has he been at the City of London School?—Twenty-seven years.

3543 Is the result of the science teaching tested in any way?—Yes, by examination at South Kensington, and, of course, by school examinations.

3544 What has been the result?—The result has been, that though we do not send many pupils up (about 20 or 30 a year, perhaps), and though it varies very much, they obtain very high distinctions. During the three years for which I have been at the school we have twice gained the Queen's Scholarships, of which there are only three for the whole kingdom, and we have once gained two out of the three.

3545 Have you taken any gold medals?—A great number.

3546 You send up only your selected boys?—Only our selected boys.

3547 But, on the average, those are about 20?—Twenty, or more than that.

3548 Taking those who have obtained Queen's Scholarships, what has become of them?—Some of them go to the Royal School of Mines, and pursue their studies, one or two are doing so now. I have one who took the Queen's Scholarship last year, and he intends to go to Cambridge, where we think he will take the highest honours; he will go in for one of Mr. Whitworth's Scholarships.

3549 Taking the school generally, have any of those boys gone up for matriculation in science at the London University?—Occasionally, but

I think not very many, about five during the last seven years.

3550 But have many of them gone up for examination in arts?—Yes.

3551 At the University of London?—Yes.

3552. Now, with regard to the mathematics, what do you do?—We do not read quite as high as we used, but frequently we have passed the differential calculus, we begin with arithmetic in the lowest class, each class being carefully graduated with regard to its knowledge of arithmetic, in the lowest class, we place the boys who could simply repeat the multiplication table fluently, that is all that we require for that class, in the next class, we require a thorough knowledge of the first four rules of arithmetic, in the next class, long division, in the next class, reduction and division of money, in the next class, simple proportion, in the next class, proportion, completely studied, in the next class, fractions, in the next class, decimals. Here we expect the boys to know the whole of their arithmetic, and at this stage begins Euclid. In the next class, which is the class where the boys mostly move off for commercial life, we continue the Euclid, and begin algebra. We have now come to what may be called the highest or professional school, we continue the Euclid and the algebra, and carry the mathematics up to the highest point, sometimes reaching differential equations, but not often. I read differential equations when I was there myself.

3553 You make proficiency in arithmetic the standard of the school?—Yes, no doubt.

3554. In the lower divisions of the school, do you teach arithmetic scientifically?—In the very lowest class, the attempt is made and encouraged, and in the middle school arithmetic is very thoroughly and scientifically taught.

3555 Then, arithmetic being made the standard of position in the school, do you take literature into account at all, with reference to the school standard?—To some extent. In my entrance examination I endeavour, if possible, to reconcile knowledge of Latin with knowledge of arithmetic. The fact is, that I examine a boy, if possible, seven or eight months before he enters the school, and if I find his knowledge is unequal, I advise him to go to a private tutor, or to some other place where he can get his deficiencies supplied.

3556 Would that apply even to boys entering the primary school?—Yes, if I find a boy can read English fluently, but has been neglected in his arithmetic, I tell him to get up the rule of three before he enters, and that saves him perhaps three classes.

3557 In all the classes you require of the boys entering your school that they should pass an examination which shall have some relation to their age?—Yes.

3558. You would not take a boy of 11 years of age if he could only pass such an examination as you think a boy of nine years of age ought to be able to pass?—I should not myself select a boy of that age as an example, but I would not take a boy of 13 who only possessed that amount of knowledge which a boy of 10 or 11 ought to possess.

3559. Is that entirely in your discretion, or do you depute any of those examinations to your assistants?—I conduct them myself.

3560. All the entrance examinations?—Entirely.

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3561. Have

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3561 Have you a great many applications for admission into the school?—A great number

3562 Are they larger in number than you can accommodate?—We have always a considerable number waiting to come on

3563 Is it the case that, generally speaking, they all do come in eventually?—Generally; the vast majority do so

3564 How long is it before they can get admission into the school after they have made their application?—I should say, from six to nine months, dependent sometimes on the wish of the parents themselves, sometimes on the want of vacancies, or absence of the necessary qualification.

3565 And, after waiting about nine months, the majority, you say, are admitted?—Yes.

3566 During their progress through the school, do you test them again by examinations?—Yes, frequently

3567 And if you find a boy is not able to pass the examination due to his age, do you still retain him in the school?—If a boy falls behind to such an extent that he remains three or four terms in one class, and has twice received an unsatisfactory report, which has been endorsed by me, we require the parents to withdraw him; but it is very seldom that, for mere dullness, we remove a boy. I think the thing has never happened since I came to the school

3568 Referring again to a former question, does the delay of six or nine months arise chiefly from want of accommodation, or chiefly from want of preparation on the part of the boys?—From want of accommodation.

3569 What is the average age of admission into your school?—Twelve and a-half to 13

3570 What is the average maximum age, if I may use the expression?—We are not allowed to take boys into our school over 15 years of age unless they can enter the highest school.

3471 A boy entering at 15 should be able to consort with your boys of sixteen?—Exactly

3572 With regard to the general education of those boys, what does your course in literature involve?—Beginning from the bottom, in the primary school, we there teach English reading and parsing, and in the highest class of that school we begin French. Latterly they have been in the habit of committing English poems to memory, and repeating them, and being thoroughly examined in them. Besides that, I have encouraged, and almost made it part of the regular work of the boys in those classes, that they should read some English work, such as "Robinson Crusoe," and be examined in it. Now, coming up from that to the middle school, we continue the study of French, and we also begin Latin. We never allow a boy, over 13 years of age to go into the primary school.

3573 The middle school is a school for boys of 13 years old and upwards?—No, not merely upwards, we should be very glad to get boys under that if possible, in that way we begin Latin and we carry it up through the school.

3574 Is it simply grammatical teaching or is it literary, does it include the same order of instruction which you would give in English or French literature?—I am afraid that it cannot be called literature, any more than it could be called literature in any of the other schools in the kingdom. The only distinguishing feature in our system is, that we carry the study of English literature right up to the top of the school.

3575 The study of modern languages, and more especially of the English language, is pursued throughout the school?—Yes.

3576 What modern languages have you?—French, compulsorily, from the point that I have stated

3577 From the highest class of the primary school?—Yes, German is not compulsory, and no other modern language but English is compulsory

3578 The primary school is not what I may call self-contained, but is essentially a preparation of a regular part of a course of study pursued up to say 16 years of age?—Yes

3579 You have not mentioned geography, have you?—Geography and history are both taught throughout the primary school, and history is now continued through the middle school, the history of the Constitution of England

3580 Is history not taught in the upper school?—The history of Greece and Rome only.

3581 Have you any instruction in physical geography in the middle school?—In one class, which happens to be under the supervision of this teacher of the natural sciences; otherwise it is not a regular part of the studies of the middle school

3582 Nor of the lower school?—Not what I should call physical geography; it is a mere commission of the names of places to memory.

3583 So that physical geography is not taught at all in the primary school?—It is not.

3584 Are there in the metropolis any other schools which follow a somewhat similar course of instruction to that of the City of London School?—Do you mean combining the highest or professional school with the two others

3585 No, excluding that, and taking the primary and middle class schools only?—I think I know only of one such school, it is not well known, but I know it, because it happens to be kept by my father

3586 Mr Acland.] What is that school?—It is called the philological school

3587 Chairman.] Is that a very large school?—Not very large, it contains 220 or 250 boys.

3588 Is it an endowed school?—It is endowed for a class of foundationers, consisting of the sons of naval and military men or merchants who are in reduced circumstances.

3589 Do you remember what are the fees of that school?—I believe they are 9l., and I am sure they are not far from it.

3590. Do you know what the addition to the capitation fee would be from the endowments?—I do not know

3591 Then we may take it that there is another school of about the same grade where the cost of education is about the same as in the City of London School, with no greater aid from endowments than the City of London School?—Up to the middle school; our professional school is the expensive part of our school.

3592. If it were not for your professional school, you would consider that there would be no great difficulty in the establishment of similar schools where the population was considerable?—No, I should certainly think not, if the circumstances were favourable; you must have some endowment to start with.

3593 Mr Acland.] And the building?—And the building.

3594. Chairman.] In point of fact, you may say that in the case of the City of London School,

School, the capitation fees of the lower classes are, to some extent, paying the cost of the higher instruction?—Yes, there is no doubt they are. On the other hand, the son of a tradesman entering the middle or lower school, though he only receives a middle class education, yet, if he shows talent, has the chance of proceeding to the higher part of the school, where he will have rich endowments, and be able to proceed to the university without costing his father a penny.

3595. But you would admit him at 15 years of age to the highest school, even if he had not been trained in your lower school?—That might be thought a hardship on the lower school if it were not compensated by the advantages I have just suggested.

3596 Mr *Acland*] Is it your opinion that the masters are adequately paid?—The assistant masters decidedly not, I am not speaking of myself.

3597 In fact, we can hardly take the annual fee of the City of London School, even after reckoning its building, as a fair test of what is the cost of the instruction, if it is fully up to what it ought to be?—I am afraid you may take it as a test of what it is, though perhaps not of what it ought to be. I think some other schools are no better paid than ours, and I know that, at King Edward's School, Birmingham, the masters are worse paid.

3598. Is it not the fact that, at University College School and at King's College School, the cost is over 20 *l.* a year?—I think so.

3599 *Chairman*.] But do you think the emoluments of the teachers would provide competent teachers for similar schools established in the provinces?—I rather doubt it. Our masters have leisure to take private pupils, and some of them make a fair sum in that way.

3600 From what you know of the teaching profession, you think that, in the provinces, somewhat similar endowments would procure competent professors?—I decidedly think so.

3601. Can you give us the entire income of the school, exclusive of the buildings, but including the 900 *l.*?—I think we have no other source of income besides the fees and the 900 *l.*

3602 But you charge 2 *l.* a year for drawing?—Yes.

3603 What would the extras come to?—I find in the balance-sheet, in the year 1866, "cash received by the secretary, in the year 1866, 6,400 *l.*"

3604 That is to say, exclusive of the 900 *l.*?—Yes.

3605. Then the total receipt of the school would be 7,300 *l.*?—Exactly, of course, part of this sum received by the secretary consists of the payments of the boys made for books, and that money would be spent by the secretary in books.

3606. Would you object to put in the balance-sheet of the school?—Not at all.

3607 The school is exclusively a day school, is it?—The regulations of the school regard it as exclusively a day school.

3608. Do any of the masters take boarders?—Some of them do.

3609. Is there any large number of pupils who board with the masters?—Perhaps 35, not more.

3610. Very little over five per cent. of the whole?—Just so.

3611. Mr. *Acland*.] I gather that the scientific instruction given in your school is almost entirely chemical?—It is.

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3612. What is the reason of that, is the master particularly fond of chemistry?—I believe he had a great taste for chemistry, but the chemical lessons are continually accompanied by references to physical sciences, and I believe the master lays great stress on such references.

3613. We have been told by another witness, who has eminently distinguished himself as a chemist, that he does not consider chemistry a subject which could form a main element in school teaching until a late period in life?—That is commonly felt, I daresay, but I find that boys are exceedingly interested in chemistry, who take but little interest in classical studies or in arithmetic, it saves some boys from complete idleness.

3614 But have you reason to think, from your own actual experience, that it is desirable to begin with chemistry, and to exclude botany, or the general laws of matter and motion, mechanics, and so on, and if you have formed that opinion, is it deliberately formed?—Deliberately, you cannot experimentalise in botany, and things of that kind, as you can in chemistry.

3615 Does that opinion at all arise from yours being a London school?—Perhaps to some extent it does, we are, of course, dealing with London.

3616 For illustrating the laws of matter and motion the apparatus would be expensive, is that your reason, or do you give your opinion as having maturely come to the conclusion that the ordinary elementary subjects in physics are not subjects suited for boys?—The expense of the apparatus would be one reason.

3617 Has this system always been the system at your school?—Always.

3618 It is a tradition of the school which is, perhaps, liable to be re-considered under altered circumstances?—Yes, of course, like everything else.

3619 In arithmetic, you mentioned the sequence of your arithmetical subjects, and you introduced the rule of three before fractions. You are no doubt aware that there is a difference of opinion as to the order in which those subjects should be introduced, what is your own opinion upon that point?—My own opinion is, that the rule of three ought not to come before fractions.

3620. But you might find it inconvenient to make an alteration?—Yes.

3621 You are aware that there is also a difference of opinion with regard to the employment of Euclid as a first text-book in geometry?—Yes.

3622 What is your opinion on that subject?

—My opinion is, that the results of many of those who wish to adopt the continental system have been obtained at schools where the boys have not the same taste for mathematics as they have at the City of London School. I have been told by my friend, the mathematical master at Rugby, that the proportion of the boys there who understand Euclid, is very small indeed. On the other hand, from my own experience as a pupil at the City of London School, and from the experience of our mathematical master, who was also a pupil at the same school, I am led to believe that nothing like the same proportion in the City of London School ever felt any difficulty in understanding Euclid. I also think that the continental system does not afford the same logical training as Euclid, but that Euclid ought to be supplemented by lessons in geometrical drawing.

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3633. Are

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3623 Are you favourable to the idea of preceding the study of abstract geometry by the practice of geometrical drawing?—Yes

3624 Lord *Frederick Cavendish*.] You seem to think that the professional school absorbs the greater part of the cost?—Yes

3625 Is there any reason why the fees for that more expensive part of the education should not be a little larger than those of the primary and middle schools?—I think they might be in the case of the boys from without who enter that school, but in the case of boys who come up to us from the middle school, it would be a most injurious step, for they are the sons of the persons who care most about education, and who pinch themselves to keep their boys at school a few years longer

3626 Could not you overcome that difficulty by having a number of exhibitions or scholarships?—Yes, that would effect the purpose to some extent.

3627 Mr. *Acland*.] I understand you to say that you see no objection, abstractedly, to the plan of having the fees of the upper part of the school placed at the fair market value, with a considerable number of exhibitions either for free education, or for education at reduced fees?—That, I think, would be more just and expedient than the present plan

3628 Sir *Charles Lanyon*.] Do you find that there is much care among those who enter the school for following up the scientific education which is given there, I mean among the sons of foremen, and pupils of that class?—I have no business to know who are the fathers of the boys, it does not come under my cognizance, there are sons of tradesmen, and there may be sons of artizans, or of professional people, but I cannot distinguish them in any way

3629 Generally, then, do you find any very great anxiety on the part of those entering the school to follow up their scientific education rather than their classical education?—Yes, in the case of a great many of the boys

3630 Do you think that you have a sufficient amount of scientific education in your school?—As long as we have our present master, I think so

3631 Have you ever been able to follow up the lives of any of the pupils who, leaving your school, have become proficient in scientific knowledge?—Yes, to some extent, but science was only made a regular subject in the City of London School about nine years ago, therefore, those who have been under the master for scientific instruction, are still young men. Still, we have some who have already achieved such distinction as young men can achieve, we had one old pupil (Mr *Perkin*, now F.R.S.), who invented a violet dye, and made his fortune by it, though that is only a manufacturing success. We have two who are assistants to Dr *Frankland*, one is at the Royal School of Mines, and one is at the Royal Institution, and we have two assistant chemists at the Royal Arsenal at Woolwich; we have a demonstrator of chemistry at King's College, and another who is senior assistant chemist to the Rivers Commission; these are all old pupils of the City of London School.

3632 *Chairman*.] When you said that the amount of time devoted to science was sufficient with your present master, I suppose you were alluding to the very great efficiency of that master?—I was.

3633 Mr *M'Lagan*.] Have you ever any pupils from the country?—Several.

3634. Do you know to what profession their parents belong?—They are very often City men; boys coming up to town with their fathers; but it is only by accident that I arrive at any knowledge of facts of that kind

3635 You said that you began to teach the elements of chemistry when a boy was eight years old?—Eight would be about the minimum, a boy might be eight years old.

3636 And 13 is the average age of the boys in the lowest division?—I admit no boy into that division over 13

3637. Do you find that the youngest of those children thoroughly understand what is taught to them?—Whether children thoroughly understand what is taught to them in chemistry or any other subject, I should think very doubtful; but I think that the study wakes them up.

3638 Do you think that one effect of then pursuing this study, is to enable them to get on better with their ordinary studies, such as reading, writing, and arithmetic?—Certainly

3639. Mr. *Bazley*.] Have you any German and Italian classes?—We have German classes which are not compulsory, but we have no Italian at all

3640 Have you many pupils who seek to learn German?—We have 120.

3641 Are you aware whether the young men who leave you, go chiefly into commercial life?—The large majority do go into commercial life

3642 How many leave your school annually?—About 200 annually

3643 You are not aware that your science teaching has any immediate effect on their pursuits in life I suppose?—On the contrary; I am aware of many cases in which the effect is traceable, I have just given such instances

3644 Without expecting that all the pupils shall become eminent men, are their pursuits after life much affected by the scientific knowledge they acquire at your school?—I should say, decidedly, from such casual knowledge as have been able to get.

3645 Are you aware whether there is much science associated with commerce?—Certainly.

3646 What branches of commerce should you say were identified with science?—I should say bleaching, brewing, soap-making, candle-making, working in metal, and so forth.

3647. You would not have many bleachers or brewers in the City of London, I suppose, who would need high class scientific attainments?—That part of the scientific instruction which concerns the more practical of the arts and manufactures is not the highest.

3648. No doubt you can answer this question satisfactorily, taking the most eminent of your pupils, are they the most successful in the pursuits which they adopt in life, I mean, taking your cleverest boys, is that the case as a rule? I should say, as a rule, it is so

3649 Mr *Dixon*.] I understand you to say that the pupils like the science teaching better than the classical teaching?—Some do, but some do not like it at all.

3650 But those who do like it, like it better than any other study?—Yes; very often those who like nothing else, like the science teaching, and are made industrious by it.

3651. What proportion of that total number of your pupils do you suppose like science?—The liking is a thing that I have nothing to do with; and the likes and dislikes of boys can scarcely

scarcely be estimated. But, as a rule, about one-tenth of the students are passionately fond of the chemical instruction, and do not like anything else.

3652 Do you suppose you would also find a tenth of the pupils passionately fond of the classics?—Certainly

3653 I judge, from the tone of your evidence, that the number of boys passionately fond of the classics would be larger than the number of the boys passionately fond of science, is that so?—In the highest school, where alone you can imagine boys being passionately fond of the classics, the number is far larger. In the middle school, where they are learning only the initial part of Latin, I should say that the number of those who like the science instruction is greater than the number of those who like the Latin, but it varies, at different stages, in the course of the instruction given.

3654 What proportion of your boys do you suppose are passionately fond of mathematics?—There again, I should say that the number is larger in the middle school, certainly, the number of those who are very fond of arithmetic is greater than those who are very fond of Latin. In the highest class, the number is, if anything, greater of those who prefer the classics. But they are very nearly equal as between the classics and the mathematics.

3655. What number of hours in the week would be given to classics and to arithmetic, on an average, from the lowest school to the highest?—In the lowest class there is no time given to the classics.

3656 Do you think that since a proportion of one-tenth are passionately fond of scientific teaching, it would be better to allow them to devote a larger amount of time to it?—They do so very much at their own homes, that the time that is given to science is thus increased, but at the same time, I should like to see a regular course of instruction in physical geography, running right through the school, superintended by the class masters, in order that they might cooperate with the teachers of natural science.

3657 So that they might have a little of that teaching which they like every day?—So far as class subjects are daily subjects.

3658 Mr *Akroyd*] By whom is the governing body of the City of London School constituted?—The governing body of the City of London School is a committee which is elected by the Common Council of the City, and it is superintended by the chairman.

3659. Of how many does that committee consist?—Of about 37.

3660 The object which that committee have had in view, I presume has been to afford a good sound commercial education to the sons of the citizens of London?—It was originally merely for the sons of citizens of London.

3661 And at present the school is open to all applicants, is it?—It is open to all applicants.

3662. Is there any preference shown to the sons of freemen?—There is a preference shown to the sons of freemen and householders.

3663 How is that preference shown?—If their sons are qualified, I admit them before I take the sons of any other applicants.

3664 Suppose, for argument's sake, the applications from the sons of freemen should fill the school, you could not take any others?—Just

so
3665. Who is responsible for the curriculum,
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which seems so admirably adapted for its purpose, is it framed by the committee or by the master?—The curriculum was originally framed by the committee, and it has been modified by the head master from time to time with their consent.

3666 Have any recent changes been made?—The study of English has received some slight development.

3667 When you say that you have paid more attention to the teaching of the principles of chemistry than to the teaching of elementary mechanical drawing, on what grounds do you make that preference?—I stated that the chemistry was a compulsory part of the course of study, and that the drawing was not.

3668 Compulsory, inasmuch as chemistry is part of the recognized curriculum of the school?—Yes.

3669 Do you teach political economy?—Not as a school subject.

3670 Do you not think it is very essential that all youths engaged in business should be taught political economy?—I should like to see it included, if it were possible hereafter, among the subjects of the school teaching.

3671 You think it would be a great advantage to lads intended for business pursuits?—Certainly, if it could be included in the school routine.

3672 Mr *Acland*] And in the school learning also?—And in the school learning also.

3673 *Chairman*] You stated that your teaching was tested by the examinations of the Department of Science and Art at South Kensington?—Yes.

3674. In what subjects have your pupils been most successful?—I have here a list of the distinctions which they have obtained, and I see they have taken distinctions in almost all subjects, in inorganic chemistry the number of candidates is far greater than for any other subject.

3675 Have they been successful in geometry?—There are cases in which they have got prizes for geometrical drawing.

3676 Have they stood for examination in theoretical or applied mechanics?—Yes.

3677 Are those subjects included in your mathematical teaching?—Yes.

3678 Theoretical and applied mechanics form part of your course in the higher division of your school?—They do.

3679 In fact, however, you have no technical instruction?—Not unless you choose to call that part of chemistry technical, which relates to manufacturing processes.

3680 That would be simply incidental to the general course?—Yes.

3681. Mr *Acland*] Do you teach book-keeping as a special subject?—It is a part of the general instruction in the middle division of the school.

3682 Is that taught because it is demanded, or rather because it is thought a good thing by the teachers?—I think there is rather a demand for it at present on the part of the parents.

3683. Is it your experience that boys who have been taught arithmetic thoroughly well, and their way in book-keeping as a general rule, without having received special instruction in it at school?—With regard to our own school, all the pupils do have instruction in book-keeping, but it is hard to say whether they find it useful in their experience afterwards.

3684. *Chairman*] Have you power, as the
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head master of the school, to alter its curriculum?—I could modify and somewhat develop that which is in existence, and of course it is hard to distinguish between development and creation, but I should say that I have not power, materially, to alter the curriculum by omitting what is already taught, or inserting what is in no way taught

3685 Have any material changes been made in the course of instruction, within your knowledge?—Within my knowledge nine years ago, chemistry, from being voluntary, was made compulsory

3686. And that is the only change of importance made within your knowledge, is it?—The study of English has been made a class subject, from being originally a voluntary subject, confined to two or three candidates in each class who wished to compete for the prize

3687 What is the number of hours devoted to instruction in mathematics in the highest school?—In the highest class, 9½ hours a week

3688. Mr. Acland.] Out of how many?—Out of 30.

3689 *Chairman*] And in the highest class of the middle school, how many?—About eight or nine hours

3690. Would that include arithmetic?—It would include such arithmetic as would be done in the highest class of the middle school.

3691. Do you think it would be possible to increase the amount of scientific instruction in the upper classes of the middle school and in the highest school, without interfering prejudicially with the other subjects taught?—I do not think it would be possible to do so in the highest school. In the middle school, if you were to confine yourself to that class in which the boys leave for business, I think the study of the natural sciences might with advantage have more time devoted to it.

3692 You mean with advantage to the general training of such boys leaving at 16 years of age for business pursuits?—Yes.

3693 But in the upper class, you think the training given to the boys now is more advantageous to them than it would be if you were to suppress any part of their studies in order to give more time to science?—I do.

3694 Mr. Acland.] Have you found any great disadvantage result from postponing the study of the classics to a later period than is usual in other schools?—If it were wished that all our pupils should go to Cambridge or Oxford, I should say yes, but with a view to an enjoyable and useful knowledge of the classics, I should say not

3695 Do you think that the general course of your early training in arithmetic and, mathematics, which are the main objects, together with the English taught, puts your boys in a favourable state for acquiring a knowledge of Greek and Latin more rapidly afterwards?—Yes.

3696. And in a state for acquiring that knowledge more thoroughly and solidly, perhaps?—Yes, a more literary knowledge of the languages is acquired, I think, under such circumstances I am bound to say, that boys have not that complete knowledge of forms and minute detail which may perhaps be found in schools where the boys do little but classics.

3697. My question had reference to the object of this Committee, namely, the general education of young men intended for business, and not the preparation of young men intended for the uni-

versities, in that view, you would say that there is no detriment in the postponement of which we have been speaking?—None whatever.

3698 And perhaps some advantage?—Yes, boys come to me, knowing more Greek after a year's instruction, than they know Latin after three years' instruction

3699 *Chairman*.] Would you say that a boy leaving your school at 16, or a boy leaving a good grammar school at 16, would have a more critical knowledge of the English language and literature?—As far as my experience of good grammar schools goes, and that is by no means great, I should be disposed to give the preference to my own boys.

3700. Mr. Acland.] You are aware that in the general division of schools proposed by the Schools Inquiry Commission, the schools are divided into three grades, should you be disposed to draw any broad line of distinction between the kind of education desirable for boys in the second grade of schools, that is to say, boys leaving school for business at 16 years of age, and the training of the same boys up to 16 years of age, on the supposition that they were going to continue at school up to 18 years of age?—If I wanted a son of mine to go to a university, I should like to see him go through the same course of instruction in English and natural science that he would have to go through if he were leaving school for business at 16 years of age.

3701. Then, supposing a boy were intended to go into business at 16 years of age, would you put him through precisely the same course up to 16 years of age as a boy who was going into a learned profession, or to one of the old universities?—I should not think of putting him through the course which is now recognised as the proper preparation for the universities

3702. *Chairman*.] Taking, then, an ideal system of education, up to 18 or 19 years of age, would you, in the case of a boy who was to leave at 16, put him through the same course as those boys who were to remain up to 19, would pursue up to 16 years of age?—I should think so.

3703. Mr. Acland.] It has been suggested to this Committee that it is desirable to have schools specially set up in the manufacturing districts, in which science should be the principal basis of the education, and that those schools should be different and apart from schools of a more general nature, you would not agree with that suggestion?—No, certainly not. I would have special technical schools for boys who had left at 16

3704. But my question was not confined to boys who were to leave at 16, but was rather directed to this. Supposing the boys to be educated together up to 16, would it, in your opinion, be desirable for those who go into manufactures, to have schools of the first grade equal in social position to the first class grammar schools of the land, only making science the principal basis of the teaching given?—I would have special technical schools for boys above 16 years of age. I would let them go on with a sound, broad, general education up to 16; and then, if they wanted to go into any special pursuit, I would have special schools, at which they might enter for special studies from 16 upwards.

3705. Would you distinguish those two kinds of schools in this way, that Greek would enter into the course at one school, and a greater amount of science into the other, while Latin should be common to both?—Yes.

3706. *Chairman*.]

3706 *Chairman*] Is there anything you wish to add to your evidence?—Suppose our endowment, which amounts, taking the interest of the 20,000*l* and the building and the cost of maintenance, to 2,100*l*, were taken away, we should need to increase our fee from 9*l* to 13*l*, on the supposition of our having 600 boys, and to 12*l* 10*s* on the supposition of our having 650 boys. This does not include the value of the site, which would cause a very material addition to the cost of the education

3707 *Mr Acland*] But do you not think that, in order to give a thoroughly adequate remuneration to the masters, you would require a higher fee than that?—Decidedly higher.

3708 *Chairman*] But at the present market value of tuition, you think it could be done at these figures?—Yes, with the addition just mentioned

3709 *Mr Acland*] But does not that market value carry this condition along with it that it is difficult to retain the services of a powerful master unless he has other opportunities of earning an income besides those which the school offers?—I think so.

3710 And to that extent the school suffers by having a tired man to do its work?—It must suffer

Rev A E
Abbott, M.A
—
25 May
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Thursday, 28th May 1868.

MEMBERS PRESENT.

Mr. Acland
Mr. Akroyd
Mr. Bagnall.
Mr. Bazley.
Mr. Dixon.

Mr. Gregory.
Mr. Lowther.
Mr. Potter.
Mr. Samuelson

BERNHARD SAMUELSON, Esq., IN THE CHAIR.

The Rev. Canon MOSELEY, called in, and Examined.

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3711 *Chairman* } YOU are one of the Council
for Military Education, I believe?—I am

3712 You were formerly one of the Inspectors of Schools, were you not?—Yes

3713 And you were one of the founders of the Bristol Trade School, I believe?—I was one of the founders of the Department of Science and Art at King's College, and the founder of the Bristol Trade School, in this sense, that I first proposed it. I asked the committee to convert the school into a trade school, and got their sanction. That is the only way in which I call myself its founder. I did not provide the funds for it.

3714. By the Science and Art Department at King's College, you mean the applied Science Department, do you not?—Yes

3715 What was the nature of the Bristol Trade School before it became a trade school?—It was a National School, a Bell's School for the poor of Bristol. In those days national schools were founded not as parochial schools, but in the case of large towns and cities they were founded for the poor of all the parishes of the town or city collectively. This was a school so established at Bristol, and it served the purpose of a central national school for the whole city, for 41 years. Then the parochial system came into vogue, and every parish began to get its own school. A system of depletion then went on, which ended in reducing the central national schools to a very small number of boys and girls. In that state of exhaustion I found this school, and I proposed to the committee of management to convert it into a trade school, or industrial science school, and they were good enough to consent to that proposition. I got together a meeting of the friends and supporters of the school, and Bishop Monk, the Bishop of Gloucester and Bristol, presided at that meeting, and so we established what we called a Diocesan Trade School, for it was impossible to alter the church character of the school, even if we had wished it, which we did not, moreover, the subscribers to the original national school were good enough to go on with their subscriptions to the trade school, and many of them still remain subscribers to the amount of 60*l* a year.

3716. It is now a Church school?—Yes.

3717 Has it a Conscience Clause?—No, no Conscience Clause; but we do in that Church school what is done in other Church schools; we respect the conscientious scruples of the parents of the pupils; we do that under no compulsion, but, as it is done in almost all Church schools, from the conscientious convictions of the managers

3718. At what time did this conversion take place?—In 1856

3719. Did the school at once fill as a trade school?—No, I think our first number was about 32.

3720-2. How many have you at present?—One hundred and forty.

3723 And what were the declared objects of the school at the time of its foundation?—The declared objects of the school were to teach the boys what is called industrial science, science as applied to industrial pursuits, as I stated in the first report which I made to the Committee, in which I proposed the establishment of such a school. I ascertained from the directory what trades or manufactures were carried on in Bristol of a scientific character, or which admitted of the application of science with advantage; in that report, I classified those pursuits, and told the supporters of the school that boys intended for such pursuits would derive very great benefit from knowing the sciences connected with them. Those sciences came under certain general classes; each class of sciences would be applicable perhaps to many trades. The idea was to make the school a school in which those industrial sciences were carefully, laboriously, and thoroughly taught, as far as they could be carried (it was impossible that they could go very far). Boys were accustomed to learn Latin in the old grammar schools, and we wanted to bring science into the place formerly occupied by Latin. One of the arguments I used was, indeed, this: the teaching of Latin, carried as far as it formerly was in grammar schools, was an extraordinary educational feat. The fact that so much was able to be taught in classics, and taught well, made it probable that a great deal of science might be well taught, and we thought even that very much less of labour and diligence on the part of the boys would be needed for the purpose of acquiring a thoroughly sound knowledge of the elements of the industrial sciences than was necessary to teach them the classics in former days. It was a substitution of one thing for another, with the belief that as much as was achieved in the one case might be achieved in the other. If the Committee ask me to state the principal cause of the success of that school, I should say it was that it carried out the idea of teaching science as thoroughly as the classics were formerly taught.

3724. Then you not only changed the subjects taught, but you also elevated the grade of the school?—It was intended to be another kind of school; it was not intended for the same class of pupils as went to it before. It was intended for the sons of the higher artificer class, and the small tradesman class.

3725. As

3725. As distinguished from the children of labourers and poor artificers, for whom the older school was designed?—Yes, our difficulty lay in inducing the committee and subscribers to make this social change

3726. Has that change, however, in fact taken place?—Yes; that is to say, the social condition of the boys has risen from the ordinary class of artificers to the first class of artificers, taking in the little tradesmen class, and warehousemen, and overseers, and clerks; the class between the working class and what would strictly be described as the middle class. These may be described as the natural leaders of the working classes

3727. Along with that change has a change also taken place in the average age and the maximum age of the boys at the school?—Some change, no doubt, has taken place in those respects, the boys generally remain till 14 or 15 years of age, though some of them go away before. In the national schools boys did not formerly stay until that age, nor do they now, the ages up to which children remain in the national schools are diminishing every year

3728. Do you consider the more advanced age of the boys is a necessary element in the success of the school?—Certainly, we could not have done what we have if the boys had been a year, or a year and a-half, or two years younger

3729. Could you, in that case, have achieved any result worth having?—Scarcely, but probably Mr. Coomber will be able to speak better to that subject. Some of those boys at 11 or 12 years of age answer at the examinations in a wonderful way, but I think, probably, boys in general would not retain in after-life knowledge which they had acquired at that age. I need not say it is one thing to communicate knowledge to children at that tender age, and quite another thing to reckon on the chances of children retaining any useful part of it a few years afterwards, any member of the Committee thinking for a moment of his own child would readily understand how little probability there would be of a child of 10 or 11, who had been taught something of chemistry, retaining much of his knowledge if he were almost immediately afterwards turned out into the hard business of life

3730. Do you require any amount of primary instruction before you receive boys into the trade school?—Yes, we require them to be well instructed in reading, writing, and arithmetic; that is our rule, and I believe it is pretty strictly carried out, but still they are not so well instructed in those matters as would be necessary if their instruction stopped there, if they received no more instruction in those subjects than they possess when they come to us, it is probable that when their scientific instruction was completed they would leave school imperfectly educated; we therefore keep up that kind of instruction. In the lower classes of the school they are taught nothing else, or very little else than those elementary matters, and then the science is taught in the class above

3731. Your school includes a preparatory school to correct the deficiencies of the elementary education of the pupils?—To carry it on further. We look upon it in this way, that an education proper for the sons of tradesmen and persons in mechanical operations has two sides; first of all, there is the science and art side, which has reference to the articles which a tradesman produces, and the methods of his industry; and then there is the commercial side. Of course, with

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regard to the commercial and mercantile purposes of his trade the tradesman's son has to be educated; but hitherto the teaching given to such boys has entirely neglected the science and art side. Our school corrects that deficiency, and deals with both, though its primary object relates to the science and art side

3732. You are speaking now of ordinary commercial schools?—Yes, our object was to correct the deficiency which is apparent in those schools. I take it that our boys resemble in social position and general characteristics boys who are trained in the ordinary private commercial schools of the lower class in this country

3733. But the education which you give them is far superior to that which they would receive in such schools?—Far superior, for in those schools only the commercial side of their education would be touched, whereas in our school both sides are dealt with.

3734. I suppose boys would remain in such private commercial schools till about 15 years of age, just as they do in your own school?—Yes, I should think so

3735. Do you find that the scientific instruction which you give those boys forms in any way an impediment to their obtaining the ordinary commercial instruction which is also necessary for their education?—We certainly think not; but Mr. Coomber will answer that question more fully than I could.

3736. I believe you have given considerable attention to the subject of instruction in science for the industrial classes, which is the question that has been referred to this Committee?—Yes.

3737. The Committee would be glad to hear from you, as concisely as possible, any statement which you may have to offer on that subject?—With regard to the teaching of science to the industrial classes, I think there is one great distinction to be made as it respects the kind of science to be taught to them, the kind even of applied science which is to be taught to them, there is a great deal of applied science which is not industrial science, and I think the scientific instruction to be given to those classes should be distinctively what might be called industrial science, I mean, of course, science in its application to industry, but always with this kind of proviso attached, namely, that we must, in the first place, take into consideration all the conditions under which the industry is conducted, and, in the next place, see that the teaching has reference to useful results. The first of these makes a great separation as to the subjects to be taught. There is a large class of applied sciences taught in the Universities and elsewhere, in the teaching of which account is not taken of these conditions, they are not applied to any industry, or if they are, all the conditions of the industry are not taken into account, so that the results arrived at are not useful results. I might instance mechanics in the teaching of which friction is not taken into account. In that kind of teaching all bodies are assumed to be perfectly smooth, that is an imaginary state of things, for no bodies are smooth. Results so obtained are, therefore, applicable to no industry whatever. That in which the imaginary case differs from the actual one is, in point of fact, that in which the interests of industry are chiefly concerned. The imaginary science leaves out all the industrial part. Another fault that they have is, that they do not consider that question of usefulness; the students in mechanics

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are occupied in solving imaginary cases and problems which, when they are solved, have no direct practical utility; but industrial science is that kind of science which takes into account all the conditions of the industry to which the science is applied, and which seeks useful applications, and only useful applications.

3738. Do you think it is possible to teach industrial science successfully without having previously taught a certain amount of pure science, for instance, as in mechanics, where friction would be left out of account?—The question of friction would not present itself in teaching the elements of pure science. Whenever it presents itself, it ought to be taken into account. It presents itself in all cases of the equilibrium of bodies in contact, or of their motion on one another. I think it is necessary to know some few principles of pure mechanics as the foundation of industrial mechanics, but then they are very elementary principles indeed; almost all the useful applications which arise in industrial mechanics are applications of the very elements of pure science. Perhaps I may take the very case which the Chairman has referred to as an illustration of what I mean, the question of friction is at once brought into the domain of very elementary geometry and very elementary mechanics, by considering that the resistance of a surface is not a resistance which is, as it is usually assumed to be, normal or perpendicular to the surface, but it is a resistance exerted, only, within a certain angle to the normal, which is called the limiting angle of resistance; if you take it in that way, it is quite as easy to work any problem introducing the condition of friction as it is to work a similar problem, exclusive of friction; any one who took the trouble to consider the study of industrial science in this relation would at once see that. We could not, I think, say that the Universities would yield this instruction in industrial science; I think it must be made a separate study for the purposes this Committee has in view, and a great many expedients of simplification must be adopted in teaching it. I may, perhaps, take an illustration of the kind of simplification I mean, from a great principle of mechanics; it is the principle of the parallelogram of pressures, which is usually proved in a very dreary and elaborate manner, but it may be proved directly by experiment to boys in an elementary school, so that no boy could fail to understand the proof of it. I would prove in the same manner that other great principle, the equality of moments, by experiment; and with those two principles, with the centre of gravity proved also, and illustrated by experiment, and that condition of the limiting angle of resistance in place of assuming the resistance to act at a right angle to the surface, you have all the principles you want for a very great number of industrial applications. The business of teaching industrial science, as far as mechanics are concerned, consists in a vast number of applications of a very few elementary principles, and those few elementary principles are capable of being taught by experiment, at least a good many of them are, and of being applied by the method of geometrical drawing; instead of solving the problems by trigonometry as is done in the Universities, they might be solved by ordinary geometrical construction with the scale and compasses with quite sufficient accuracy for all practical purposes.

3739. What would you say applying that more especially to the teaching of geometry?—I should

say that practical geometry is a thing which you want; I have been speaking of the science of statics especially as applicable to construction generally; every builder ought to be familiar with those three or four principles; he ought to be able to work a problem in the application of those principles by means of the scale and compasses. Then we come to another great class of skilled workmen, that of mechanical engineers. One kind of scientific teaching which they especially require is the teaching of what is called the theory of work, it is a most wonderful thing that that subject is so little known or taught in this country; it is the foundation of the industrial teaching of mechanics in France, but scarcely to be found in our University books; it is extremely elementary in its nature, and it may be taught in its first steps without any mathematics beyond arithmetic, just as statics may be taught by the method of construction with a scale and compasses without any trigonometry.

3740. *Chairman.*] Will you state what you mean by the theory of work?—Work is the union of pressure and motion; a column bears a weight on its summit for years, and it never works, because, although it sustains a pressure, that pressure is not overcome; there is pressure but no motion; but if that column moved up continually, it would be constantly working, because there would be in that case a union of motion with pressure. The unit of work is the pressure of one pound overcome through a foot of space, so that if a weight of 500 lbs. were moved up 10 feet, there would be 5,000 units of work done. Work is what is being done by the steam on the piston of a steam-engine continually; there is a pressure being constantly exerted through a space. Taking the question of fuel again, there is a certain quantity of work, a certain number of units of work, which would be yielded by a bushel of coal if it did its utmost and best, so that calculations of work to be done are also calculations of the consumption of fuel to do it. Work, in fact, is that element in mechanics which costs money, because it costs fuel, or it costs animal labour, of which each animal will do only a certain number of units per hour on the average and under given conditions. Work is also that form of force under which it is directly convertible into heat. So many units of work exactly, viz, 772, are necessary to raise 1 lb. of water one degree of temperature, and conversely 1 lb. of water, raised one degree of temperature, yields by expansion that number of units of work, neither more nor less. This enables us to tell how much work an engine ought to do by the evaporation of a certain quantity of water, because we know the heat expended. A machine is nothing but an expedient for the transmission of work from one point, where the work is received, to the other different points where the mechanical products of the machine are yielded. All this work would go through the machine as water goes from a reservoir through conduits to supply a great city, without wasting any, if it were not for the friction of the rubbing surfaces. All these things could be taught to boys, and they would be able to calculate the horse-power of engines, and knowing how much was lost by the friction of the engine, they would be able in that way to calculate what quantity of work must be done on the piston, and what amount of coal must be consumed, to yield any given mechanical result. That is the kind of instruction to which I have been referring.

3741. You

3741. You are of course aware that every educated engineer is familiar with calculations of this nature in his profession; what you would aim at I suppose is, that it should be taught at school before he entered the workshop?—I have only been dealing with the elements of it; some few of those elements are understood by every intelligent engineer, but not by any means all. The subject is an extensive one on which various systematic treatises have been written. In its further stages the applications of the theory of work are not understood ordinarily by practical engineers; for instance, they do not I think understand generally the principal of the Indicator-diagram, although they may know how to use it (working in the dark), or the working of steam-engines expansively, or the accumulation of work. I have met with remarkable ignorance on these subjects; I have met with the case of a practical engineer of eminence who was curiously ignorant of things which he should have known, the explanation of which was to be found in the theory of work, and I have met with the same ignorance in very distinguished mathematicians.

3742. I suppose that would go to show that the Universities would not be the best possible institutions for training teachers for industrial schools?—I certainly think not; I have the belief that you must put something between the Universities and the industrial schools. I think it is very important that a theoretical knowledge of work should be developed; it is the great industrial scientific knowledge which is proper to the engineer, and even to the village blacksmith, who is now passing into the village engineer. I will give the Committee an example of a deficiency of theoretical knowledge on the part of a practical engineer, which might, if not in this case in others, have involved important economical results. There was a certain engine which was kept at work by means of steam from a steam-pipe coming from a boiler, and the question was, what was the pressure of the steam on the piston when the engine was turning with a uniform velocity. He applied a steam-gauge in the pipe pretty near the place where the piston worked, and he argued that the pressure of the steam on the piston must be essentially the same as that shown in the pipe by the steam-gauge, whatever might be the resistance. From this, if it were true, it would follow that more work might be done on one side of the piston by the steam that was expended on the other side on the resistance without accelerating the motion. This is directly contrary to the theory of work.

3743. But you are aware that the diagrams of work in steam-engines are not usually taken in that way?—Just so; but this was not by a diagram, it was a case of a kind of rotary engine, from which a diagram could not have been obtained.

3744. Perhaps this gentleman had no better means of ascertaining what he wanted to know than by approximation?—If he had had this taught him at school he would have known.

3745. Will you now kindly continue what you were saying with regard to the formation of industrial schools?—With a view to creating schools of this kind, the first step must, in my opinion, be to train the teachers.

3746. Have you formed any scheme of a general organization for the purpose of science teaching in this country, always keeping in view its application to industrial pursuits?—Yes, I think the first thing you have to do is to make a

normal school, or a training school for the teachers. I think that your students at the industrial normal school would be best drawn from the ordinary normal schools of the country, and that they should be those young men who have shown a taste for science in those schools. They would then have had great experience as ordinary teachers from an early period of their lives, and they would have given attention to teaching as an art. Besides that, when they left the industrial normal school, they would have received special instruction in science, and in the art of teaching science. For such a school must teach the teaching of industrial science, as well as the science itself. You would in this way obtain an accomplished class of industrial science teachers such as would yield you great results.

3747. If it were objected to you, that after having taught these teachers at the public expense, they were very apt to become absorbed in other professional avocations, how should you meet that objection?—I should still say that the public would not lose anything by that, or that it would get in one form, perhaps, what it might lose in another, for such men as these would be sure to become teachers, although they might not be teachers in schools. A man who knows a specialty in industrial science is sure to make others know more or less of that science. If such men went into practical life and entered into important industries, they would improve those industries and so teach others. Every such man would in some way or other become a teacher.

3748. Having got these special normal schools, will you now pursue your scheme a little further?—I think you ought to have a special normal school to train a good number of teachers boldly to begin with. Then the next step which I think it would be well to take, would be a development of the existing system of giving grants upon results by the Department of Science and Art. I think there should be a development of that system, and I would give those grants to all schools for that particular class of scholars, private as well as public, which undertook to give instruction in industrial science.

3749. By that class of schools, you mean the class of schools in respect of which payments by results are now made?—Yes, but they are now only made with regard to public schools conducted by committees or public bodies, but with regard to the results obtained in private schools, it is to be borne in mind that by the census of 1851 there were 7,500 of those middle class private schools; a class of school below the endowed grammar school, and that they taught 250,000 children. Now, if it is wished to make industrial scientific knowledge at all co-extensive with the wants of the different departments of manufacturing industry in this country, you must more or less influence all those schools, you will only dip here and there into the ignorance of the subject, unless you in some way or other influence those private schools. What I should recommend would be, that every private school, or public school, every school of that class, in fact, should be allowed to send up candidates for examination in industrial art and science, and so get grants on results, however the school were taught; but on this condition, that those private schools should be liable to inspection. I think you would find it very difficult to get public schools established on the voluntary principle for scientific objects, with all their apparatus of promoters, committees, and subscribers. People do not do

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this kind of thing, and come to the front, and make these sacrifices from patriotic motives; it is from personal motives, and that is the reason why we have so many religious schools, it is from the personal motive of religion, and because the originators consider it a part of their Christian service. If you ignore in any case these religious motives, you will not find the people come forward readily, because the gain to any individual personally by institutions such as science schools must be very remote indeed, there might be doubts in the mind of a man whether he would ever see any results in his lifetime, and there would not be motive enough to influence the great body of men who must co-operate in establishing these schools if they are to do much. I think you must, therefore, fall back very much upon private schools, where the personal motive in the shape of the interest of the schoolmaster would exist.

3750 You have hitherto spoken only of schools for the lower middle class?—Yes

3751. Now, with regard to schools for the middle and upper classes, would you recommend any Government action there, in order to encourage the teaching and learning of science?—Certainly. Mr Whitworth has shown us the way in that matter. I think you may do that by exhibitions, fellowships, and the like, and that unless you do it by that means you will not accomplish it. I think there ought to be a free selection of the subjects of instruction, you must bring other subjects up to an equality with those now taught, in reference to endowments, or else you will never find people select those other subjects, either you must bring those other endowments down to the same level, or you must level up; you must bring the four great subjects of instruction, the classics, the mathematics, the sciences of experiment, and the sciences of observation to the same level in order to have a free selection; and I think that may be done by means of exhibitions, scholarships, fellowships, and endowments. It is to the universities that schools for the upper classes look, of course. And I think the rewards of such schools ought to be given in connection with university teaching

3752. You would look rather to legislation tending to the conversion of endowments than to any direct money grants from the State in aid of the scientific education of the middle and upper sections of the industrial classes?—No, I do not see why both means should not be employed. I think the State might very properly aid in the case of the middle and upper classes. There is a new condition of things in this country which has grown up by degrees, a certain kind of knowledge has been attained to, of late years, which very much influences the well-being of the public, and I do not see why the State should not, under these new and altered circumstances, in every way endeavour to encourage that kind of knowledge. The difference between that kind of learning of which I have spoken and the old learning is, that the old is a kind of learning which is done by the hand, with no relation to what is done by the hand, it makes nothing, and is not intended to do so; it does not make railroads or steam-engines, or build houses or bridges, or contrive machinery to economise human labour, and so promote the material well-being of mankind; whereas the other does all these things. It is that which is done by the head with a relation to something which is to be done by the hand. Of course, work of the lowest class

of all is that which is done by the hand alone. I think the universities are the places for that kind of knowledge which is head-work only, with no relation to what is done by the hand. We may divide all knowledge into two kinds, that which makes or does something, and that which makes or does nothing, and is not creative in any way.

3753 Have you formed any opinion as to whether it would be desirable to make the Royal School of Mines in Jermyn-street and the schools of a similar kind, which are now under Government control, available as training colleges for science teachers?—Yes; I think that would do very well. You have some of the very best teachers in the world at these colleges; you would have to add to their number very much; you must have a master whose business it is specially to teach the art of teaching industrial science; but I think the other professors and masters of that place would be admirable. You would have to add to that establishment a kind of great model trade school.

3754 You mean a trade school resembling that at Bristol, and by no means a school in which handicrafts were taught?—No, not all; I mean a boys' school in which the students of the normal school of industrial science should teach, and where they might practise under the eye of what we call a normal master in the ordinary training school.

3755. A school holding the same relation to science schools as the normal schools do now to the ordinary elementary schools?—I mean that there must be established, in connection with the normal school, a practising school, which should be a trade school.

3756 As is the case at the present time in the Borough-road School?—Yes, they have attached to their normal school for teachers, a school for boys, which they call a practising school, in which their teachers practise their teaching. Just such I would have attached to the normal science school.

3757. Have you formed any opinion with regard to the influence which the Science and Art Department through science schools has exercised over the teaching of science in this country?—I can only speak with regard to the teaching in our own trade school. I should say the influence has been excellent, and that the department has done good work in that respect.

3758. Do you attribute any portion of your success to the fact of your trade school being a day school?—Yes, the greater success of our trade school than the other schools connected with the department is, that ours is a day-school for boys; whereas the others are only night-schools for young men. We have the control of the whole of their time every day, we have the whole day to teach them in, and are completely masters of the situation. We devote the whole of this time in the first class to teaching them science and art.

3759 Have you formed any definite opinion with regard to the value of these night schools, in connection with the Department of Science and Art?—Yes; I think they are excellent, as they are worked in our trade school, but I believe that it is chiefly as supplementary to the day school; the boys who have been trained in the day school can carry on their instruction in the night school when they go out to a trade. A great number of those who have taken the highest prizes given by the Government at our trade school have been night-school boys who were at first day-school boys.

3760. But

3760 But with regard to boys leaving school at about 12 years of age, which I suppose is the maximum age in national schools, do you think they are sufficiently prepared to avail themselves of the teaching in night schools in connection with the Science and Art Department?—I think not at all, I think not, if you mean boys leaving ordinary national schools, they have acquired no taste for science which would induce them to make the sacrifice, and to go to a night school; and if they had, it would be very soon obliterated.

3761. *You think those night schools can make no great impression on the scientific education of the country unless primary education be more advanced than it is now?—I think decidedly not. Unless their primary instruction in science were already commenced, I think it would be futile to make the attempt.*

3762 *Mr Bagnall*] I should like to have your opinion with regard to the possibility of introducing science in our present ordinary inspected schools?—I do not think it could be introduced with any prospect of great success I think it very desirable that the schoolmaster should have a little knowledge of science, because it may become a source of interest now and then with the children, and tend generally to the opening of their minds, but I do not think that that could ever be attended with any very important results I think if it were pushed to any length, it would carry them so far out of the way of the ordinary elementary school teaching, which is after all so very important to them, that what would be gained on one side would be lost on the other.

3763. You would not, then, recommend that ordinary schoolmasters should be trained in the knowledge of science as well as the other ordinary subjects?—Certainly I would; I would recommend science as a branch of general instruction for them, it would make them useful in our villages. We have lectures and night schools in some of our parishes, and if the schoolmasters were instructed in popular science they might be useful in giving those lectures; and sometimes they might get hold here and there of a young man who was clever, the blacksmith or the carpenter of the village, and they might be instrumental in giving such a young man a taste for science, which might have good results.

3764. But you would not be disposed to make some scientific knowledge an absolutely necessary qualification for such schoolmasters?—I would rather they should have it. I strongly advocated that when I was inspector of normal schools myself, I think that it is very desirable, but is rather as a means of their general education and culture than for any special use in teaching the children of these schools, as at present constituted, in respect to age. I am thinking, however, of schools as they are now in respect to the ages of the children, not as they ought to be.

3765. *Mr. Gregory*] Would you propose, for the purpose of spreading technical instruction throughout the country, that there should be a central university in London?—No, that was not the idea that I had. I think there ought to be a normal school for training industrial science teachers, and that then the thing would work its own way.

3766 When you said a normal school a few minutes ago, did you mean normal schools
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scattered throughout different districts in England?—No; what we understand by that is a school for teaching teachers.

3767. Then you think one would be sufficient?—Yes, for the present.

3768 You mean distinct from the existing ones?—Distinct from the existing ones. I think that when the men should have completed their course of instruction in the existing training schools, they should be drafted to this normal college, that those who had afforded evidence of possessing a certain amount of scientific knowledge and capability should be admitted to this normal science college by examination.

3769 I presume, in the model school to which you refer, you would have a workshop attached?—I think a laboratory should be attached, but I do not know about a workshop.

3770 Do you attach any importance to workshops being attached to our great public schools?—I believe there is a certain class of boys who would go into the workshop, and that it might be a useful accessory, but I do not attach great importance to it I had experience in relation to a workshop when I was a professor at King's College. It was on my suggestion that the workshop was introduced there, and there was always a certain class of boys who were tempted to go down to the workshop, boys, I think, who could not do much besides; and although it was useful in that way, no great results came from it, except in the encouragement of that class of boys.

3771. In those scholarships proposed by Mr. Whitworth, you know it is a condition that manual dexterity should be part of the test of success?—Yes, because, as I understood Mr. Whitworth, he is very desirous to get in the first place the artizan class, and he would wish, if possible, by means of these exhibitions to raise their standard of education; an artizan who has a little knowledge of science, may hope, by the aid of his manual skill in addition, to win one of those exhibitions; although his knowledge of science alone would not enable him to do it, he may do it by the two combined.

3772 You do not think that the actual teaching of work is an element of much value in technical instruction?—I think not, if you mean work with the hand, unless there is some special application of knowledge to the work.

3773. That is to say, you would think it very valuable in the case of a man who might be employed in trade or manufacture in which he would have to use his own hands, but in the case of other persons it would not be so necessary?—I think not; I do not see any culture in it.

3774 A previous witness has stated to this Committee that in some parts of England there was a very manifestly increased desire for technical instruction; now, if in other parts of England there was comparative indifference on that subject, would you be at all disposed to send persons into any of those districts to lecture upon science and stir the people up?—I think that would be a very good plan.

3775 You would propose that, by the agency of the State, some of our eminent men of science should go down and deliver lectures in different parts of England to awaken public attention to the value of scientific education?—Yes, and inform the people what opportunities of such instruction would be afforded by the State.

3776. Did you ever happen to hear any of the lectures which were delivered in Ireland, until recently

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cently called provincial scientific lectures?—No; I think lectures of that sort would be of very little value in communicating instruction in science, what went in at one ear would go out at the other, the only use of them would be that they would awaken people's minds and induce them to establish science schools.

3777 They would help to show the people the value of scientific knowledge in the actual business of life?—No doubt

3778 Mr Akroyd] With respect to Mr Whitworth's scholarships, do you not think that, perhaps, one reason of his making manual skill a condition of getting an exhibition or a scholarship, was that he wished to confine the thing to the working classes, and if that were so, would you not think it desirable also for the manufacturers themselves to have some practical knowledge of the use of tools?—Yes, most desirable

3779. Mr Whitworth himself having practical skill, you would say that that would add very much to the weight of his opinion and to his authority among workmen?—Yes, but I think the gentlemen to whom you are referring would get that kind of practical knowledge in their father's establishments.

3780. You think they would get it by simply watching workmen as well as they would by using the tools themselves?—They would obtain a general knowledge, special instruction would be useful, but I do not attach much importance to the use of tools coming in as part of the education of a youth, and intruding into the business of a school.

3781 But you attach some little weight to it, perhaps?—Yes, I attach the utmost importance to the application of science to work, but I think that it may be taught and understood without the exercise of manual skill.

3782 You say that the Bristol Trade School is a Church of England school?—Yes

3783 But I understand, from the report of the institution, that in case of any objection being made by the parents of Dissenting children, they are excused from any special Church teaching?—Yes, we should object to a conscience clause, but we do that of our own conscience.

3784. Mr. Dixon] I understand you to say that, in the event of there being a central normal school established for training up science teachers, you would be quite prepared for some of the teachers leaving the profession, and becoming connected with manufactures?—Yes.

3785 I wish to ask you whether in that case you would object to those persons so trained up having received part of the cost of their education from the State?—Not in the least. I see no objection, that was one reason which was urged against helping normal schools for common teachers, it was said that when you had given them some education they would desert the business of teaching and go into other avocations, but that has not been found to be the case to any great degree. I should think the result would be the same with regard to those scientific teachers of whom we are speaking.

3786 You are not aware that it has been found to be quite different in the case of science teachers, that is to say, that they do leave their profession much more than teachers in primary schools?—I was not aware of that, that seems to me a proof of the commercial value of industrial science.

3787. I understand you to say that you would

wish that the scholars in private schools should be paid for by results, with regard to science teaching?—Yes.

3788. In such a case, how would you distinguish between those children who were the sons of middle-class people, and able to pay for their science education, and those who were the sons of the working class, or would you pay for all alike?—Already the department has a rule in that respect; that very question has arisen in our own trade school, for instance, and the department has a rule about it. I forget what the rule is, but Mr. Coomber will be able to tell you. I think that rule might be continued, and applied to private schools.

3789 Would you object to the sons of middle-class people being paid for part of their science education by the State?—It would depend on what section of the middle-class the children belong to; middle-class is a large designation. I think, for my own part, that the skilled mechanic, or engineer, or small tradesman, is quite entitled to have his son helped in his education, particularly if it be education of a kind which it is of national importance that the boy should receive. I think that is the very reason why the boy should be assisted by the State. All our educations have been assisted by funds, the distribution of which is under the control of the State; and probably there is not a gentleman in this room whose education has not been more or less *elemosynary*. I think it is cruel to exclude the lower sections of the middle class from any extraneous help by endowment or otherwise in their education, while we are helped by fellowships, or scholarships, or tutorships, or exhibitions, which are all extraneous helps to education; and I might well ask, what would our education be without them.

3790. Did I understand you to say you thought that only those science scholars got benefit from the night science schools who had had some training in the day science schools?—I think that is the case with the majority. If you look for extensive results, my opinion is that you only get them from the night schools by having your pupils first taught science in the day schools.

3791. So that you do not appreciate very highly the science teaching in our mechanics institutes?—No, nor the teaching in night schools, unless it is supplemented by day teaching.

3792. *Chairman.*] You have stated that there was, perhaps, scarcely a gentleman in this room whose education had not been helped by the State in the sense that he had received some aid from endowments?—Yes.

3793. Am I to understand that you consider the old endowments, speaking broadly, to be now the property of the State?—I do not know that the State has any right to them, and I doubt whether it has; but the State exercises control over the application of them.

3794. Mr Acland] Allow me to put to you a question which I put to many other witnesses; do you think it desirable to make Euclid the first text book in teaching geometry, or would you adopt either of the more modern methods?—I confess I am very fond of Euclid. I think the first book of Euclid ought always to be taught; I believe there is great culture in it.

3795 Do you think it desirable that, before Euclid, pupils should be taught some of the practical applications of geometry?—Yes; I think it is desirable, before they learn Euclid, that they should

should learn some practical geometry, meaning by that, geometry with the scale and compasses

3796. What do you contemplate as the future of the teachers who are selected out of ordinary normal schools and placed in the science normal schools after they have left the latter?—Some of them would, I think, be employed in trade schools, established as the Bristol Trade School is, maintained by subscription, but, perhaps, a great number would become masters of private science

schools You would then get science largely taught in the country by private schools, and if they were encouraged by grants, the teaching of science would add considerably to the income of the teachers, so that they would teach industrial science in preference to other things, from pecuniary motives

3797. Mr *Dixon*.] You would contemplate that some of these teachers would go into manufactures, perhaps?—Yes; and there they would also be indirect teachers of science.

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THOMAS COOMBER, Esq., called in, and Examined

3798 *Chairman*] I BELIEVE you are Master of the Bristol Trade School?—I am.

3799 And you have been so, I believe, from the first organisation of that school?—After the first 12 months I became head master

3800 You have been head master during the entire existence of the school, with the exception of that 12 months, have you not?—Yes, for 11 years

3801 What was your previous training?—I was at first in a normal school for two years; and next in the school in Jermyn-street for 12 months

3802 In what normal school were you for two years?—Cheltenham.

3803 Under what conditions were you in Jermyn-street?—By an exhibition that was given to the Cheltenham School by the Science and Art Department, at the instance of Dr. Lyon Playfair.

3804 Was that an exhibition awarded on competition?—No, I was selected without competition

3805 Had you had any training in science in the Cheltenham Model School, or elsewhere?—I had received lectures from the principal in chemistry, and from the vice-principal in experimental physics

3806 Are you aware whether those courses are still continued in that normal school?—Yes, I believe they are continued at the present time by a gentleman who devotes his whole time to teaching science.

3807. When you were in Jermyn-street, were there any other pupils from normal schools besides yourself?—Yes, there were two.

3808. Will you be good enough to give their names?—One was Mr. Buckmaster, who is now the organising master of the Department of Science, and the other was a young man from Scotland, whose name I do not know; he failed in his examinations, and his connection with the department ceased.

3809 Do you know Mr. Scaping, the master of the Hull Navigation School?—Yes, I believe he was trained at the Marine School at Greenwich, and not in Jermyn-street.

3810 Is that also a Government school?—I think it is in the hands of the authorities of Greenwich Hospital

3811. Was Mr. Mayer of Glasgow trained in Jermyn-street?—I think not.

3812. Are you aware whether any other pupils were sent up subsequently to Jermyn-street?—Yes, Mr. Tait, who is now geologist to the Chontales gold mines in Nicaragua, and Dr. Burkenhead, who is just dead.

3813 Are you now the only science master who was trained in Jermyn-street, Dr. Birken-

head being dead?—I believe I am the only one engaged in the work

3814 Was the organisation in Jermyn-street at that time similar to what it is at present?—Very similar

3815 There is no change in the general organisation of the Jermyn-street School, so far as you know, is there?—No.

3816 Did you work in either of the laboratories?—Yes, in the chemical laboratory, under Dr. Hofmann.

3817 Did the department pay the fees for your instruction in the laboratory?—I cannot say, I paid no fees

3818 If you had had to pay fees, that would have been a very considerable tax on your resources, I suppose?—Yes

3819 In fact, it might have prevented your availing yourself of the instruction in Jermyn-street?—Possibly so

3820. You have now the entire charge of the instruction in the Bristol Trade School, have you not?—Yes, under the surveillance of Canon Moseley

3821 And that instruction is chiefly scientific?—In the upper school, yes, in the lower school, not at all so

3822 The lower school is a preparatory school for the upper school, is it not?—Yes.

3823 The instruction there given is of an elementary literary character?—Yes

3824. Is Latin taught in that school?—Not at all.

3825 Nor in the upper school?—No.

3826 At what age do you usually admit your boys into that upper school, which may be called the science school proper?—At 12 years of age; but the standard is not a standard of age, but a standard of attainment

3827 But you find that at 12 years of age the boys generally are fit to be admitted?—That is the minimum age, the average age would be higher.

3828 What is the course of instruction in the Trade School, properly so called?—We teach chemistry, organic and inorganic; theoretical and applied mechanics, and experimental physics, including electricity, magnetism and heat; we do not teach acoustics and light, inasmuch as our pupils have no use for them; we also teach descriptive geometry, by which I mean the description of planes and solids, and apply it to the construction of machinery and building, and mathematics.

3829. When you say you apply that to the construction of machinery and building, do you mean that you give any courses or any lessons on construction?—We do; we have not done that

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that subject so thoroughly as we shall do it in future, inasmuch as our teaching adapts itself to the examinations of the Science and Art Department, and it is only just now that those examinations are beginning to take a really practical character, previously they had been merely initiative.

3830. How many pupils have you in the upper division of your school?—In the scientific division at the present moment 56 I will hand in to the Committee a table of the avocations of the boys' fathers, the intended avocations of the boys, and their names and ages

3831. What is your staff?—We have four masters. I teach chemistry, electricity, magnetism, and theoretical mechanics, the second master teaches the drawing subjects, and the applied mechanics, the third master teaches English, and devotes his attention to mathematics, the fourth master gives instruction of an elementary character in the lower school.

3832 The teaching of that master is confined to the lower school, is it?—Yes, and the third master teaches mathematics only in the upper school

3833 Are you engaged in the lower school at all?—But little in the surveillance of the work

3834 Is the second master at all engaged in the lower school?—Yes

3835 In fact, there is a common fund for the teachers applicable to both schools?—I do not think the school ought to be spoken of precisely in those terms, but in their work they are thoroughly distinct.

3836 Are the fees the same in both divisions of the school?—Yes

3837 Then, assuming for a moment that the science school were to be entirely separated from the lower division, would that science school be self-supporting, including the grants which you receive upon results?—I am not prepared at once to answer that question, but I think not

3838 But which of the two pays most; the lower to the upper, or the upper to the lower school?—Since the lower school contains the majority of boys, it certainly contributes most through the fees to the upper school, but inasmuch as a great part of our income is derived from the assistance we get from the Science and Art Department, the upper division comes in with great strength

3839. What is the average amount of the aid received from the Government?—Between 200 l. and 250 l. per annum.

3840. Assuming these two schools to be separated, do you think the science school could be carried on?—I do not think it could, either as regards income, fees, or as regards the supply of properly-prepared pupils.

3841. What are the fees?—Fifteen shillings the quarter, these fees are paid in advance. We commenced with a very low fee, namely, 3 s 6 d a quarter. From Canon Moseley's explanation of the origin of the school, the Committee will see that at its starting it depended to a great extent upon subscriptions; when the school assumed its higher character, the subscriptions fell off, and it became necessary at the end of two years to look for a new source of income. At my suggestion the fees were raised to 5 s 6 d. a quarter; that, however, was not found enough, and I then suggested that the fees should be raised to 15 s a quarter, which would make the school at that time pretty nearly self-supporting. After con-

siderable hesitation I succeeded in getting this hazardous step taken, and in order to satisfy people who were still subscribing, I suggested a scale of exhibitions which may be interesting to the Committee, inasmuch as it has an application to the question of sustaining these institutions by local aid. The fee for the school is 3 l. per annum, every subscriber of 3 l. has the power of nominating a boy to the school without the payment of fees; that is to say, we call on every boy to bring into the school, either by himself or by his friends, 3 l. per annum. The nomination of the subscriber of 1 l. would relieve a boy of the payment of one-third of the school fees; of two such subscribers, of two-thirds, and three such nominations would enter him free. We have at the present time six free exhibitioners, and one whose exhibition only extends to one-third of the school fees. In this way subscribers have a return for their money in the education of those in whom they take an interest. I think that plan might be carried out in the support of local schools of this character elsewhere

3842. But that plan does not increase the revenue of your school, it only goes in the reduction of your fees?—It does not matter to us how the money comes in, provided we have an income which pays for the education of the children.

3843 Do I understand you to say that the 3 l. per annum from the children, and the grants on results from the Government, are sufficient without subscriptions to maintain the school?—At the present moment it is very nearly so

3844. You having, however, the building rent free?—Yes, having the building rent free; the school income is now more than its expenditure; it has cleared off a debt.

3845 Is there a laboratory attached to your school?—Yes

3846 Is that laboratory used exclusively by the school?—No, the laboratory is used, firstly, for the purpose of the experiments that illustrate my lectures, secondly, for my private work, thirdly, for the education of the pupils in practical chemistry at night. We have only a night class for the purpose

3847 And the entire amount of your grants from the State is about 250 l. a year?—Yes.

3848 What is the entire income of the four masters from the school and the State?—Between 500 l. and 550 l. per annum.

3849. Have the masters any other sources of income?—Yes, I have a source of income in the lectureship at the medical school in Bristol, in which I have just succeeded the late Mr Herapath, and another source of income in my private work and in the teaching in the laboratory; one of our masters finds additional sources of income in teaching machine drawing in Clifton College, and in two of the leading boarding schools in the city; the master engaged in teaching mathematics also adds to his income by private teaching in that subject.

3850. Then, unless there were these sources of income, it would be impossible, I suppose, to secure such a staff of teachers as would be necessary to carry the instruction to the point to which it is carried in your school, even with the Government aid; you would not be able to exist as masters unless you had other sources of income, would you?—Yes, we could live on the incomes we derive from the school.

3851. You mean that for 500 l. a year you can provide

provide a staff of four masters, some of whom are highly qualified as science teachers?—We should not live so comfortably without the help of those additional sources of income

3852. Would you be content to live in that way?—I should not be content at the present time to suffer any loss of income

3853. Do you think it is possible to establish such a school in a fresh locality with an allocation of 500 *l* a year for the salaries of four masters who shall be competent to conduct such a school, as the Bristol trade school?—I think you might very reasonably start with such a sum, for I do not think you would require four masters in a new school, and moreover you might very well charge a higher fee for the instruction, the boys could well afford to pay more than the boys are paying now at the Bristol school

3854. What are the pursuits of the parents of the boys at your schools?—They are the very first class of mechanics. The class of the parents of the boys has gradually risen with the fees, and so has their appreciation of the education given. We absolutely had some difficulty at first to make them receive the education. We met with exceedingly little sympathy on the part of the parents and friends of the boys, but we have now no difficulty at all

3855. But if it were proposed to establish schools of this kind for the sons of labourers earning from 12 *s* to 18 *s* a week, would you consider that possible?—I should consider it in the highest degree impracticable, because no labourer could afford to keep his son at school long enough to do any good with such instruction as ours, the labourer would be forced to have his son's wages.

3856. Your school has been remarkably successful with regard to the number of Queen's medals and other prizes which the pupils have taken at the periodical examinations of the Science and Art Department; to what do you attribute that success as compared with the success of other schools?—High rewards are taken in our night classes, but we have already done half the work in the day-schools, and the consequence is that we have an immense start in the race.

3857. That is to say, the boys who take those rewards in your night classes have been previously kept at a good science day-school up to the age of 15, or thereabouts?—Yes.

3858. And without such preparatory instruction you think it would be difficult to obtain equal results, or results approximating to those which you have reached in your night classes?—I am sure of it. We only make any success at all in our night classes with those pupils whom we have not previously taught, in those sciences which require very little preliminary work. For example, we make very good success in machine drawing and architectural drawing, much better than we make in descriptive geometry, which is still more difficult, and as to still higher subjects, such as theoretical mechanics, we get no one to enter that class who has not already been educated in our day-school, or otherwise received a good education. The members of my class in theoretical mechanics last session were students of the Baptist College, who had received a good mathematical education, and my own former pupils alone. I had no others.

3859. You would say that as a subject advances in difficulty so the probability of a pupil's

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entering himself for such a subject diminishes?—Yes, certainly. In fact I have some difficulty to induce my boys, who really ought to do so, to continue their studies in theoretical mechanics, and it is only a very few who do continue that study, because, as the boys say, it is impossible to get a higher position reached in theoretical mechanics than they have reached in the school, whereas in other subjects, such as drawing or experimental physics, their work tells

3860. It is easier for them to take a high place in the examination for those subjects than in the more difficult subjects?—Yes, in theoretical mechanics I am within bounds in saying that although 80 per cent. of the boys who leave us would find their interest in continuing the study of that subject rather than any other, yet even with all the influence that I can bring to bear upon them, from having known them before, I cannot induce them to do it. You will see from the lower paper of the examination the point to which mechanics may be taught; but with regard to the higher paper, I think that mechanics, speaking of the class we have to deal with, never can be taught up to that point.

3861. Then, in addition to the difficulty in inducing students to prepare themselves for those classes, the labour of teaching those classes is very much greater?—Yes, there is no comparison. I may put in three times the work to that subject, and not get half the results that I should get in such a subject as experimental physics. That is a subject boys are extremely fond of, and which they take up in a very ready manner; but still making every allowance of this kind, there ought not to be the difference in the results which we find exists.

3862. I believe the payment on results is the same per head in each case?—Yes

3863. Would you say that that is an encouragement to masters to take up the more difficult subjects?—It is a question which hardly requires an answer.

3864. Would you say decidedly the reverse, and that it is a great discouragement?—Looking at the returns which I hold in my hand, I find that theoretical mechanics, which is the most important subject on the list, is almost deserted; whereas other subjects will have six or eight sheets of results throughout the country, one single sheet, or at most two sheets, of foolscap paper, suffices to give all the results throughout the empire in theoretical mechanics.

3865. And that you say arises partly from the reluctance of the pupils to prepare themselves in the subject?—The subject is made too difficult for the class of people who have to deal with it. Canon Moseley has said all that can be said on that subject, the teaching which he figured out is the teaching which we ought to be induced to give

3866. Then, what would be your remedy for this state of things which you consider to be so undesirable?—With regard to this subject of theoretical mechanics, I think it should receive in the teaching the simple practical character that Canon Moseley proposes.

3867. And then you think the masters would devote themselves to it for the same capitaton grant which they receive for teaching inorganic chemistry or physics?—I do not think that inorganic chemistry, as they examine in it now, is at all an easy subject.

3868. You think the teachers would devote themselves

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themselves to teaching theoretical mechanics, and that the pupils would be prepared to take up that subject if the examination were of a more practical character?—Yes.

3869. And that without any change in the capitation fee?—Yes; if it were recollected what an apprentice-mechanic, or a boy studying mechanics, could be expected to do.

3870. With regard to metallurgy and mining, and other subjects, would you say the same?—As far as I know, the examination in metallurgy and mining is very good, both practical and practicable; but of all the subjects that we are examined in, I think the most practical papers are those given by Professor Tyndall in physics. He says, "I want the students to know this, or I want the students to do that." Above all, he demands an experimental knowledge of the subject. It is a very taking subject, and I do not think there is a lad in my class who studies experimental physics who has not made his electrical machine. I may, perhaps, add here, that I intend to recommend the Committee to set up a carpenter's bench, with a tanner's bench, with lathe, tools, and so on, at Bristol; for almost all my boys are now at work in making experiments which illustrate the science they are studying. I am so strongly convinced of the value of that, that I am disposed to foster it all I can; namely, to teach the boys to handle tools, so that they can make their own experiments. I had to learn it myself; and I look upon it as one of the faults of my original training as a teacher of science that I was not prepared in that respect.

3871. You would not for a moment propose to substitute workshop teaching of that kind, I suppose, for a real apprenticeship in the workshop?—No; it is merely to assist a lad in the study of science.

3872. You would do that entirely regardless of any time which it might or might not save the boy in his actual apprenticeship?—I had no thought in that direction. I was merely thinking of the increased power of studying and acquiring experimental science, which is given by the ability to use a few simple tools.

3873. Is there a museum in connection with the teaching in your trades school?—Yes; but we have never made any great point of it. I looked upon it as a failure at first. In an institution like ours, which must of necessity struggle to make both ends meet, we cannot afford any portion of the time of the master to the museum; and besides, we could not afford the time to exhibit the museum. In an institution like ours, I think a museum altogether out of place, and impracticable.

3874. You think a museum is of no use unless it is systematic and tolerably complete?—My opinion only goes to the connection of a museum with a trade school.

3875. You think you could not hope to have a complete and systematic museum in connection with a trades school?—No.

3876. You spoke of the questions in experimental physics as being eminently practical, and you referred to a paper published in the Directory of the Science and Art Department as a guide to teachers, is a similar course adopted with regard to other subjects?—There is in each case a sort of syllabus of the course of instruction, but in no case is there a syllabus which is of the value and directness of the one I speak of.

3877. You think it would very greatly facilitate the efforts of teachers if a similar plan were adopted with regard to other subjects?—Certainly, if other examiners would deal with the syllabus in the same practical and direct manner as Professor Tyndall.

3878. Of course you do not expect that it should be carried so far as to indicate to you what the detailed nature of the examination was to be?—Certainly not, but only clearly to define the course of the teaching, so that if a man has done a certain amount of work, he may be certain that his work will tell.

3879. Mr. Acland.] In the same way that the examinations at Cambridge or the London University are defined?—Yes, I know the London University definitions very well, and I think they are very practical and just to the point.

3880. Charman.] There is a mining school at Bristol, is there not?—Yes.

3881. Is there any connection between that school and your trade school?—Yes, they both go on under the same roof, and the pupils of the mining school are each of them connected with the trade school, receive all the science lessons, and pay the whole fee of the trade school, but the notion of the school at present is, that it shall be self-supporting, and it is so; in addition to that they pay 7 L. per annum to a mining engineer for lectures on his branch of technology.

3882. Can you give the Committee the history of that school?—Yes, the school grew up with the trade school, and owed its origin to the exertions of the late Mr Mackworth, the mining inspector; the school was supported by voluntary subscriptions, the fees being only nominal, 3 s. 9 d. in every case, those who were sent to this school were the sons of coal miners from a distance, who could well have afforded to pay for their education. Upon the death of Mr Mackworth, the energy which had sustained the subscriptions to the school was lost, and the subscribers gradually dropped off, the only gentleman who stuck to the school at all being Mr. Handel Cossham. I do not exaggerate when I say that during the last three years of that mining school Mr Cossham must have spent, at the very least, 100 L. a year upon it, out of his own private pocket. I constantly protested against this state of things, and told Mr. Cossham that he would get tired of such an expenditure. And thus, of course, was at last the case. He declined to pay the master's salary, and the school closed. I will hand in a pamphlet to the Committee, explaining my views upon the proper mode of conducting a mining school. On my own responsibility, with the consent of Canon Moseley and his co-peers on the Committee, an excellent mining engineer has been employed, who is now giving lectures in the school, and receives for his remuneration only 7 L. per annum for each pupil, and although the school on its present basis has only had six months' start we have eight pupils, and his income from his lectures is 56 l. a year, we hope the next year we may get some supplementary aid by means of the Department of Science, for this gentleman will assuredly get a certificate; but there is this difficulty in the way, of course a man cannot live on 56 l. a year; he has an office in the city, as a mining engineer, but the coal-owner of Bristol do not carry on their mining with any great appeal to science, and consequently there is not much work for a mining engineer in the neighbourhood, so that I fear he will carry his influence to the other side of the river, and the

of course our mining school will fall to the ground again for the want of a master, but I am seeing Mr Handel Cossham in London to-day, in the hope of getting some guaranteed employment for this master to keep him on this side of the Severn, when, no doubt, the mining school will flourish.

3883. You hope that with some extraneous aid you will be able to maintain this school?—Yes, not money, but employment for this gentleman as a mining engineer.

3884. That is to say, you do not think it possible to procure a teacher who should not be engaged in some professional avocation, in addition to teaching in the school?—At present, not, but as the school goes on I believe we could as fairly charge 14*l* a year as 7*l* a year, and by the raising of the fees we might make it worth the while of a teacher to devote his whole time to the school.

3885. Do you think the difficulties of the school would be very much diminished if it were situated at Merthyr Tydfil instead of Bristol?—Yes; I think at present a school at Merthyr Tydfil would be more favourably situated with regard to the employment of a mining engineer to teach mining, but there would not be the means of giving instruction in general science, which we have at Bristol.

3886. But assuming that there were a trade school attached to a mining school at Merthyr Tydfil, do you think the number of pupils entering themselves would be very much larger than the number at Bristol?—Yes, certainly.

3887. Then do you think it is desirable that secondary schools of this kind should be established in the various centres of industry?—Yes, I believe the public are beginning to see the necessity of insisting upon it.

3888. Do you think there would be any difficulty in procuring teachers of science for such schools?—Not at all.

3889. Do you think it is necessary, as Canon Moseley has said, to train these teachers specially, or do you think they are already existing in embryo?—We have a number of teachers of science scattered throughout the country, who have been called into existence by this Minute, and who have never cost a penny, and if they leave their profession, the State has nothing to regret, for they have been of no cost, they often do examine those teachers, and if they have reached a certain standard, pay them on the results of their teaching, though they do not assist them to reach that standard.

3890. What do you think of Jermyn-street as a school for training science teachers, you having yourself been a pupil there?—As far as chemistry is concerned, I think it is an excellent school, but with regard to physics, it lacks the element which I have just spoken of as being a desirable element to introduce into my own school; there is no physical laboratory, and there is no instruction in fitting-up and making apparatus, my own apparatus for illustrations in experimental science has cost me nothing since the foundation of the school, everything I have wanted since that time I have made; this kind of apparatus is costly, and unless a man is prepared to deal with his subject in that way, he will be fettered for want of the power I speak of.

3891. You know that mathematics are not taught in Jermyn-street?—No; and I think that is a great blot in the school, but my idea of a model technical school is the school which has

just been established in Dublin; adding to that technical school in Dublin a physical laboratory to instruct the teachers in the construction of apparatus, you would have a perfect school.

3892. You are now speaking of a school for teaching teachers?—Yes.

3893. As a technical school, do you also consider that a model school, as far as the programme goes?—Yes; there is one point in connection with the history of the Dublin school which I may refer to here, the authorities of the school insist upon two of the most important teachers devoting the whole of their time to the students, they are not allowed to come and give their lesson and then go away again regardless whether the student has received solid instruction or not, their duty is to devote the whole of their time to the students; those teachers are the teacher of engineering, and the teacher of mathematical surveying, now, in the technical school in Jermyn-street, which is called a mining school, the subjects of surveying and levelling are not taught, moreover a student will attend that school, and, if he is a working man, he learns from it; but there is no such thing as interrogation or recaptulation, or anything to ensure sound progress where the work is not met by diligence, now, I think, you can only get a small per-centage of results unless you have diligent recaptulatory hard work.

3894. Would you say that in a school of that kind, there should be an entrance examination, or some certificate standing in the stead of an entrance examination?—I think there should be an entrance examination; and that no certificate to guarantee that the student is prepared to receive the instruction which is given in the school should be taken in lieu of this.

3895. You contemplate the training of teachers for secondary schools, for schools of the class of the Bristol Trade School?—Yes, I have not yet addressed myself to the point of their education as teachers, there is one point on which I might supplement what Canon Moseley said, that is to say, as to the work of those students in such a school as mine, it would very much damage my school if I had a young man who was to come in, say for a week's teaching, to be followed by another young man who came in for a week's teaching. I could not get on at all in that way, but, if you will give me a young man who has done his work at the school, and let him come to me to work for a year, that would be a practical method of enabling him to acquire skill as a teacher, but for men to be coming in, in succession, that would never do.

3896. You think that normal schools conducted on that plan, however desirable they might be for teachers, would be very undesirable for the head master, who is responsible for the children?—No doubt of it.

3897. Now, with regard to teachers of elementary science in evening classes, such as those scattered up and down the country, what do you think of the minute which has recently been passed which allows payments to be made on results to persons who have passed the May examinations, but who have not passed any special teacher's examination?—I do not attribute any evil to that; the success of a man as a teacher does not depend on the number of certificates he gets, but upon his work. If he makes his work tell, he gets pupils; and if he does not, all the certificates in the world will not bring

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him any I do not know that the department of Science and Art has damaged science teaching by that minute in the least.

3898 Do you know what are the opinions of science teachers generally with regard to that minute?—No, but I know that in science teaching, like other matters, you very soon get introduced to the feeling of monopoly.

3899. Are you not afraid that persons who are not qualified should take classes, and they being unsuccessful in the conduct of those classes, that the whole system should suffer in reputation?—There is a danger in that direction, but I think it is compensated by the fact that people will now have science education, and if they cannot get it one way they will get it another.

3900 Have you considered the Minute of the 21st of December, establishing scholarships and exhibitions in connection with the Science and Art Department in reference more especially to elementary schools?—Yes; with regard to the 10 *l* scholarships, I am desirous to avail myself of the benefit of that in the trade school. I have two boys who are very clever; their friends have struggled to keep them at school up to this time, and they would derive considerable advantage from being kept another year at work; and now, if they get each one of those 10 *l* scholarships, they will be able to stay another year, which will be much to their advantage, and to the advantage of the master to whom they may hereafter be apprenticed.

3901. But suppose your school were an ordinary elementary school, or even a good elementary school, do you think a boy would derive much advantage from remaining at school under that minute?—No; the teaching of the school cannot be directed to that one boy.

3902. You think it is not desirable that it should be a condition that he remained in an elementary school?—I should think that his remaining in an elementary school would be impracticable.

3903. Is there anything you wish to add to your evidence?—With regard to payments on results in connection with the papers of the department, it seems to me that it is necessary that the payment on results should be supplemented by some additional aid apart from the results on examinations attendant upon work.

3904 What do you mean by work?—The department now on the art side pay a teacher for work independent of results, but it is not so in connection with science; there is a case in our own school, it is not of great importance to us, because the master who teaches the subject does not depend entirely upon it, but it would be important where a gentleman was engaged in teaching applied mechanics only. In this subject the department have changed the examiner without communicating at all with the teacher; the teacher teaches with the hope of doing something with a particular order of examination, but any one has only to cast his eye over the two last examination papers (which I hand in) to see that the treatment of the subject by the two different examiners is as widely different as it could possibly be made, so that the teacher who has been at work with the hope of getting results in that subject in the former kind of examination, cannot possibly be at all well paid for his labour, and that introduces an element of failure into the system.

3905 How would you prove the work without results?—I have not set myself to the solution of

that problem, and there is a greater difficulty in the case of science than in the case of art; but unless a teacher is to be driven away in disgust, such a contingency as this must be guarded against.

3906 It is Mr Anderson who has succeeded to the Rev. Mr. Cowie as examiner in this subject?—Yes.

3907. And Mr Anderson being superintendent of machinery to the War Department, his questions will probably be of a more practical character than those of a gentleman who, though he is a member of a University, has not given his attention so much to practical questions in mechanics?—Yes, I think it is a most fortunate thing that the department have made the change. I mean fortunate for our school, and for other schools of the kind, but under the circumstances it is very bad for the teacher, and this present examination is very seriously affected by the change in the treatment of the subject.

3908. Would you say that upon the whole the examination papers set by the department are adapted to the class of persons whose instructions they wish to encourage?—Most decidedly, the majority of the papers are very fair and very practicable.

3909. You would take exception to one or two subjects, in one of which you think the remedy has now been applied?—Yes.

3910. Mr. *Acland*.] But do you think that Mr. Cowie's papers are set for schools such as yours?—Yes.

3911. Are there many other such schools as yours in the country?—I do not think there are. There have been one or two attempts, but our school is the only one which has succeeded.

3912 Are not those papers set for some other purpose, perhaps?—I now see the drift of your previous question. The object of the examinations of the department, as far as I know, is to educate the working classes in science, and they only pay for results on the working classes. It would be absurd to suppose that their examination was intended for any higher class. What I say is this, my school, from the fact of my having them entirely with me, has special advantages in this subject for the class of working men, and if it hits my school hard, how much harder must it hit the classes of workmen throughout the country.

3913 Those papers presume a considerable amount of mathematical knowledge, but there is not much systematic teaching of mathematics in your school, is there?—Yes, there is. We teach, and that is all we can do, up to the lower elementary paper in mathematics in the Science and Art Department. That is to say, a little trigonometry and logarithms, and algebra, as far as simple equations with the first book of Euclid.

3914. But, if I understand that paper of Mr Cowie's, it implies a knowledge of conic sections, and also even some knowledge of Newton?—It implies altogether a higher mathematical treatment than we can get from boys or working men.

3915. But there are working men in England who study mathematics, are there not?—No doubt; but we are talking of the mass of working men.

3916. But is it not the fact that there are a good many working men in England who do study mathematics?—I have heard of isolated cases in the north of England.

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3917. May not those questions in Mr. Cowie's paper be intended for such men?—If the questions be intended for those men, how unfair they are to the teacher who has been working at different corners of the country in getting up average working men in the subject.

3918. This paper, however, does presume a mathematical education?—Yes.

3919. Which do you not profess to carry beyond a very limited extent?—Just so.

3920. The question is, whether artisans are prepared to answer such questions, or desire to do so, is it not?—To that question I say decidedly no; the point I am addressing myself to is this, the possibility or impossibility of doing this with average working men.

3921. Mr. Potter.] Do you pay any rent for your school?—No, we pay taxes.

3922. What would be the value of the building if it were let?—The rateable value is 36 l. a year.

3923. What are your subscriptions?—They amount now to 60 l.

3924. You receive on an average from the Government 250 l. a year?—Yes.

3925. That is 350 l. a year, which you receive from extraneous sources?—Yes.

3926. And your school could not be carried on without that fund, extra to the fees?—Just so.

3927. You educate about 140 scholars, do you not?—Yes.

3928. Mr. Acland.] Your total income is about 700 l., is it not?—Yes.

3929. Mr. Potter.] Half of the support of your school comes either from subscriptions or from the Government?—Yes.

3930. Mr. Acland.] Then what did you mean when you said that your salaries were 500 l., and that you had 450 l. from fees?—The fees have not up to this time reached 300 l. a year, but they will, I have no doubt, this year be nearer 400 l.

3931. You have 140 boys at 3 l., you say?—Yes, we have now; the school has grown rapidly lately, but we make some bad debts, and you have also heard me explain our scheme of exhibitions, which brings down the fees according to the extent to which it is employed.

3932. Mr. Potter.] Practically, the school is only half self-supporting?—Speaking with reference to the fees, that is a very fair statement, I think.

3933. Chairman.] Does the 3 l. cover the cost of books and other things which the school provides?—The school provides nothing.

3934. Then what are the other expenses of the school in addition to the salaries?—Keeping the place clean, and keeping it in repair, finding chemicals and apparatus, to which 10 l. a year is devoted.

3935. Mr. Acland.] Do you think you have fully satisfied the demand for such education at Bristol, or do you think that if your school were much larger it would still be filled?—The school is growing, and I think we shall grow with the demand, but I think we now do all the work for the class we cater for, which has to be done at present; there is, however, a very great enthusiasm awakening with regard to technical education, and we have room to grow in the building itself.

3936. Do you suppose that the fees of private schoolmasters for teaching the same class of boys are higher or lower than yours?—They are a little higher for the same class of boys in
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private schools, I should say a guinea a quarter, T. Coomber, Esq.

3937. The additional 6 s. is paid for the sake of fashion and social importance, I, suppose, but you think, perhaps, that if there were a wider system of schools like yours, such schools would be more sought after?—The private schools cannot offer the same advantages which we offer.

3938. Mr. Akroyd.] You divide the instruction carried on in your school into three heads the trade school, the mining school, and the evening classes?—Yes.

3939. In your day school you give as the number of the science scholars about 50, but you have about 82 boys in the elementary school?—Yes.

3940. And no boy can be advanced from the first division to the science school without a satisfactory acquaintance with the elementary subjects?—No, we demand an accurate knowledge of fractional and decimal arithmetic, and the power to spell with absolute correctness.

3941. In fact you make some knowledge of those elementary matters, reading, writing, and arithmetic, a condition of admission to the Science School?—Yes.

3942. You have in your evening science classes how many?—The report gives the result of our last year's work with regard to the number. The total number of individual students was about 140.

3943. So that in fact you have nearly three times as many science students in your evening classes as you have in your day school?—It is so.

3944. Out of those 140 students in your evening classes how many have attended the day school?—At a guess I should say one-third.

3945. Then the object of your evening classes was to extend instruction in science, and to give the older pupils an opportunity of keeping up their knowledge after they had left the day-school?—We looked to our older scholars for support in the evening classes, but not alone to them, the chemical class is larger than any other, and the great majority of the pupils are druggists' assistants or apprentices, and those who live to some extent by practical chemistry.

3946. How many of the 140 students belong to the artisan class, or the working class?—There are very few who do not, very few that we cannot claim upon, the Department of Science and Art only pay for results on men in the position of artisans who are not paying income tax. I shall be giving the maximum of those who do not belong to that class if I say that we had not more than 10 altogether last time, whom we could not claim upon.

3947. In fact you would call these evening classes specially for the benefit of the working class?—Yes.

3948. Chairman.] Was there, in your judgment, any straining of the conscience at all in regard to the rank in life of these people?—No.

3949. Mr. Akroyd.] I should like to get at the results of your trade school in the evening classes, not merely with regard to examinations under the Science and Art Department, but with regard to their influence on trade and manufacture; can you then tell me what has become of the 140 students, and whether any of them have been placed advantageously in connection with our trades or manufactures?—I can speak for my own subject of chemistry, and I can say this, that every chemist engaged in manufactures in Bristol, save one, has been educated by me
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3950. Are there any large sugar manufactories in Bristol?—They do not employ chemists; the chemist at the gas works was my pupil, the chemist at the alkali works was my pupil, the chemist at the vitriol works was my pupil, the chemist at the sal-ammocac works was also my pupil, and I might go on still further by appealing to my memory, but this I have ascertained, that there is only one case in which a chemist is employed in that city where the chemist has not been trained by me

3951 Can you explain the exception with regard to the sugar manufactory?—They did employ a chemist, but have ceased to do so.

3952 *Chairman.*] Did many of those gentlemen receive private instruction from you in addition to class instruction in the day or the night school; in putting that question, I include in the class instruction everything which is paid for by the ordinary fee, and I exclude everything that is not?—I can scarcely answer the question put in that way; every class has its scale of fees, the class for lectures on the principles of chemistry has one scale, and the laboratory class, which is necessarily expensive, has another; but every one of the gentlemen of whom I have spoken have not only attended my lectures, but have also worked in my laboratory and acquired a knowledge of practical chemistry

3953 But laboratory practice would not have been necessary in order to enable him to get a prize from the Science and Art Department?—No; of course it helps him, but he might do without it.

3954. *Mr Dixon*] In Birmingham we have an institution where there are science evening classes, but no day classes, therefore, the class rooms are not opened during the day. I presume that you would recommend the establishment of day science classes in such a large town as Birmingham?—Certainly, and you would find in your night classes the advantage of such a step

3955. From what class of people would you expect the people to come to those day classes?—

I cannot do better than ask the Committee to cast their eyes over that paper which I wrote in my class-room yesterday, from the mouths of the boys, they are of the superior artisan class and the lower shopkeeping class.

3956 What scale of fees would you suggest should be charged in a place like Birmingham?—I think you might well charge a guinea per quarter, and then with the assistance of the department you would doubtless realise a sufficient income; but in addition to that you might enlist local sympathy by a system of local exhibitions such as I have suggested.

3957 Do you think the masters that we already have for the evening classes could undertake the teaching of the day classes, or that we should require a different staff of masters?—We do the work of both in our school, and you introduce an element, as far as expense is concerned, when you come to talk of two staffs of teachers, which makes the practicability of the step rather more doubtful.

3958. Have you any other suggestions to offer with regard to the establishment of day schools for science in large towns, such as Birmingham; I mean any suggestions based on your own experience in Bristol?—No, I don't think you could do better, to start with at any rate, than to adopt the plans we have found practicable in Bristol.

3959. *Mr Aroyd.*] Do you believe, from your experience, that there are many advantages in combining day schools and evening classes in the same building, and under the same staff of masters?—Very great advantages; for example, in descriptive geometry, speaking broadly, we can only work that subject in our night school with those pupils whom we have prepared in the day school; the artisans come in unwilling and perhaps incapable of making the effort which is necessary for that severe study; so that unless we have a day school to take the students over the threshold, we can hardly hope to do anything with them in studies which require great mental exertion.

The Rev JOHN G CROMWELL, M A, called in, and Examined.

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3960 *Chairman*] You are a Master of Arts of Oxford, and the Principal of St Mark's College, Chelsea?—Yes

3961. St. Mark's College is a college for elementary teachers in connection with the National Society?—Yes

3962 You were formerly Principal of the Training College at Durham?—I was

3963 Your attention has, no doubt, been drawn to the question of the introduction of instruction in theoretical and applied science into our elementary schools?—To a certain extent.

3964. And to the acquisition of the requisite knowledge by the future masters who are in training in the normal schools?—Yes, that was more the case formerly than it is now, more the case 10 years ago than it has been for the last few years, inasmuch as the examiner of that time was in the habit of putting questions which required a fuller knowledge of science from our students than has been the case since 1863

3965. Do you attribute that partly to the change in the person of the examiner, or is there any other cause?—I attribute it not to that change,

or, at all events, not mainly to that change, but to the very great change which took place in the elementary education of the country, at the introduction of the Revised Code, it lowered the standard of the education of the students in our training colleges, and we were discouraged from advancing them as far as we had done previously

3966 How did that discouragement arise?—Before the period to which I refer, it was common for the Government to make special grants towards lecturers in training colleges. Physical science was one of the subjects to which a special grant of 100 £ a year was devoted by the education department in Downing-street. Any normal school might have that grant by sending up for examination a competent teacher, but the grants were withdrawn, and the result was that it was found impossible to maintain competent teachers in science, and the subject dropped out of the curriculum of study in most of the normal colleges.

3967. There was a grant of 100 £ a year to each of those colleges?—To each of those colleges which might send up a gentleman who could pass the examination, after that the gentleman continued to receive the 100 £ a year so long

long as he satisfied the inspectors that he was doing his work in each normal college well

3968 And that is now done away with?—That is now done away with

3969 The reason why that was done away with was because it was thought that there was no necessity for the future teachers of elementary schools to possess that knowledge, and the capacity of communicating it, I suppose?—That was so, and, as a matter of fact, we were not paid any longer for teaching those subjects

3970. You believe that was because the Government did not consider it essential that those subjects should be taught in our ordinary elementary schools?—Yes

3971 *Mr. Acland.* What is your opinion with regard to the value of science as an element of teaching in a primary school?—I should say it would be impossible to teach science, in a perfect and complete manner, in primary schools, but what I do conceive is possible is this, that in all primary schools a certain amount of elementary knowledge of scientific principles might be communicated, which would be of common use and common application in the ordinary walks of every-day life.

3972 You are aware what Dr. Dawes did at King's Somborne School, are you of opinion that such a use of science as that which was made of it by Dr. Dawes in that case, the age of the pupils being, of course, taken into account, would be advantageous in all primary schools?—Yes

3973 Would you extend that to town as well as to country schools?—I should make a difference, of course, in different schools.

3974. But you think that that might be adopted as a principle?—Yes.

3975. Then what difference in detail would you make?—Probably the schools in the country would select a schoolmaster who could give instruction in agricultural chemistry, or mensuration, or land-surveying, or vegetable physiology, while managers of schools in towns would select a man who could give instruction in applied mechanics. I used to have applications from sea-board towns for persons who could give instruction in navigation, that is what I mean by making the instruction suit the wants of the locality.

3976. You would, of course, say that the extent to which science could be taught must be limited, among other things, by the age of the pupils?—Yes.

3977 But as an element in the preparation of the master to teach and interest his scholars, you think natural science should enter?—I think so

3978 Will you give us briefly any results of your experience either at Durham or at St. Mark's which you think apply to this instruction in primary schools?—I think there is one subject which should be taught in all primary schools, I mean geography, it may be within the knowledge of this Committee, that by the Revised Code, even the most elementary knowledge of geography is not required, but I think it ought to be required; I think there should be in every primary school a certain amount of commercial geography taught, and also a certain amount of physical geography taught; now, it would be the physical geography which would touch upon the question of science, that physical geography of which I was myself a teacher at Durham for many years. Although you cannot say it is a

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precise, or an accurately scientific subject, yet it touches upon many important and useful subjects in science. In order to understand physical geography, the pupils must know the principles of heat and light, and the laws of matter and motion, the subject also brings them in contact with geology, and more or less with minerals, and the facts of animal and vegetable life. This is a subject then which, in my opinion, should be taught in every primary school, I think I should make it a condition that no school should have a grant from the Government in which that subject was not thoroughly taught. In order to teach it thoroughly, the students in normal colleges ought to have some knowledge of the principles of elementary physics

3979 First, then, the Committee understand you to say that you think physical geography is one of the most essential elements of knowledge when we go beyond what are called the three R's in all primary schools?—Yes, in both town and country.

3980 And you think, in the second place, that physical geography could not be intelligently taught by a master who had not received a grounding in the elements of physics?—Quite so.

3981 Is it your opinion that normal colleges could advantageously give such scientific knowledge to the teachers as you now refer to?—Certainly, many of them could, for example, at St. Mark's College, there is a special laboratory provided with all the ordinary apparatus for giving regular lectures in chemistry, and there is a number of models for giving regular courses in mechanics. We have also the apparatus which would enable a lecturer to give courses on heat, light, and electricity.

3982. That laboratory has been established a good many years, has it not?—Yes.

3983 Its origin, I believe, was not at allowing to the action of the Government, but to the sense of its importance in the college?—That is not within my knowledge

3984. At all events, its origination was long anterior to the recent examinations of the Science and Art Department?—Certainly.

3985 Speaking generally with regard to training colleges, is that loss of 100*L.* a year a very great consideration, and one which would be very detrimental to their power of giving scientific instruction?—Certainly, because it very nearly prevents the possibility of securing competent lecturers

3986 A college must be in exceptional circumstances to be enabled to carry on its teaching without that Government aid, you think?—Yes, that is proved by the fact that in most of the training colleges the instruction was given up when the grant was withdrawn

3987. *Chairman*] Is it the case that some of the training colleges are again taking up the subject of physical science?—Yes, that is under the encouragement which has been offered by the Department of Science in South Kensington. At St. Mark's College, I think, we were among the first to resume scientific instruction. When I went there in January 1865, I found the laboratory closed, and no lecture had been given for some time, but within a few months I opened the laboratory, and, with the consent of the Council, I appointed a teacher who had passed the examination of the Science Department at Kensington, and since that time we have annually sent in candidates from the college to that department at South

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Kensington, and we have received grants sufficient to enable us to retain his services

3988. You mean grants on results?—Yes.

3989. *Chairman*.] The students being regarded as poor students?—The students being regarded as poor students, they are almost all of them the sons of artisans who can conscientiously fill up the paper, saying they do belong to the artisan class. Besides sending in candidates in chemistry to South Kensington, we send in candidates in elementary mathematics, and in physical geography. In the latter subject last year we were very successful, three of our students carried off respectively the gold, silver, and bronze medals in the competition open to candidates from the whole of Great Britain and Ireland. That shows that our present teachers are anxious to teach the subjects, and also it shows that our students are anxious to work in this way.

3990. Have you any peculiar facilities in getting teachers from the circumstance of your college being a metropolitan college?—I dare say we have, and our students have an advantage over those of other colleges, inasmuch as they can easily visit South Kensington.

3991. *Mr. Acland*] But your staff of teachers is entirely within your own body, is it not?—Entirely

3992. You are not dependent on the occasional aid of professors imported from outside?—Just so, I keep up that state of things on principle.

3993. *Chairman*] Do many of your pupils attend the evening classes in Jermyn-street?—No, it would interfere with our ordinary work. The young man who got the gold medal last year has a right to attend all the lectures, but at present he has not done so

3994. *Mr. Acland*] I suppose it would be hardly consistent with your principle to let the young man be out at night?—No, but that young man is now no longer a student in the college.

3995. Do you know anything indirectly of what is going on at Battersea?—Yes

3996. Does what you have said of Saint Mark's College apply to Battersea?—Yes, the principal at Battersea allowed a gentleman last year to give instruction to the students, on condition that he received the grant paid by the Science Department.

3997. Is there any great difference between the general course at Battersea, and the general course at Saint Mark's College?—No, I think not

3998. The institution at Battersea was originally founded with reference to the factory districts, was it not?—Yes

3999. But the distinction is now gone, is it not?—Quite

4000. Originally, physics and physical geography had a preponderance at Battersea, while language had a preponderance at Saint Mark's College, but that difference is gone?—Yes

4001. Let me ask you whether you think those masters, when they have been instructed in the college, would have any other career open to them?—I conceive that if the students in our normal colleges were instructed in the way I have indicated, the more able men among them would frequently find their way into middle-class schools, that would be of advantage to the middle-class schools themselves, and it would be an encouragement to deserving students. At present the middle-class schools have the greatest possible difficulty in obtaining teachers, clergymen and

others come to me begging me to let some of our men go to the middle-class schools, but we cannot possibly do it.

4002. What do you think of Canon Moseley's plan of selecting certain students out of the normal schools, and sending them out to the science schools?—I see no objection, only it would be expensive; but as far as I see at present, I think that some of the existing normal colleges could give the required kind of instruction to the more promising students, who are able to do much more than pass the ordinary examination now required by the Education Department in Downing-street.

4003. You would say that it is hardly necessary to found a special science normal school?—I think not, unless you intend to go much further than is indicated at present.

4004. But you think the wants of the country would be satisfied by the introduction of a certain amount of science into our existing normal schools?—Yes

4005. You think that the teachers would not be tempted away from elementary schools?—I think the more able of them might be; but even as it is now, the more able men are tempted away into lines of life less legitimately open to them than the career that would be open to them if they were to become teachers in middle-class schools. At present some of the clever men cease to be teachers at all after a few years' service. I think it would be wiser to encourage them to remain true to the calling for which they have been trained, than to drive them into entirely alien occupations.

4006. *Mr. Dixon*] At what ages do you consider children could commence the study of physical geography?—At a very early age, and certainly at whatever age they could commence the study of geography at all, in fact, many teachers, from the time of Pestalozzi downwards, have argued that you should teach physical geography before commercial geography, because in the case of physical geography, the facts are presented to you at once by the hand of nature; I think you could begin physical geography at a very early age indeed, certainly when a boy was 11 or 12 years old.

4007. Do you think it would be advisable to introduce geometrical and mechanical drawing into primary schools?—Yes, we do that already to the class of students who have passed through those grades in drawing, which the Education Department requires as essential, our teacher has established lately a class for this very subject of geometrical drawing.

4008. *Chairman*] Is that with the view of its being taught in primary schools afterwards?—No, we find that the young men whom we send out, can increase their incomes by establishing night classes; several of our students who have gone away, and taught night classes, have increased their salaries very considerably; one of them told me that he was making 70*l.* by his day-school, and 100*l.* by the drawing class in his night-school, I know that free-hand drawing, and several other branches of drawing, have been taught in a common primary day school with success.

4009. *Chairman*] Within the limits assigned by the customary period of the education of such children?—Yes, up to 11 or 12 years of age.

4010. What do you think would be the best preparation for the teaching of mechanical drawing and

and geometrical drawing in evening classes, such preparation being given in an elementary school?—I could scarcely give a reliable opinion upon that subject, but I know it has been done

4011 Mr. *Akroyd*] You spoke of the advantages which national schoolmasters and others may derive from a general acquaintance with scientific subjects, but that in your judgment would not obviate the necessity of having special science teaching connected with evening classes?—No, not necessarily, you might have separate science teachers. I do not go so far as to say that it is necessary that all national schoolmasters should be scientific teachers.

4012 Taking chemistry, do you not think that a trained master, who was thoroughly acquainted with his subject, would be a much better teacher of chemistry than a schoolmaster who had merely got a general knowledge or smattering of the subject?—Certainly, he would be a better teacher of chemistry. I do not suppose that any schoolmaster who had only a smattering of his subject, would be able to teach evening classes of adults, but he would be able to teach certain principles to boys which would be useful in their ordinary pursuits. In Manchester I heard the manager of the Duke of Bridgewater's mines (I think it was he) state that the young men whom he had to send down the mines were so unacquainted with the most elementary facts of physical science that they could not understand the common orders that were given to them with respect to precautions necessary in going down into the pits

4013 Under the ordinary conditions of a day-school, particularly in the manufacturing districts, boys must leave, say at about 13 years of age, and I gather that you would have all the masters of such schools acquire sufficient scientific knowledge to enable them to teach the first principles of various branches of science in those elementary schools?—Yes

4014 But you would hardly expect that they would have sufficient knowledge of the different branches of science to teach evening classes of adults?—No, it would only be in the case of the men who had sufficient faculty for it, I know a case of a man who was an elementary schoolmaster, and who developed such a faculty in chemistry that he subsequently became, I believe, lecturer at the Polytechnic Institution.

4015 Mr. *Acland*.] Have you considered the question of scientific instruction to the lower middle class, meaning by lower middle class all

persons who come just above those whose children would go to elementary schools?—Yes, I am now making an experiment in that direction. A master who taught chemistry at the college has been recently appointed a master in the upper school at St Mark's College, namely, in the highest of the three schools, for we have three schools, the upper, the middle, and the lower, and the lower is attended by the children of artisans, the second school being attended by children a little above that rank

4016 What is the rate of payment?—7s 6d a quarter in the middle school, and a guinea in the upper school, in that upper school we get a rather superior grade of boys, and they stay with us to the age of 14 or 15. Up to this time an attempt has been made to teach Latin and French. Last Christmas we had it from an independent examiner that the Latin was scarcely worth pushing on, because the boys did not come early enough or stay late enough, therefore I got a grant from the Science and Art Department, for the purpose of having a course of lectures on heat, and the boys from the upper class now come down to the college laboratory and there receive this instruction

4017. You find that there is an increasing desire for instruction in science among the parents of the children in the upper school?—Yes, last year we sent some boys from the upper school to the Science Department for examination in elementary mathematics, and the year before in theoretical mechanics

4018 Do you find that physical science is an equally efficient instrument of education with languages?—More so, because many boys cannot stay long enough to learn the languages thoroughly

4019. Would you say that Latin was not worth teaching unless boys could continue at school after 14 years of age?—I would not go so far as that, perhaps.

4020. But would you make mathematics essential in all middle class schools?—Certainly, up to a certain point. I believe in many schools French is in demand, in our own upper school it is much in demand, and we have a French teacher.

4021. Do you think physical science can be taught usefully without some mathematical foundation?—No, I suppose not.

4022. But you do not give a decided opinion upon that point?—No.

Rev J G.
Cromwell
—
28 May
1868.

Monday, 8th June 1868.

MEMBERS PRESENT.

Mr Akroyd
Lord Frederick Cavendish
Mr Dixon
Mr M'Lagan

Mr. William Lowther.
Mr Edmund Foster.
Mr Read.
Mr Samuelson.

BERNHARD SAMUELSON, Esq, IN THE CHAIR.

Mr. HENRY WILLIAM RIPLEY, was called in; and Examined

Mr H W.
Ripley

8 June 1868

4023. *Chairman*] I BELIEVE you are the
Chairman of the Bradford Chamber of Com-
merce?—I am.

4024. You have come here to give evidence
with the knowledge and consent of that cham-
ber?—Yes, with the knowledge and consent of
the chamber, but not with any special instruc-
tions from the chamber.

4025. But they are content that your evidence
should be taken as representing public opinion
among the manufacturers of Bradford?—Yes.
What I propose to do is this to get a copy of my
evidence, to read it to the committee of the
chamber, and then that they should supplement
anything which I have said, if they think proper,
by additional evidence

4026. How long have you resided in Brad-
ford?—I have resided in Bradford and the neigh-
bourhood all my life.

4027. And you have carried on business there?
—Yes, from my earliest youth

4028. What is the nature of your business?—
Dyeing, but I have been connected with other
branches.

4029. But you are very extensively engaged
in the dyeing business?—Yes, my father and
grandfather carried it on before me in Bradford

4030. Have you made yourself acquainted with
the reports of the English jurors in reference to
the question of scientific instruction to the indus-
trial classes?—Yes, as applied to the particular
branch of industry carried on in Bradford, I
have

4031. You are aware that they have stated
generally that our manufacturers were receiving
detriment from their comparative ignorance of the
scientific principles on which the manufactures
carried on by them should be conducted?—Gener-
ally, I am aware of that.

4032. Will you state to the Committee gen-
erally what is your opinion on that point?—Look-
ing back for the last 25 or 30 years, previous to
that time the trade of Bradford, and I may say
the district generally, comprising Halifax, Keigh-
ley, Bingley, and the adjacent villages, was exten-
sively engaged in the worsted manufacture, that
is to say, materials principally intended for female
apparel made entirely of wool. Soon after that
period cotton began to be used in combination
with wool, producing articles for the same use,
and the introduction of cotton so cheapened those
materials that a great impetus was given to the

trade of the district generally. Very soon after
that, the manufacture of what are called fancy
goods began to be introduced into the district,
that is to say, goods made of cotton of one
colour, wool of another colour mixed with silk,
and of various designs or patterns, and that
branch of trade has rapidly grown from year to
year over the whole district, so much so that
now the fancy trade, which had no existence 25
years ago, stands, perhaps, quite equal in impor-
tance to the plain trade of the district

4033. You mean the plain worsted trade?—
Not only the plain worsted trade but the trade
or manufacture of goods made of cotton and
worsted, as distinguished from the fancy trade;
the fancy goods which have been manufactured
in the district generally have not been produced
from the original designs of parties living in
the neighbourhood; from time to time, manu-
facturers in the district have been in the
habit of receiving patterns of silks and other
goods from France which they have not exactly
copied, but have adapted to the various wants of
the community, producing fancy goods materially
varied in design, but still carrying out the general
idea of the silk and other patterns which had
been received from France. It is a singular fact
(but I believe it is the fact), that anything like
originality of design (speaking broadly and gen-
erally, and as to dress goods more particularly)
has never had any great amount of acceptance
among the merchants, it has only been after the
fashion has been set in superior fancy articles
which have come from France, that the fancy
goods of our districts have really been required
in large quantities in this country as well as in
other countries all over the world.

4034. France has set the fashion in those goods,
and has made them in expensive material, and
Bradford has copied them in less costly materials?
—Not copying them but adapting, copying would
not do at all. The most successful designers are
men who do not produce, but who can adapt the
designs of superior articles from France, so as to
make them available and useful for the wants of
the community generally, that does not merely
apply to the production of dress goods in fancies,
but as a matter of colour also, a colour which
is fashionable in France becomes a fashionable
colour here after a certain time. I have seen the
attempt made again and again to introduce a
comparatively new colour, but it was perfectly
useless,

useless, unless the colour had come previously from France as a fashionable colour.

4035 Does the necessity for adaptation, as distinguished from mere copying, arise out of the difference in the materials that you have to deal with?—Yes, to some extent perhaps it is so; it is difficult to say precisely, the designs simply copied would to my idea often be in better taste in many cases than the adaptation, but you have to suit the taste of another class of people, and to suit that taste, this kind of adaptation is apparently necessary

4036 It is necessary for trade purposes, and not from any inherent difficulties in the material?—No.

4037 In making these adaptations, do you think that any scientific, as distinguished from artistic, knowledge is required?—Yes, I do, I think it is very material that the man who makes the adaptations should have the scientific knowledge which would enable him to know the manner in which his adaptation could be most successfully made. In that way he becomes more useful, especially in small concerns where he may guide and direct the mechanical part of the work.

4038 You mean chiefly the arrangement of the looms?—Yes, the arrangement of the looms.

4039 And also the chemical manipulation required for the dye stuffs?—That would come under the care of another class of men, the two things are not generally carried on in the same works or under the same direction; the dyeing of our goods is on so large a scale that it is carried on quite separately from the manufacturing processes.

4040 But the scientific acquirements of which we are speaking would be useful in both departments, I presume?—They would be useful in both departments, and they are becoming absolutely necessary to enable us to maintain our present high position; that position is at this time inferior to that of no manufacturing country in the world, but every thoughtful man is coming to the conclusion, if he has not already arrived at it, that we must have scientific training for our leading workmen if we are to continue to hold the position which we now occupy.

4041 By leading workmen, I suppose you mean your foremen and overlookers?—Yes, in point of fact the great want in the manufacturing districts, to which I have referred generally, is the want of men who are scientifically trained, such training would prevent an immense amount of waste, for it would enable the foremen to understand the processes, and give directions about them which they are now unable to give.

4042 You have said nothing yet respecting the proprietors of large manufacturing establishments, but do you think it material that those proprietors should possess the knowledge which you would like to see possessed by foremen and managers?—As a matter of course, scientific knowledge is equally important to the owners and principals of those establishments, and, perhaps, more so. Many of the principals of those large establishments do not, however, profess to understand their business thoroughly, with regard to the small manufacturers, there are many of them who have been brought up as foremen and workmen, and from their point of view they do thoroughly understand their business, it is, no doubt, exceedingly important that all classes should have the opportunity of giving

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to their sons who are intended to prosecute the business in which they themselves are engaged, a thorough scientific education

4043 You say that small manufacturers have often been engaged previously in the position of foremen and managers, and therefore thoroughly understand their business, you mean by that, I suppose, that they understand their business as thoroughly as foremen and managers ordinarily understand it?—Yes, their business as foremen and managers, but unfortunately they do not understand it scientifically.

4044. And you consider that for all classes, except those very large capitalists who only direct their works generally without interfering in the details, scientific instruction is of the greatest utility?—It appears to me to be vitally important

4045 And with regard to those large capitalists, do you think it would be desirable if it could be combined with a good general education, that their sons should also possess scientific knowledge?—Very desirable indeed; if their sons are to hold their own against the rapidly growing intelligence of the small manufacturers, they must, as a matter of necessity to a certain extent, attain more scientific knowledge, and even a more general knowledge, having reference to their business, than they have been in the habit of acquiring for some years past at all events

4046 Have you found in your own experience that the supposed superior knowledge of the foreign foremen and workmen is enabling them to make a progress which places our manufacturers at a disadvantage?—I think that the scientific knowledge which has been rapidly progressing in France and Germany, has enabled both those countries to progress much more rapidly during the past 12 or 15 years than they otherwise would have done. Speaking with regard to matters which come within my own knowledge, I may mention that, with respect to the dyeing business, whilst we in England have maintained our superiority in the dyeing of mixed cotton and wool goods, we have attained it by the indomitable perseverance for which Englishmen are so notorious, and which has led us to fight our way through the difficulties of our want of chemical knowledge. It has only been because the French and Germans have not had the goods on which to try the experiments that they have not been able to raise themselves to some extent to the position which we occupy with regard to the dyeing of the goods; it is the fact at present, as far as France and Germany are concerned, and perhaps I may add America, that we in Bradford and Halifax have sent to all those places dyers for the mixed descriptions of goods; that I say is the fact, although it may look at first sight a little inconsistent with what I have said before.

4047. The foreign manufacturers have endeavoured to avail themselves of your experience by importing dyers from this country?—Yes, and applying their scientific knowledge to the knowledge which they are thus gaining, I think they will at no very distant period be able to produce results, in consequence of that scientific knowledge, cheaper than we can do. For many years past I have seen that the waste which goes on among our men from the guess work to which they have to resort from want of scientific knowledge, is perfectly frightful. Following out that idea, and noticing the waste which took place

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Mr H W.
Reply

8 June - 868

from

Mr. H W,
Ripley
8 June 1868.

from day to day in my own concern, I have made two or three attempts to introduce science. In fact, I have sent two young men at different periods to be educated as chemists, for the purpose of bringing them in contact with practical workmen in my own concern, and I am sorry to say that in both cases the attempt proved a failure. I will not say that it is entirely the fault of the young men, but of course you do not know beforehand precisely how an experiment of this kind will turn out. In the first case, the young man did not prove himself acceptable, in the second case, my leading man, or dyer, turned rebellious. During the two years while this young man was educating, I said to my leading man, "You shall shortly have a young man with you who you will see can never take your place, but he will help you and point out the reasons of your difficulties sometimes when the difficulties occur." That is now some years ago, I well remember the morning when I introduced the young man to my dyer, he said, "Well, we shall see," and then in the course of the day when I met him again, he said, "They are all fools, and if he is going to stop, I shall go," and go he did, a man who had been brought up on my premises for 30 years.

4048. What became of the chemist?—He did not prove himself at all equal to the position, and we fell back pretty much into the old rut, where we still remain up to this moment, with an exception which I name, because it may help to bring out a point bearing upon this matter. One of my sons, who has shown some taste for chemistry, has been at Cheltenham, studying under the Professor of Chemistry at the college there. In the winter of last year I introduced him into my works, for the purpose of his getting a general and complete knowledge of them. He is quite willing to do it, and he is now coming in contact with the works and the men, and I hope to see results which I have never seen before, in connection with scientific knowledge being brought to bear on practice in my establishment.

4049. Your son is still young, of course?—He is 19 years old.

4050. He is necessarily unacquainted with the practical part of your operations?—Yes, although the Professor of Chemistry at Cheltenham College wished me several times to state to him what particular branch of chemistry I desired my son to pursue, I declined, and said that I should wish him to study chemistry generally; and I am sure that I now see the benefit of having done so.

4051. You think that the same amount of time, if devoted to special technical study, as well as to general instruction in chemistry, would probably have been frittered away, and that the result would not have been equally good, even with a view to the after application of his knowledge to your own special trade?—I think that if he brings his general knowledge to bear on the practice, he learns the practical part much more quickly and satisfactorily than he would have done if there had been any attempt by a science teacher to instil practical knowledge first. The first department he went into was my own chemical works. The foreman there is very clever, but he has little or no scientific knowledge; and my son had not been in that department more than three weeks when I asked him how he got on, and he said, "Oh, sir, he knows all about it directly."

4052. By chemicals you mean dyes and mordants?—Yes, and all the acids.

4053. Then, would you state it as your opinion generally, that, with reference to such manufactures as yours, it is desirable that young men should receive a general scientific education in schools without any attempt being made at special technical training?—I should be strongly in favour of such a course, where the boy had time, at all events. I think the principle is sound.

4054. That answer refers to chemistry?—Yes.

4055. Have you formed any opinion upon the same point with regard to the construction of machinery?—I should come generally to the same conclusion, namely, that it is not desirable that a young man's time should be wasted in going into details at first, that it is better to deal with general principles, and then follow that up afterwards by going direct into some speciality.

4056. You are now speaking of young men who remain at school till about 17 years of age, I suppose?—Yes; and not only from what may be termed the upper classes, but also the young men from the middle classes, who can go for a course of instruction passing into what I may call the secondary schools, after they leave the primary schools.

4057. That is to say, for boys who remain at school to 15 or 16 years of age?—Yes, my idea would be that if they were intended for manufacturing pursuits afterwards, they should go into some special training schools or secondary schools, where they would have an opportunity of studying chemistry, mathematics, and mechanics, without special reference to any particular business.

4058. You would wish them to go into such secondary schools, but are there any such secondary schools, for instance, in Yorkshire?—I scarcely know of any such schools of any importance, and that is our great difficulty, not only in Yorkshire, but also elsewhere. When I wanted a practical chemist, if I could have gone to a training school and taken my choice, I should most likely have been able to select a fit man for the purpose, but there is no such opportunity now afforded.

4059. Your choice is very much limited, and to that you partly attribute the failure on your part to introduce a practical chemist into your works?—Yes, altogether so. If it so happened that I had taken any active part in my business for some years past, I should either have gone to Germany or France, for some young man who had had the requisite scientific training. I have seen such young men, I have come in contact with two or three, and have been struck with the mode in which they carry on their operations. I am now speaking with special reference to the Germans, young Germans from the middle class, after studying chemistry in their own country, have frequently been sent into French dyeworks, for the purpose of learning the business practically. Some 14 years ago I came across a young German whose scientific knowledge was altogether superior as a dyer to that of any Englishman I ever knew in the same position.

4060. Was that abroad?—No, it was in England. I bought a French patent of Frenchmen, and he was sent over for a few months to show us the *modus operandi*.

4061. And he returned to France?—He returned to France and then to his own country.

4062. From

4062. From your position you were fortunately able to send your son to Cheltenham, but I presume that smaller manufacturers, managers, and foremen, could scarcely afford to send their sons to any great distance from home?—No, and I do not think it is desirable, as a general rule, that they should do so. There are schools scattered over the country, at which they can get their sons educated up to 15 or 16 years of age.

4063. But they could not get a scientific education at those schools?—No; they could not get a scientific education. of course. My son at Cheltenham only got his special instruction, by taking lessons out of the ordinary course, there was no other boy in the whole of that school who was acquiring the knowledge that he did in the same space of time; he devoted his entire half days for a year or two to chemistry.

4064. Was he in the military and scientific, or in the classical department?—He was in the classical department up to a certain point, and then for 12 months I made a special arrangement that he should go to the College, and that he should devote a large amount of his time to chemistry.

4065. If he had been in the military department, would he not have been able to obtain adequate instruction in chemistry?—Not, I think, to the extent to which he did attain it, or to which it was absolutely necessary that he should attain it, except by spending a much greater length of time. I mean extending over a longer period.

4066. That is to say, he would have had to begin earlier?—No, he did begin early, but he would have had to remain longer, perhaps for two years.

4067. Are you aware of any schools, besides Cheltenham, in which sufficient chemistry is taught to qualify a young man to go to business in a large dyeing establishment or chemical works?—I should not like to hold up Cheltenham as an example of a place at which boys could obtain any such knowledge, because it was only under special circumstance that my son himself got it. I think Cheltenham stands very high indeed, both in the military and in the classical school, and I think the scientific teaching given at Cheltenham, in connection perhaps with both departments, is very good as far as it goes, but it is not at all that amount of instruction which is adequate to fit a boy to pass forward into a manufacturing establishment unless he had had some special instruction as my son had.

4068. Where did you send those young men of whom you spoke?—One went to Manchester, and the other came to London.

4069. If you wished to prepare a young man for entrance into some chemical works, to what institution or institutions in this country would you prefer to send him?—I should have to cast about a good deal, for it would be difficult to find a place. From what I have heard, I suppose Owen's College would be the place, but really we want such institutions, that is the point, not in Manchester merely, but in various other parts of the country where manufactures are carried on. What we require is institutions where young men could have access to good sound scientific teaching.

4070. You do not consider that it would be practicable to send young men from Yorkshire to London, or to Edinburgh, if they were the sons of parents of very moderate means?—I think secondary schools would rapidly spring up, where

young men could attain scientific knowledge. In Leeds, Bradford, and Halifax, I should hope very speedily to see schools where the sons of our middle class and foremen could go while they were living at home, and study science thoroughly. And from those boys, I think a certain number would, after receiving that education, pass off into manufactories and be found exceedingly valuable, while a certain portion of them who showed special capacity would perhaps come to London, and go to some institution where they might still carry on their education, some of them would perhaps become teachers in science, who are very much wanted indeed.

4071. Do you think they would be better paid as teachers than as managers?—I think their choice of the profession of a teacher would be a matter of taste, in all communities a certain proportion of people will look at the question, not from the money point of view, but from the side of taste or inclination. I should think you would find persons who would prefer the profession of a teacher to even the better paid position of foreman or manager, or perhaps even that of a master manufacturer.

4072. You suppose that the love of science would influence them in some degree?—I think so, you find the same kind of thing occurs in other departments.

4073. Are you aware that there are scattered throughout the country, classes in science in connexion with the Science and Art Department?—Yes, I am aware of that.

4074. Have you any such classes at Bradford?—No, unfortunately we have not at present. There has been a feeling in Bradford, a very foolish feeling, I think, against anything which would have the appearance of being in connexion with Government aid to education directly or indirectly. We have made two or three attempts to form art schools, two have failed entirely because they had no local support sufficiently to uphold them, there was such a decided objection to receiving aid from the Government, and they fell to the ground. We have one very recently established, which is assuming a healthy appearance, and that is in connection with South Kensington, but with regard to science, we have no teaching whatever, except that slight amount of chemical knowledge which is given in a small class in connexion with the mechanics' institute.

4075. But that is not in connexion with South Kensington?—That is not in connexion with South Kensington.

4076. Is that class pretty well attended?—Occasionally it is, but not regularly.

4077. Is it an evening class?—It is an evening class.

4078. From your knowledge of the habits of boys of from 15 to 18, do you think that evening classes could become a substitute for regular systematic instruction at school?—Not a substitute, but I lay a good deal of stress upon evening classes during the winter months, during the winter months a very large number of boys and young men, from 16 years old and upwards, would in our district attend such classes, but I should not regard them by any means as a substitute for what would be very much more important in many respects, namely, daily teaching in a scientific institution school by good teachers.

4079. Do you think that boys would remain at school to a more advanced age if scientific instruction were given instead of the ordinary routine

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instruction in the classics which is now given in middle-class schools?—I should fear very much in those schools, as they exist now, any attempt to give scientific knowledge to the extent which is absolutely necessary, would be, in a great many instances, a failure. I should prefer seeing separate establishments formed in which young men might study chemistry, mathematics, mechanics, and other sciences.

4080. At what age would you propose that they should enter such schools?—If you had a school of that kind established in Bradford (and I hope we are making some progress towards providing a building for such school) I think the ages of the boys would vary, one man would take away his son from an ordinary school and send him to this institution at 15 years of age, while another would let his son remain at the ordinary school till 16 years of age. I should think, possibly, it would be boys of from 16 to 17 who would leave the ordinary school to come to that school, though probably there would be some as young as 14.

4081 You think the boys would pass into this scientific school at ages varying from 14 to 17?—Yes.

4082 And remain there two or three years perhaps?—Yes, that is my impression.

4083 And you consider that the necessity for a school of that kind is becoming so much felt in Bradford that it is likely some such school may be soon established?—We shall very soon provide the building for such a school, and if we can see our way to obtaining teachers and some reasonable help (I do not say in what form) from the Government we hope to establish such a school; I do not say in what way Government is to give the help, for that is really a very wide and difficult question, but perhaps it is too early to expect that people should now, whatever they may do in the future, supply the entire funds for working such a school. Still, the growing want in this direction is now so much felt that the question cannot, I think, be much longer overlooked, either by the Government, or by the people themselves.

4084 Although Bradford has not availed itself of the advantages now afforded by the Science and Art Department in the night schools, you still think that if a suitable building were provided, and an attempt made to establish a day school for science, Government aid towards the establishment of such a school would be acceptable and accepted?—Yes, there would be no objection on that score now, the feeling has passed away most completely, I feel sure there would be no question raised upon that point.

4085. Do you look upon Bradford standing at all in an exceptional position in that respect, or do you think that what applies to Bradford would apply to other large manufacturing centres?—I do not see why it should not, indeed think it would apply to other large manufacturing centres with much greater force in some respects, because there are other towns all over the country which are feeling the effect of foreign competition much more than Bradford, in Bradford, however, we are quite aware that if we have not felt it much yet, we shall feel it if we do not progress.

4086 What is this building of which you have spoken?—We have two committees sitting at present, one appointed by the Philosophical Institute, and another appointed by the Mechanics' Institute, for the purpose of considering the

feasibility of erecting one large building which shall be for the use of the Philosophical Institute the Mechanics' Institute, the School of Art, and the School of Design.

4087 What is the proposed outlay?—That is perhaps rather a personal question, but at the meeting of the Mechanics' Institute committee with our committee, the other evening, when they seemed rather alarmed at the idea of a cost of 40,000 £ or 50,000 £, I said that if that was any difficulty, I would give a tenth of the whole cost, whatever that might be, 40,000 £ or 50,000 £.

4088 You would subscribe 5,000 £ towards a total cost of 40,000 £ or 50,000 £?—Yes.

4089 And from what you know of your fellow-citizens, have you any fear of the remainder being raised?—I think not, I think we can beg the rest of the money.

4090 So that you are not going to wait upon Government aid for the purpose of erecting a building?—No, I think we must help ourselves, and then ask the Government to help us in providing teachers and encouraging proficiency in the pupils.

4091 In what form do you think Government aid, if afforded, would be most acceptable and useful?—I should rather prefer to express no opinion upon that point, except generally, that I think the same principle which has been working so satisfactorily in connection with our primary schools for many years past might now be applied for the purpose of giving Government help to what I may call secondary schools for scientific instruction.

4092. And that is, broadly speaking, payment on results?—Payment on results. I think that is a sound and right principle, and one which ought to be adopted in this case, but perhaps it is better that separate individuals should not all of them express their opinion at once upon those points of detail.

4093 Do you think teachers of a higher class would be willing to accept payment on results in the form in which it is given for the teaching in elementary schools, and the classes of the Science and Art Department?—It is there that the precise difficulty comes in as to whether the Government ought not to provide to some extent those teachers of a high class.

4094 You mean to say the teachers would be likely to expect some fixed endowment?—Yes, fixed to a certain extent somewhat in the mode in which the principal of Cheltenham College is paid. He receives a fixed sum, and has also a capitation fee which more than doubles his income when the school is large.

4095. When you speak of teachers of a high class I may presume that Bradford would not be satisfied with teachers of any other kind?—I think inferior teachers are almost worse than useless, they give young men and boys false ideas; the pupils fancy they are learning when they are not learning, we are better without teachers unless we have good trained teachers.

4096 Have you any experience of the science classes in connection with the Science and Art Department?—No, not much.

4097. Are there any recommendations that you would wish to make to the Committee, in addition, on the subject of scientific instruction?—I think not.

4098. Lord *Frederick Cavendish*] You spoke of the want of scientific training for foremen and managers of works?—Yes.

4099. Should

4099. Should you propose to endeavour to attain the result you aim at by educating all the young men employed in manufactories, or by choosing out of them a small number who seemed the most promising?—By means of the schools which I have suggested I would give them all an opportunity of acquiring that knowledge

4100. Do you mean the institution which you propose to found at Bradford, or do you mean an ordinary secondary school?—I should call that proposed institution a secondary or scientific school

4101. But would the sons of foremen, and people of that class, be usually able to attend such institutions?—I think so

4102. From 15 to 18 years of age?—To some extent, at all events, they would

4103. Without spending any of their time in earning wages?—I have no doubt that at first the evening classes would be more in favour than the day classes, but when the young men and their parents saw the advantage of the instruction given, I think they would make great efforts, and many of them are now in a position to spare their sons for a year or two for the purpose of receiving scientific instruction

4104. Should you, in your institution, combine evening classes with day classes?—Yes; by all means

4105. So that those who were at work in the day-time might attend your classes in the evening?—There would be many cases in which it would be a great hardship if you did not afford such opportunities, and some of them, after getting lessons in the evening school might be able to spare six or twelve months for day teaching too.

4106. I believe that, in mechanics' institutions, a great difficulty in the way of science classes has been the want of elementary education, numbers of those who attend them requiring to be taught almost their A B C, instead of chemistry and mathematics?—No doubt.

4107. Do you think, judging from your knowledge of the manufacturers and artisans of Bradford, that there would be a general readiness to raise the age under the half-time system from 13 to 14 or 15?—I do not think that question is mixed up with this, the class of boys from whom this institution would receive its pupils would not be generally those who attend the mills

4108. Would not the foremen and managers generally come from the class whose children had attended primary schools?—Very few of the managers' and foremen's children attend the mills for half time.

4109. That may apply to Bradford, but, in a smaller place, would not the case be different?—No, I should say that foremen's children, as a general rule, are not half-timers.

4110. What kind of wages do those foremen and managers usually earn?—Their wages vary very much, according to the works they are in, but it would be from 30 s. up to 40 s., 50 s., or 60 s.

4111. Do you consider it important that such artisans and mill hands should also have some technical teaching?—If they had an opportunity, I believe there would be a certain portion constantly drafting off from those mill hands into secondary schools; the numbers might be limited, and, perhaps, would be so for some years, but I certainly think that a few of the children of our artisans or day labourers would pass on

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from time to time, first to the evening school, perhaps, and then, in some special cases, to the day school if a boy showed any special aptitude, his master or his friends might help him as they do now help them from time to time when they send a boy to South Kensington, who has shown some special taste in art

4112. But you have no immediate hope of seeing the bulk of our mechanics and artisans receiving a fair education by means of the half-time system, and then completing it by means of evening classes in connection with mechanics' institutions and the like?—The education of the half-timers is rapidly improving, and there is a change in the quality of the teachers, so far as my experience goes, since the last Minute of the Council under which they are paid so completely by results, and that change has been very materially for the better, and then we must take into account the multiplication of evening schools. I think there is a strong desire on the part of mill hands to improve themselves in evening classes, wherever there is an evening school some portion of the mill hands are found ready to avail themselves of the opportunities which it offers for following up their education

4113. But in an educational point of view, do you think it would be a great advantage if the age of 13 under the Factory Act were raised to 14?—Yes.

4114. Can you judge what would be the general opinion in Bradford with regard to the making of such an alteration?—No, I should not like to give an opinion

4115. Mr *Louther*] Did I understand you to say that a colour invented, or brought out in England, would not take English taste much unless it first went to Paris?—Unless it came from Paris, the fashion for a colour or design, as a general rule, is set in at Paris.

4116. Was not the Magenta colour invented in England?—It fell out of use much more rapidly than 20 other colours which I have seen come from France, it was so completely new that, for the time being, it had a run, but it fell completely out of use very soon

4117. Before your son went to Cheltenham, where was he?—He was there for a number of years I have a house there, and all my boys were educated at Cheltenham.

4118. Did he study Latin and Greek?—Yes.

4119. Did he find them of use to him?—I think he retains his knowledge of them to a certain extent.

4120. Can you state what was the expense of your son's education at Cheltenham?—Cheltenham College is supplied with two classes of pupils, one class of boys board with the masters, a certain number of whom are licensed to take boarders, and those boys pay about 45 or 50 guineas a year for their board. The educational charge at the college is altogether an independent charge, all pupils pay alike

4121. What is that charge?—For a boy of from 14 or 16 years of age, it would average according to what he was learning, 28, 30, or 35 guineas a year.

4122. Do you know how that would compare with the cost of education in Germany or France?—No.

4123. Did I understand you to say that the objection to Government interference at Bradford, had entirely ceased?—Yes, altogether

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4124. Have

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4124 Have you any museums or collections at Bradford or Halifax, where people can see designs and collections of drawings for patterns and so forth?—We have none in Bradford; we propose in connection with the new institution I have named to have a museum to some extent founded precisely on that principle.

4125 But at present you have no such means of interchanging ideas?—None whatever.

4126 You have no collection of patterns which is open to people?—We have in the Chamber of Commerce sets of patterns which had been previously exhibited in 1851, 1862, and in the last Paris Exhibition.

4127 But you have no fresh supplies of patterns coming in and exhibited?—Of course every manufacturer during the current year, tries to keep his own patterns to himself.

4128 He does not try to help his neighbour?—He does the reverse, as far as possible he keeps his patterns secret until he has had the benefit of them; it is a description of trade, in which that is exceedingly important, not only for the purposes of the manufacturer, and for the people, but for the merchant.

4129 Mr *M'Lagan*] Did I understand you to say, you thought that the present position of English manufactures with respect to dyeing, was due rather to the perseverance of the English than to their scientific knowledge?—So much so, that knowing as I do the great want of scientific knowledge in England, it is perfectly astonishing to me that we do hold the position that we occupy.

4130 Do you think the English have derived no advantage whatever from science in this respect?—I could not say that, because all our intelligent workmen try to get a smattering of scientific knowledge.

4131 But do you think that our progress in this particular department would have been much greater, if our labouring men, and particularly our foremen and managers had been taught science?—I am not aware that it would have been very much greater, but I think if we had had science applied thoroughly, we should have prevented an immense amount of waste which now arises from the fact that men go on ignorantly using materials in a wrong manner.

4132 One of the effects of scientific education is to improve a man's habits of observation, is it not?—Very much so.

4133 So that if the workmen being scientifically taught were carrying on any particular operation, they would be more likely than they are now to observe narrowly anything important which occurred in the course of the process?—Not only that, for they may be said to observe now, but they would then observe from a scientific point of view, and would be able to prevent waste.

4134 Do you attribute the progress which in these matters has been made on the Continent to the superior scientific knowledge of the people on the Continent?—No, they have not actually made the progress simply because they have not had the material to work on, they have not been manufacturing largely the same description of goods, and they have therefore had no opportunity of continuously from time to time trying the experiments which would have enabled them to do what we have done.

4135 Is there no particular district on the Continent which is famous for the superiority of

its dyes?—Not in mixed goods; my remarks apply to mixed cotton and wool goods especially.

4136 At Dusseldorf is there not a superior mode of dyeing?—Not for mixed goods.

4137 Do you know anything about the dyeing at Dusseldorf?—I have seen some of their colours, they are very brilliant.

4138 They are very superior dyes, are they not?—They are very fine, and the Germans in several places produce very beautiful dyes, but not as a rule more beautiful than we can produce in England.

4139 *Chairman*.] Have you any knowledge of the dyes at Bruun, in Moravia?—I have seen them.

4140 How would you compare them with what are produced in Yorkshire?—There are shades of colour sent over here from Germany which are very brilliant, I was going to say almost startling, but speaking broadly we can do in Yorkshire equal to what they can do in France or Germany, or any part of the world.

4141 Does that apply to the highest class of dyeing which is executed in the neighbourhood of Paris?—Yes, I have more than once given this challenge, and I am ready to do it again. I am ready to let any manufacturer take a quantity of French merinos, and cut them in half, giving half to me to dye and half to the French to dye, and every piece which I do not dye better than the Frenchman, I am ready to pay for. That challenge has been open ever since 1851, and it has never been accepted yet. Still there may be peculiar tints of colour the quality of which is partly attributable to the clear atmosphere which they have in France, and it is very difficult to get those peculiar tints here unless we were in the habit of dyeing those particular shades. I have no fear of our doing the same if we were in the position that the French are in of having to produce those particular shades almost daily and hourly for a number of customers.

4142 Mr. *M'Lagan*.] Are you aware of cotton goods being sent from this country to Dusseldorf to be dyed?—Yes, some special colours.

4143 I think you stated that, generally speaking, when a new dye came in, it did not take in this country until it had been to Paris?—Yes, any speciality in colour, or shade.

4144 Do you think that that is to be attributed to any peculiarity in the situation of manufacturers in France as compared with manufacturers in this country?—We have been in the habit of considering it a mere matter of fashion.

4145 But is it not the fact that in France some of the principal manufactures are situated near the seat of the fine arts, namely, in Paris, and that they have thus the advantages of the superior taste of the best artists in the country, whose advice given to the manufacturers may be of use in making such improvements in colour or design more fashionable?—I have no doubt it is highly important to the French manufacturers who produce those designs from time to time that they should have the best artistic skill at command, and that they do have that skill in Paris superior to what is got in any other place.

4146 And you would say that the manufacturers in this country labour under great disadvantages in that respect compared with those of France?

France?—No, I think not, for some goods we set the fashion rather than France

4147 But in the present situation of the two countries, is it possible for the manufacturers of this country to set the fashion in matters of taste?—I think not

4148 Then do you not think that the superiority of the French position, in that respect, is due to the circumstance that their manufacturers are more favourably situated than ours?—No, I would not venture to say that by any means

4149 Do you not think it is owing to the superior education of the manufacturers in France that the improvements which they bring out there more readily become fashionable than improvements which are brought out by manufacturers in this country?—It strikes me it is only like a good many other things France, for some cause or other, has led the taste in these fashions for a good many years, and it would be difficult for us, even if we could produce superior articles in design and colour to take the lead in fancy silk and other fabrics.

4150 Then, do we not come back to this, that the reason why France has led the taste in these manufactures is owing to the establishment of the Government manufactories, and owing to those manufactories being situated near to the centre of the fine arts, namely, Paris?—No, I should not like to give that opinion

4151 Mr. *Potter*.] Are you aware what Government manufactories there are in France which would tend to improve the taste in such matters?—No

4152 Do you know of any beyond Gobelins and Sévres?—Those are the only two purely Government manufactories.

4153 You have been speaking of the very rapid progress of Bradford, and its great prosperity during the last 25 years, I suppose the increase of Bradford in that respect has been greater than that of any other town in England?—It is generally thought to have been so.

4154. The population has also increased very rapidly, being now about 130,000, I believe?—From 106,000 in 1861 it has increased to between 130,000 and 140,000.

4155. And may we not take it as a fact that the annual return of the woollen trade in Bradford is equal to 33,000,000 *l.*, and the profits proportional?—It is said that we pay more income-tax in proportion to our population than any other town in the kingdom, but that perhaps may say something for our honesty as well as our prosperity

4156. At all events, Bradford has been the most prosperous manufacturing town in the kingdom for some years?—Yes.

4157 You have not felt the force of competition very strongly in Bradford hitherto, have you?—We have had no competition but what we could meet. We have had a very wholesome competition, I think, to a certain extent, with France, but it has been easy to meet up to this time.

4158. And is it not the fact that the dread of competition has caused a little excitement among the chambers of commerce in your district, so that they are anxious to prepare themselves for it?—I think it is rather the growing intelligence of the people; it is not dread of competition, by any means, for we believe that we can hold our own if we continue to adopt sound principles in carrying on our business.

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4159 During the whole of this time you have admitted that scarcely anything has been done for science and art in Bradford?—Very little indeed

4160 Now, feeling this dread of competition, you come to the Government for assistance?—I do not say that we come to the Government for assistance, we shall help ourselves first

4161 But are there not very strong hints given that there is a necessity for Government assistance to every class in Bradford, even to the master class?—I think we have never made any such suggestion

4162 I think I hold in my hand something to do to that effect in the report of your chamber of commerce, in what is said by Mr Huth, for instance?—That is not Bradford, and I should repudiate all that idea.

4163 You have spoken of a very great desire for education of a higher class for your foremen?—Yes, I have had a feeling for many years that that is imperative

4164 That is a strong point in your mind, is it?—The education of the foremen and master manufacturers who themselves take the lead in their own businesses.

4165 And you think that the Government should to some extent supplement that education?—I think so

4166 The education both of the foremen and of the masters?—Incidentally it would be so with regard to the help which would come through the provision of those teachers, if the sons of the masters availed themselves of it; you could hardly supply the teachers and then say that they should be for one class of people only

4167 But you do, in fact, indirectly ask Government aid for the education of the masters?—I think that would be rather an unfair way of putting it

4168 The foremen themselves have, of course, all sprung from the working class?—Yes

4169 But nothing, I think, has fallen from you in favour of a better class of education for the workmen themselves?—If I had been asked the question, I should have said that it was exceedingly important that the primary education of the masses should receive the closest attention from the community generally, and from the Government.

4170 Would not that, then, be your starting-point?—Yes, I have been taking that for granted.

4171 Would you be in favour of a compulsory system?—Compulsory in some senses, as to the precise manner in which you might do it, that might be open to discussion

4172 Would you be in favour of a very broad extension of the Factory Act?—In some way or other, yes

4173 It has been admitted, I think, that one-third of the masters and employers of labour in Bradford have sprung from the working class?—A greater proportion than that, I think

4174 And another third only removed from that class by one generation?—I should say a greater proportion than that in both cases

4175 I think you have stated that scientific progress is more rapid abroad in relation to manufacture than it is at home?—Yes

4176. But I think you have not given us any strong facts to support that statement?—No; it is simply based on what I have read

4177. I think you referred to the dyeing of mixed goods being an English discovery, almost a Bradford

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a Bradford discovery?—Yes; a Bradford discovery.

4178. What date do you fix for that?—It is all within the last 25 or 30 years

4179. Are you not aware that the process was carried on in Lancashire in *de laine* goods previous to that?—I was aware that for several years, at about the time I was naming, our friends sent their goods from time to time to Lancashire, for the purpose of getting them dyed, and they came back spoiled, and it was only by years of perseverance that we succeeded at last.

4180. You admit that you had not much scientific instruction, and that you blundered with it from that period?—Yes, it was certainly a system of blundering I was pretty much in it myself in trying to bring what scientific knowledge we had to bear upon the subject.

4181. But still you admit that the attempt originated in Lancashire?—No, I should not make that admission, the goods were sent there from time to time for dyeing, and they were spoiled, and I believe they cannot dye mixed goods yet in Lancashire.

4182. The only competition which you would dread would be from the French and Germans, I suppose?—Yes, of course we should not anxiously look about to see where it comes from; but we shall meet it, come from where it may Russia has astonished me as much as any country by producing some dyed goods which I saw in the Paris Exhibition, we may perhaps have to look for some competition from Russia

4183. Do you suppose that those goods could be produced at anything like the price at which they could be produced in Yorkshire?—Probably not

4184. Then it would be purely a question of cost in relation to Russia, would it not?—They get yarns from Bradford or Halifax, and then they manufacture and dye those goods in the way which so astonished me.

4185. They dyed them in a much more costly way than they would have been dyed in, in the Yorkshire market, I suppose?—With the limited quantity which they have it must be so, but the surprising thing was that they dyed them at all.

4186. But the French goods are produced at a much higher cost relatively than our goods are produced in this country, are they not?—No; with regard to French textile fabrics the merinos which come here, they are, as far as we can judge, producing them at a less cost than it is possible to produce them here

4187. On what facts do you base that opinion?—On the fact that we have manufacturers who have from time to time produced similar goods and sent them to the London market, and that the French have beaten them by 5, 10, 15, and sometimes 20 per cent. in price

4188. Then how would you account for the fact that there being no duty on French goods our English market is not more fully supplied?—The French do supply the English market entirely with merinos, so much so that we have ceased in Bradford for years past to make what are called French merinos, the French have beaten us out of our own market

4189. But except with regard to labour, how can they produce those goods much cheaper than we can?—It is the fact that they have done so; and as they have done so for many years the inference is, that they do it at a profit. I know French manufacturers with very large concerns,

and it is evident from their thriving condition that they have been making a profit for the last 10 years.

4190. Would you suppose that that result was attained by their greater scientific knowledge?—Yes, to some extent, I should be disposed to think so, by greater scientific knowledge and by the greater care and attention which they devote to the details of their operations, it is notorious to men who know the manufacturers of both England and France, that the French pay an infinitely greater amount of attention to all the minor details of the carrying on of their business than we do; and I attribute their success in the production of those French merinos to the extra care and attention which they bestow on that class of manufactures.

4191. If it were worth their while, could not the Bradford manufacturers beat them in that respect?—Probably, if we had a time of depression sufficiently long in the Bradford trade, we should have a class of men spring up, who would see the necessity of devoting more attention to the details of their operations.

4192. Then a still stronger competition than you now have would be beneficial to you?—No; because Bradford is doing extremely well generally in its manufacture at present, and you could only bring about the requisite attention to that subject by a state of depression which should produce a great amount of distress.

4193. But that would force you to greater activity in respect of attaining scientific knowledge applicable to manufacture, would it not?—We have ceased to manufacture those goods, and there the competition ends.

4194. You have found other employment?—Yes

4195. With regard to the improvement in these woollen goods which you dread so much, have you any facts to give the Committee on this subject?—I do not say that I dread it I have maintained all along, previously to the Paris Exhibition I maintained it, and I maintain more strongly since, that we have nothing whatever to dread.

4196. Except that you have lost the trade?—Yes, but we have filled up the blank with other branches of business

4197. And now you suggest scientific education as the means of keeping your ground?—Certainly.

4198. You do not want to lose more ground?—Certainly not, scientific education is required for the purpose of more economically carrying on our business. I think very strongly that if our foremen and managers were scientifically trained an immense amount of money would be saved annually in our establishments, which is now positively lost from their want of knowing, not only when things are wrong, but how to put them right, and conduct their operations in an economical manner.

4199. Are you aware of the amount of import of woollen goods from France during the last four or five years?—No, I have not the statistics here.

4200. You are aware perhaps that it is very small comparatively?—I know it is not very large

4201. In 1860, the total import of woollen goods from France was 1,097,000 *l.*; and in 1866, it had risen to about 1,900,000 *l.* sterling, those

those figures being for all classes of woollen goods?—Yes

4202 And the export of English woollens of all kinds in 1860 to the whole world was 16,000,000 *l*, and in 1866, 26,000,460 *l*.?—Yes

4203. The increase of English exports is much larger in proportion than the increase of the imports from France?—Yes, but like a great many other figures those statistics are very fallacious, the export of worsted and woollen goods and yarns in 1860 was 16,000,000 *l*, and in 1866 it was 26,000,000 *l*, but between the two periods, there was an advance in price of at least 25 per cent, so that the apparent increase is not a real one by any means

4204. But the same argument would apply with regard to imports coming from France, would it not?—No, it would not. It is notorious that the French merinos did not materially advance in price during the same period, at least, I do not mean that they absolutely do not advance at all, but not proportionately to the advances which took place in goods manufactured in this country.

4205 You have referred to the non-originality of fashions in your goods in Bradford. The great demand for your goods in Bradford is for foreign merchants, is it not?—Yes, in export goods, but we have a large home trade

4206 But the designs for export are chiefly suggested by foreign merchants, are they not?—Occasionally so.

4207. A great part of the goods which you imitate or adapt are produced by machinery, I believe?—Yes, machinery is adapted to produce a similar effect

4208. And the French woollen and silk goods are chiefly produced by hand?—I suppose so, but machinery is rapidly extending.

4209 Which is a much more expensive process?—No doubt.

4210 That school of arts of which you spoke is a new institution in Bradford, is it not?—Yes, very recent indeed.

4211. Are you aware of the amount of support which schools of art have met with in the West Riding for the last 10 or 12 years, or do you know what the subscriptions are to the Bradford School of Art?—Two previous attempts have been made in Bradford, but in the present one the parties proposing it have asked a few gentlemen to give their 5 *l* each, and the very limited wants of the school have been readily supplied in that way

4211 The total subscriptions would be under 100 *l*, I suppose?—About that, more or less.

4213. *Chairman*] Could you have got more, if you had wanted it?—Our difficulty at present is only that of accommodation for the school of arts. The necessity for such a school is felt in a much greater degree than it was ever felt before, but we have no place in which to hold it.

4214. The present actual result would be no criterion of the success which a school of science might expect?—Not the slightest.

4215. *Mr Potter*] Have you above 100 pupils in the school?—Under 100, but there are applications for about twice the number we can accommodate. I may add, that the day classes are at present wholly for ladies

4216. But with regard to your evening class, is that over-crowded?—I am in fact speaking of the evening classes; we have not sufficient accommodation for them, and if accommodation 0.72.

would be provided, twice or thrice the number would attend the evening classes at once

4217 *Mr. Atwood.*] The art of dyeing a great variety of mixed goods in Bradford is a much more complex and difficult operation than that which was carried on 25 years ago, is it not?—Yes.

5218 You have now to deal with cotton, silk, alpaca, mohair, and a variety of other raw materials with which you were formerly not accustomed to deal?—Yes; of course alpaca and mohair are pretty much in the nature of wool

4219 Your chief difficulty, I believe, has been with cotton, which, being a vegetable fibre, would not take the same dye as the woollen fibre?—Yes, you could dye cotton one colour, black or brown, and then weave the cotton into the wet worsted, and dye the worsted, but the great difficulty was to take the two materials, and weave them together, and then so arrange the dyeing operation that the two distinct fibres, animal and vegetable, should take the same colour

4220 When the manufacture of mixed goods was first introduced, the warp was dyed separate from the weft?—Yes.

4221. And afterwards when both were put into the dye-pan the cotton part was dyed previously and the worsted was afterwards dyed in the pan, both were put into the pan together?—Of course.

4222 The fact being as you have stated that there is more difficulty in dyeing with those different materials, there is much greater necessity for scientific training on the part of foremen and assistants, is there not?—Yes; it was that difficulty of dealing with those two fibres which first called my attention to the great necessity for scientific knowledge in dyeing, previously to that period, I looked on at our processes without thinking that any scientific knowledge was necessary, but from that time I turned my attention to the necessity for scientific knowledge, and from time to time from that date I have endeavoured to bring it into operation, but without the success I could wish for, thus far The practical dyers in this trade are the best men in the world, and they do these mixed goods superior to the way in which they are done in any other country whatever, but I do not know of a single foreman in the trade who possesses the scientific knowledge which is absolutely essential to produce the work at the cheapest rate.

4223. Up to a recent period the art of dyeing those mixed fabrics was almost unknown to foreign dyers, was it not?—Yes, the foreign dyers have from time to time introduced English foremen into their works; at Roubaix, which is a great centre of manufacture, they were utterly ignorant of the art of dyeing those mixed goods.

4224 The French dyers in order to acquaint themselves with the processes of the English dyers imported at high wages English assistants, did they not?—Yes.

4225 Supposing your foreman had this scientific knowledge, you apprehend that there would be a considerable saving in the use of material?—I am sure that there is great waste in dyeing materials and other ingredients, which waste might be avoided, the saving in point of money is much more startling in amount than many people would suppose.

4226 You were at the French Exhibition, and you examined specimens of French and German products in those mixed manufactures?—Yes.

Mr H W. 4227 Did you see much to learn there?—No, of course you could only compare the colours.

Rivley. 4228 There were no new processes suggested which you think you could introduce?—None

8 June 1868 4229 You feel sure that you could hold your own against the French?—Yes

4230 With regard to the wages paid by the French master dyers, have they any advantage over you?—I believe that they have a material advantage over us in point of the amount of wages paid, but we have a much greater advantage over them in point of the quantity of work done

4231 An English workman would turn out more work than a Frenchman?—Yes

4232 And you have also an advantage in better machinery?—We have an advantage in better machinery, the French dyers up to the present moment, except at Roubaix, and in two or three other instances, have used little or no machinery, while we use it very largely.

4233. They are now importing some of our machines, are they not?—Yes, either drawings of them or the machines themselves

4234 You stated that the fancy manufacturers in this country derive their patterns and examples in taste chiefly from France?—Yes.

4235 Are you aware that many of the home manufacturers have ceased to do that, and now produce original designs of their own?—To some extent for the home trade

4236 Is it not a fact that the French taste is more bizarre and prone to loud effects than the English taste, which is quieter?—That is very much the case.

4237 Alpaca was first introduced in this country, and the French derived their fashions in alpaca chiefly from the products of English manufacturers, was not that so?—In what I said before, I spoke of fancy patterns rather than of materials which are produced in plain cloth; alpaca could scarcely be called a fashion, except with reference to its being largely used.

4238 But it was first introduced into England, and since its introduction the French manufacturers have copied our style, and perhaps improved upon it, is not that the fact?—I intended to limit my explanation about foreign goods to fancy goods, we have introduced plain goods here which have become the fashion without their having been first introduced in France, alpaca being an instance in point

4239. Some of the Bradford manufacturers have tried hard to copy the French merinos, and with some success, have they not, Messrs Craven, for instance?—That has been done very limitedly, it has been a question of perseverance, but our manufacturers are not continuing successfully to produce French merinos, for they have been tempted to go off to the production of larger quantities of cheaper articles instead of producing steadily those finer descriptions in which the return was much less.

4240 The English manufacturer has turned his attention to the production of articles which sell largely and pay better than the French merinos?—Yes, since the last Exhibition, one of our spinners and one of our manufacturers seeing the French merinos, were incited to try and do something like them; they said they would make those French merinos. It so happened that there was a great depression of trade in Bradford, and for some months after that, they proceeded steadily and very successfully to produce goods

which ultimately were pronounced by the merchant to be equal to any French goods, but I saw the spinner a fortnight ago, and I said, "How are you going on with your French merinos?" and he replied, "The manufacturer is so busy that I cannot get him to go on with them."

4241 You were speaking just now about the derivation of many of our fashionable colours from foreign dyers, but take the Bismarck brown, the success of that colour depends on no peculiar market or superior dyeing, but arises simply from the fact that the French milliners set the taste in dress, is not that so?—Precisely, I do not think there is any credit to the French dyers.

4242 Ladies were in the habit of going to the French milliners, and getting their ideas of taste from the French artistes, and, on the other hand, the English fashions in woollen goods are adopted in Paris?—That is my impression.

4243 I think you referred to some foremen, or sons of foremen, whom you sent to Manchester or elsewhere to receive instruction in chemistry; now, suppose it had been possible to have evening classes in all your works, say in connection with a mechanics' institution, or with your new institution, would you not then have an opportunity of sending promising young men to those classes without interfering with their daily routine of work, so that they might in that way receive the scientific instruction which you wish to give them?—I did not speak of the sons of my foremen, my foremen have no sons, neither could I find any young men in our own works who had had sufficient primary education to fit them to go and receive the instruction in question. I selected young men away from my own works who had received a better education

4244. The difficulty you had in introducing those superior men arose from the jealousy of the foremen and others who were afraid of the young men being put over their shoulders, I suppose?—No, it was pure prejudice on the part of the foreman dyer, who thought it would be interfering with his modes of operation

4245. You referred to the desirability of sending to day schools the sons of foremen for a longer period, and a question was asked you about the wages of such foremen, I suppose you would admit that a foreman who was receiving much less than 100*l* a year would hardly be in a position to send his son to a day school for any longer period than, say up to 13 years?—Thirteen or 14 years old

4246. Have you had much experience under the Factory Act?—Not very much.

4247. Under the Hours of Labour Regulation Act you have, I suppose, a number of youths who attend those schools?—Yes, our own works are under the Bleaching and Dyeing Act

4248. Are you erecting any schools specially for that purpose?—No, but I have erected three schools near my own works which would be available.

4249 Do you work many half-timers?—Not many, only a few.

4250. Can you say how many?—A very small number.

4251. *Chairman.*] You spoke of having sent two young men to London and Manchester, in order to study chemistry; you are aware that there is a Government school of chemistry in connection with *Jermyn-street*?—I am aware of that now.

4252. You

4252 You were not aware of it then?—I was speaking of eight or nine years ago

4253 I think you stated that you thought it would be necessary to improve the elementary education of workmen before it could be expected that they should be drafted largely into science schools?—Decidedly

4254 Then did you mean to imply that there were no persons at this moment, no matter whose sons they might be, who might be able to avail themselves of scientific instruction?—I think there are a great many young men, sons of foremen, and young men of the middle class, who are ready at this moment to enter into secondary or scientific schools and receive a scientific education, but the primary education of the masses of our workpeople must attain a much higher standard before they are, as a body, fitted for passing into secondary schools

4255 But is it not your opinion that it is of greater importance that our foremen and managers should be scientifically trained, than that any number of workmen should be so trained?—Yes, I think if you give the opportunity to all our managers and workmen to send their sons to schools of that description, we shall practically attain all that we want

4256 With regard to the position of manufacturers abroad, as compared with the position of manufacturers in this country, is it not the case that the capital employed in manufactures abroad has of late increased immensely?—I believe so

4257 Formerly, manufacturers abroad were at very great disadvantage as compared with English manufacturers, through the absence of capital, were they not?—That was much more the case formerly than it is now

4258 So that, in point of fact, they were not in a position to bear the expense of the requisite trials for effecting any great improvements in manufactures?—It is very evident that the manufacturers abroad now are men of abundant capital.

4259 But formerly that was not the case?—No.

4260 Were their operations conducted on a very small scale?—On a very small scale.

4261 And in a very primitive manner?—Very much so

4262 You would suppose therefore, without any special knowledge, that the majority of inventions would be made in this country where capital was greater, and where the returns were very much larger?—Yes

4263 But now that there is a greater parity between the manufacturers abroad, and manufacturers in this country, you would say that if the manufacturers abroad were more scientifically educated than ours, they would, in that respect, have a great advantage over us, without labouring under the practical disadvantage under which they formerly laboured?—They will have an immense advantage if they prosecute their operations as they have now begun to do it, and if they have men of scientific intelligence in their establishments, while we continue contented to go on with the men we now have, who, clever and willing as they are, are deficient in scientific training.

4264 You are speaking now of foremen and managers?—Yes.

4265 That is to say they are rivalling, or very nearly approaching us in matters of practice, and

it is therefore necessary that we should not be behind them in science?—They are very much on a par with us now

4266 Mr Akroyd] While you were in Paris did you come in contact with French and German manufacturers, or the sons of such manufacturers?—Yes, I saw two or three of them

4267 Comparing them with English gentlemen of the same order, do you think they are, on the whole, more intelligent, particularly on scientific subjects, than a similar class in this country?—I expressed an opinion on that subject years ago, and I expressed it again very strongly last year at Bradford, in the spring I have come in contact with manufacturing gentlemen abroad, whose friendship I could claim, and, from my point of view, those men are superior in scientific knowledge to gentlemen of a similar class in England, they are undoubtedly superior in scientific knowledge to any men occupying similar positions in England, they have appeared to me to be more in earnest than our manufacturers are on this subject, and, I am ready to use the word "alarmed," the only thing that has alarmed me, is the earnestness with which these foreign manufacturers are conducting their business, and the attention they give to every point of detail: comparing them with our own manufacturers, I see a great want of earnestness here in many cases

4268. *Chairman.*] How do you account for that?—Possibly from their point of view, it may be the necessity which they have seen for not merely maintaining their position, but following it up by competing with us more thoroughly

4269 Do you think it may arise partly from this, that they do not look upon their pursuit as simply a means of making a living or a fortune, but that they actually take great pride in their pursuits?—I think they look upon them as much more honourable pursuits than, as a rule, is the case in England

4270. And would not that arise in part from their superior scientific knowledge?—Possibly so

4271 They look upon manufactures as a vehicle for applying the scientific instruction they have received?—Yes

4272. Mr Akroyd] Then the superior education of foreign manufacturers has, you would say, something to do with that greater earnestness and intelligence of which you spoke?—A great deal

4273. Mr. Potter] Is it your opinion that the leading French manufacturers have a very accurate knowledge of all that passes in our own manufactories, in textile fabrics in particular, or, at all events, you are aware that they dread our competition?—Just so. They keep themselves much better informed with regard to what we are doing generally than we do with regard to what they are doing generally, they look upon it as of much importance to study the general course of affairs connected with their business

4274. All French woollen goods which come into this country are free of duty, are they not?—Yes.

4275. And the Yorkshire and other English products, which go to France to the extent of 3,000,000 l. or 4,000,000 l a year, pay a duty of 10 per cent?—Yes

4276 Therefore they have that protection against us?—They have that protection against us.

4277. And they are striving very hard to keep that protection?—I suppose they are.

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Mr. H. W. 4278. Do they not state it as an absolute necessity?—Some of them do.

8 June 1868 4279 Are there exceptions?—Yes; one of the largest manufacturers in the neighbourhood of Paris is an exception.

4280. Lord Frederick Cavendish] With regard to the education of our future foremen and managers, the institution which you hope to see at Bradford would begin by a distinctly scientific education at 14 or 15 years of age, but are there any schools of that class which the boys could attend after leaving the primary school, where they could continue their education between 12 and 15 years of age?—There are a number of private schools in the neighbourhood of Bradford and everywhere else, I suppose, where, for a few pounds a year, boys can get a

very efficient education. I know one which is a very efficient school, containing above 100 boys, and I should think that the sons of foremen and small shopkeepers would, in schools of that kind, find without any difficulty an education fitting them to pass into the institution of which we were speaking.

4281. Do you mean boys who have received their entire education in such schools, or those who have first attended ordinary national schools?—As a general rule these boys at Bradford receive their entire education at the private school, although no doubt there are instances where a man who has had children in the national school has risen in life and then has changed the school; that is by no means a rare case.

Mr GEORGE GIBB, called in, and Examined.

Mr. G. Gibb.

4282 Charman.] You are the Head Master of the Working Men's College, Halifax, and of the Haley Hill Day School?—Yes

4283 In that capacity you have had considerable experience in the scientific instruction, so far as it has gone, of the children of working men and adults of the same class?—Yes, as far as it has come under my observation in connection with the ordinary classes of the college, but I do not know much about their acquirements, not teaching them the scientific subjects myself.

4284. What subjects have you taught?—Reading, writing, arithmetic, algebra, mensuration, and so on

4285 Mr Akroyd] When was this Working Men's College formed?—In 1855

4286 What was the object of its formation?—The object of it was to carry on the education given under the factory system, from the age of 13 upwards, to give a good general education to those lads who had passed as full timers, and, as far as possible, to afford chances to those who had neglected their education before, of retrieving what they had missed

4287 The instruction given by the Working Men's College is entirely by evening classes, is it not?—Entirely by evening classes

4288 What are the hours of attendance?—From a quarter past seven to a quarter past nine for four nights of the week.

4289 Are those classes open all the year?—No, they are open from September to April inclusive, it is found next to useless to open them in the summer time.

4290 Are your students derived chiefly or almost entirely from the working classes?—At least five-sixths belong strictly to the working classes; they are handicraftsmen or mill workers

4291 What is the number of students in the college at present?—On the books in the college at present we have, in the senior division 92, and in the junior division 106, making in all 198

4292 What fees are paid?—Eighteen-pence for the general classes for the term of eight weeks, which comes to about 2d. a week, and for the science classes, one lesson per week, 2s. 6d. for the term of four months, which is about 2½d. per lesson.

4293 Has the attention of your students been called to the advantages of technical and scientific education?—Yes, last August we published a prospectus or address upon the subject, which I

have here.—(The Witness handed in the same, vide Appendix)

4294 What was the response made to that address by the students, and have you had any increase in the number of students consequent thereupon?—Yes, immediately on the opening of the classes in science, we doubled the number of students of the former year, the art class began with 35 or 36, that class was quite a new thing; but the science class had existed before

4295 You divide the students into a senior and junior division?—Yes.

4296. What is the age in the junior division? In the junior division we admit them at 12 years of age, although the Factory Act keeps them at school up to 13 We find that many children from other schools wish to be admitted, and we admit to the junior division at 12 years of age, and keep them there till they are 17 or 18, 18 is the proper age for entering the senior division

4297. The senior division embraces all students above the age of 18?—Yes.

4298 What is the oldest student you have?—The oldest we have is 35 years, but we have several above 30

4299. What portion of the education given at the Working Men's College do you consider technical and scientific, and by whom is that education given?—Chemistry, organic and inorganic, magnetism, electricity, and light, applied mechanics and machine drawing, the chemistry and scientific classes being conducted by Mr Jarman, of Huddersfield, and the art classes by Mr. Stopford, of the School of Art, Halifax.

4300 Speaking as the head master of the college, do you believe that these science classes are popular with the students, and appreciated by them?—I think that hitherto the young men of Halifax have not given that attention to the subject which they ought to do, but there is growing desire upon their part to take advantage of our classes, and I believe the attendance will go on increasing

4301. The college is worked in connection with the day schools?—Entirely.

4302 Those schools being factory schools?—Yes, all the teachers are engaged both in the day and night schools, with some exceptions, in the case of extra teachers who are brought in on account of pressure of work.

4303 Do you find that many of the day scholars who were factory workers become members of the college?—Yes, a very fair number indeed,

indeed; out of 76 who left as full-timers during the past two years, 35 immediately joined the college

4304. In fact, nearly half the day scholars being factory workers up to 13 years of age, afterwards become members of the Working Men's College?—Yes, immediately, but after they have been away a few years others often come back to us very ignorant, and enter the college

4305. What is the number of the day scholars at the Haley Hill School?—94 day scholars, that is, who attend for the whole time, and 504 who are mill workers

4306. Short time workers?—Yes, 598 is the total, and there are 257 infants besides.

4307. In your day schools, do you teach social science?—Not in the day school, but in the night school we do.

4308. Have you any drawing classes in connection with the day school?—Yes, we had 150 candidates this May for the Science and Art Department, in the first grade

4309. Have you any classes in the working men's college for social and political economy?—Yes, both in the senior and junior division

4310. Are those classes well attended?—Very well attended indeed.

4311. Do you see any special advantages in conducting evening classes in connection with the day school?—Yes, they are decidedly better in connection with the day school; I mean that it is better that the teachers in the day school should also teach in the night school, the discipline is much better where you have a properly trained teacher in the night school, the system of instruction is uniform when it is carried on in the two schools, and another advantage is that we can often recommend boys who seem to have a liking for a particular subject to go from the day school to the night school, and pursue that subject. In this way we are often able to carry a boy to the night school who would never go to it at all if he were not under such influence

4312. Can you point to any successful results as proved by your annual examination?—Our great test of success is the examination by the Society of Arts, for the general subjects in those examinations we have gained 48 first class, 85 second class, and 96 third class certificates, in arithmetic, English literature, book-keeping, geography, music, and one or two other subjects, we have also the Science and Art Department examinations for those who are in the science classes, and in those we have done very well. Then we have also a general examination, which is conducted by a member of one of the universities, who takes all the students and examines those who are willing, which is nearly all, as very few refuse. Valuable prizes are given in each class after that examination.

4313. Can you put in any of the reports of the examiners and the examination papers?—Yes—(Copy put in for 1867)

4314. Could you charge higher fees than you now charge without reducing the number of your students?—I scarcely think that it would be advisable to attempt that, I think that the students now pay as much as you can expect a young lad voluntarily to tax himself for.

4315. *Chairman*] Have you the balance sheet of the school?—I have not the balance sheet, but I have some rough notes here, being a copy of the manager's return to the Government.

4316. Can you tell the Committee approximately what was the entire cost of conducting the Working Men's College for the last year?—About 362*l*

4317. And what portion of that is covered by fees?—About 65*l*, and the Government grant was 57*l*

4318. How was the rest provided?—Entirely by the manager of the night school

4319. It is contributed by the founder of the school, who, I believe, is Mr Akroyd?—Yes

4320. And that is about 240*l* a year?—About that.

4321. You say that you think the connection of the day school with the night school is of very great importance?—I think so

4322. It is important, I suppose, as enabling you to provide teachers possessing higher qualifications than you could get if each department were worked separately?—Yes

4323. The emoluments would not be sufficiently large if the two schools were separately worked?—Quite so.

4324. Do you find that the children leaving the day school to enter the night school persevere in their attendance at the night school?—Not so well as we should like; but still we have a great many who do persevere year after year. A great many pass through the school, as we say, last year we had 367 who had passed through the school, which is a very large number, as the average attendance of last year was 170

4325. Can you state how many continue in the school for more than one session?—I cannot state that

4326. But a very large proportion attend for more than one session, do they?—A very large proportion

4327. And in addition to that, others who have not entered the college on leaving the half-time school, return to the night school after an interval of several years?—Yes, a very great many come back to us when they are about 18 or 19 years of age. When they have begun to seek other situations, wishing to raise themselves in social position, they find that they require more education than they possess, and they come back to us and say, we want to learn so and so, I think arithmetic is the subject that most of them require, and they come back to us honestly saying that they have wasted their time and require additional instruction

4328. The children who enter your night school after they leave the half-time school are probably the *élite* of your school?—No, not necessarily so, they are simply those children who have claimed their right to pass to full time from the day school, the great majority are in the upper classes, but not necessarily so, when they are 13 they can demand their certificate

4329. But you say that the great majority are in the upper classes?—Yes, five-sixths.

4330. In what state of preparation do they enter your school when they leave the day school?—Those of them that come immediately are very well up in their work, having passed standard 6, which is the highest standard; but we have a great number who enter besides, who have nearly forgotten all they had learned in the day school

4331. Can you state how many leave your day school yearly?—In the last two years 76 passed out as full-timers.

4332. How many of them entered the night school?—Thirty-five entered immediately

4333. It is the fact then that of those leaving the

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the day school and remaining in the employment of Messrs Akroyd, about one-half ordinarily enter the night school?—Yes; but it is not *sine quâ non* that they should remain in the employment of Messrs Akroyd, they very often leave their employment.

4334. And yet they continue to attend the night school?—Yes, certainly.

4335. The night school is a school for the town and not merely for the workpeople of Messrs. Akroyd?—Exactly, and at the school of the Mechanics' Institute, there are very large classes, those are the only two very large night schools at Halifax.

4336. At the Mechanics' Institute are there many classes in connection with the Science and Art Department?—None, the only science class is held in the Working Men's College, there is an art school at the Mechanics' Institute, but it is not in connection with it.

4337. The science school which is held at the Working Men's College is a science school for the town of Halifax?—Yes.

4338. Lord Frederick Cavendish.] You say that a great part of those who join the Working Men's College after leaving the school have passed the sixth standard?—Yes.

4339. They can read and write, and cipher very fairly?—Yes.

4340. Which subject of education do they seem most anxious to continue?—Arithmetic, reading, and writing, they go on in fact with the subjects they have learned at school.

4341. Do you find any considerable number of those youths join the chemical class?—Very few indeed, they are generally 18 or 19 years old before they join.

4342. If they were much younger, they would not be able to benefit by the chemical instruction, you would say?—Just so.

4343. Have a considerable number of youths of that age joined the chemical classes?—Our classes have not been anything like what the town should have produced, but this last year we had 35 students who entered the classes.

4344. Mr Lowther.] Did I understand you to say that there were a good many prizes given in your college?—Yes, but the Society of Arts' certificate is what we look upon as the test of the work in the senior part of the college, we have gained 229 certificates in nine years, of course it is only the *élite* of the college that go in for those subjects, because they are very stiff examinations by the Society of Arts.

4345. Chairman.] What are the subjects generally?—The favourite subjects are arithmetic, book-keeping, English literature, besides chemistry, which is also rather a favourite subject.

4346. Mr Lowther.] How many who go up for examination fail and how many succeed?—I cannot tell you that, but we are very particular not to allow any students to go in for examination, of whom we are not pretty sure that they will succeed, for examiners complain if papers are sent to them which are scarcely worth looking over; I do not think that out of 40 in a year more than two or three fail, we sent up 39 this year, and none have failed to get one certificate, though five failed to gain two.

4347. Mr Read.] Did I understand you to say that the whole and the half time children attend the same school?—Yes.

4348. And the same classes?—Yes; the same

classes, and they are taught by the same teacher and treated in the same way in every respect.

4349. When one child is at school for the whole of his time, and another child is at school for only half his time, can you manage to work them very well together?—Yes, we find practically that there is no difficulty in the matter, the teachers take care in the afternoon to try to vary the work; but there are not more than four or five day boys in a class of 25, they give them perhaps sums to set down in ciphering books, and try in that way to get over the tedium which a boy might otherwise feel in going over the same ground that he had gone over in the morning.

4350. For what time do the half timers attend?—From 9 to 12, and from 2 to 5 in summer, or half-past four in winter, according to the Factory Act. The children at our mill change the times every week; a child that has been at the mill in the morning will be at the school in the afternoon one week, and next week he will go to the school in the morning and to the mill in the afternoon.

4351. Are the ages of those children pretty much the same for the half timers and the full timers?—Yes, very much the same.

4352. You find no difficulty you say in teaching the two in the same school?—None whatever, we have such a small proportion of them in the day school.

4353. Mr. M' Lagan.] Do you teach reading, writing, and arithmetic, in your day school?—Yes, and we have an extra subject, this year we take history as the extra subject.

4354. But you have not attempted to teach the elements of any of the sciences?—We have not.

4355. Have you had that subject under your consideration at all?—Not with regard to science, I have really thought that there was not time for it; but I have fancied that political and social economy might be introduced, and we have drawing taught throughout the whole school.

4356. We have had it in evidence that the introduction of one hour's teaching a week of elementary science, in some elementary schools, has been attended with advantage?—I can understand that in full time schools, but not in half time schools.

4357. Mr Potter.] Did I understand you to say that you had 504 half timers?—Yes.

4358. What proportion of full timers have you mixed with them?—Ninety-four, but while we have 504 half timers, we know that that number really do attend regularly. Of the 94 day scholars, very possibly we should not have three-fourths there regularly.

4359. Do you not think that the 94 full timers would attend much more regularly, if they had separate classes to themselves, and that they would in that way have a better chance of receiving good instruction?—In my own experience, I have not seen reason to think so. I have had no complaints, and there are other schools which they could go to.

4360. But as a matter of choice, would you not rather have the half timers and the full timers educated under separate masters?—I do not think there is practically any evil from mixing the two together, if you introduce a little variety in the teaching.

4361. Do the 504 all come from one establishment?—Yes, they are boys and girls.

4362. Mr

4362 Mr *Dixon*.] Do you not find that the half-timers progress as rapidly in their learning as the full-timers?—I think, as a rule, they do, here and there the full-timers do sometimes get on better than the short-timers, but, as a rule, the latter get on nearly as well as the day children

4363. Is not the expense per scholar of your Working Men's College rather high, namely, about 35 s. a head?—Very possibly it is One very important feature is the value of the prizes, which makes the expense considerable They run about 15 s. a prize, and that of course makes up a very large bill.

4364 Have you any idea what is the cost per scholar of those prizes?—I have not.

4365. *Chairman*] Have you the total cost of the prizes?—We give 23, or 24, averaging 15 s each

4366. That would be somewhat under 20 L for prizes?—Yes

4367 Mr. *Dixon*] Do you expect that the present average cost per scholar is likely to be continued, or are you looking forward to some reduction in connection with projected improvements?—No, I had not thought the matter over in that light

4368. Suppose your number of scholars were doubled, for instance, would the cost per scholar be materially reduced?—Doubled would be a very large proportion, but if we had more scholars

we could teach them with the present staff quite as well We have room for more scholars, but not to double them

4369 Of what does your staff of teachers consist?—There are three masters belonging to the day school, and two young men who have been pupil teachers and come to assist at night, we have also a French master who comes to those who require lessons in French, besides, of course, the science and art teachers and two teachers of bookkeeping

4370 *Chairman*] How long have you conducted Haley Hill day-school?—Nine years

4371 Prior to that time, did you conduct any school?—I did.

4372. Was that a half-time school, or an ordinary school?—An ordinary school

4373. In stating that you found the half-timers made almost as much progress as those who went to school for the whole time, you spoke from an experience of schools of both descriptions?—Yes. I had ten years' experience of an ordinary school before I was head master of this college

4374. You attribute that result partly to the great regularity of the attendance of the half-timers?—Very much so.

4375 Mr *Akroyd*] You were trained at St. Mark's College, were you not?—I was

4376 (*Chairman*] Is there anything you wish to add?—No

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Mr WILLIAM HENRY STOFFORD, called in, and Examined,

4377. *Chairman*.] You are Master of the Art School at Halifax?—Yes

4378 In that school geometrical and mechanical drawing are taught by you?—Yes

4379 Mr. *Akroyd*] You were recommended to Halifax by the Science and Art Department, were you not?—Yes.

4380. What number of pupils for artistic drawing have you in Halifax, and what number have you for mechanical and geometrical drawing?—111 for artistic instruction, and 25 for geometrical and mechanical instruction.

4381 One branch of the Halifax School of Art is held at the working men's college, and you are also master of that branch?—Yes

4382 What is the number of pupils in the day school at Haley Hill learning elementary drawing?—150

4383. How many students are there in the working men's college receiving lessons in art, and how many in mechanical and geometrical drawing?—Twenty-five receiving instruction in art, and 10 in geometrical and mechanical drawing

4384 Have you recently passed an examination in geometrical drawing under the Science and Art Department?—I have passed an examination, but I am not yet aware of the result.

4385. Before this examination your students were, I presume, classified under the Art Department and not under the Science Department?—Yes.

4386 From your experience, do you find young men of the artisan class are desirous of acquiring proficiency in mechanical drawing?—Yes, that is to say, when once they become aware of the importance of such knowledge, and the benefits they may derive from it.

4387. Can you give the Committee a return of the general occupations or employments of the

0 72.

students in your science classes?—There are 10 mechanics, six joiners, five architects, pupils, one plumber, one ironmonger, and two clerks; total 25.

4388 If greater facilities were afforded, and public attention were called more directly to the advantages to be derived from art drawing and applied design, would you expect an increase in the number of your pupils?—Undoubtedly.

4389. More particularly in mechanical drawing, perhaps?—I do not say in particular mechanical drawing

4390 I would confine my attention more particularly to mechanical drawing?—I have no doubt that it would also influence the number of pupils in mechanical drawing

4391 Have you ever given any public lectures on the subject?—No

4392. What do you think are the special advantages to be derived from such instruction in geometrical and mechanical drawing?—In geometrical drawing the student acquires a knowledge of the construction and combination of symmetrical figures, the inscribing of one figure within another, and the construction of ovals, &c These are all applicable to certain branches of trade and manufacture In mechanical drawing it would enable the student to make plans and sections and elevations of any machine from actual measurement; he would thus acquire the power of representing by drawing any machine which he might conceive, or which was explained to him, his power of conception would become expanded, formerly, before mechanical drawing was taught, models and plans of machines were necessary to be made by the students, but after mechanical drawing is taught there is no necessity for that.

4393 Take the case of an ingenious mechanic who has got in his brain some invention; if he had

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had the power of putting his invention on paper, he might save himself time and expense in making models, and trying to carry out roughly his trials of his machine into practice?—Yes

4394 Have you any recommendation or suggestion to make with respect to diffusing more largely a taste for geometrical drawing as subsidiary to the development of local trade and manufactures?—I think the present method might be more largely developed. for instance, in the study of mechanical drawing it is impossible for me now to give proper attention to the subject in the school of art, for there are so many other subjects which I am expected to teach, and the time is so limited, and the number of students so large, and the assistance which I receive is so very little

4395. How would you define the difference between the art culture given under the Art Department, and that which comes under the Science Department?—As I understand it, under the Art Department the student in geometrical drawing is simply expected to be familiar with the construction of the various problems, but under the Science Department, as I understand it, he is expected to be acquainted with the theoretical principles upon which such constructions are based

4396 What are your fees?—At the school of art 7 s. 6 d per quarter

4397. And in the Science Department for geometrical drawing?—That is included

4398. With those fees, and with the aid of the grant from the department, are your classes self-supporting, so far as the teacher is concerned?—I think not

4399 Could higher fees be charged without reducing the number of your pupils?—I think not, there are so many incidental expenses which the student is liable to, that it would be very unadvisable, in my opinion, to raise the fees

4400 Are you of opinion that an art master who has taken a first class mechanical certificate is competent to instruct classes in geometrical and mechanical drawing under the science division?—Decidedly.

4401. Can you speak at all with regard to the results of your teaching; you have not been long in Halifax, have you?—Not very long

4402 *Chairman*] Geometrical and mechanical drawing are taught in art schools and in science schools?—They are.

4403 And you have stated the distinction between those subjects, as taught in the art schools and the science schools, to be, that in the art schools they are taught more as mere drawing, and in the science schools they are taught more with reference to the theory of construction?—Yes, as I understand it.

4404 In order to qualify a teacher in both cases an examination has to be passed?—It has.

4405 What is the difference in the examination of an art master with regard to geometrical and mechanical drawing, and a science master in the same subjects?—It seems to me that the knowledge required is, in each case, identically the same; if I were preparing a student for examination, either under the head of art or under the head of science, I should put him through exactly the same course of study.

4406. In fact the requirements from the art master are sufficient to pass him as a science master in this subject?—I think so.

4407. You would say that there is no reason

whatever why an art master should not qualify himself as a science master?—None.

4408. And that, after having done so, he would, as a science teacher, obtain higher fees upon results than as an art master?—Considerably higher; the payments upon geometrical drawing under the science division are considerably higher than the payments upon geometrical drawing under the art division.

4409. But the instruction he would have to give would be of a higher standard?—Judging from the examination paper which I have lately gone in for the problems seem to be exactly the same, certainly some of them are more advanced; but as a rule the knowledge which would be required for one would do quite as well for the other

4410. But I am speaking now of your pupils?—The same paper is given in both cases.

4411. Are papers given to the students in art schools in geometrical and mechanical drawing?—They are

4412 That is part of their ordinary examination?—Yes.

4413. An art master would not be paid on results unless his pupils passed in those papers?—He would be paid under the Art Department for those subjects.

4414 But unless his pupils passed that examination he would not be paid, even under the Art Minute?—No, certainly not.

4415. What is the highest payment which a master can take in those subjects in the art school?—Ten shillings

4416. What is the highest payment a master can take in those subjects in the science school?—Five pounds.

4417 Would you recommend art masters generally to qualify themselves as science teachers in geometrical and mechanical drawing?—It would be decidedly to their advantage

4418. You see no obstacle whatever to their doing so?—None; except the disinclination to present themselves again for an examination which they have already passed

4419. And that is a matter simply of feeling I suppose?—Yes.

4420 Would you approve of any person hesitating to pass that second examination?—It is just a matter of opinion I may perhaps read to the Committee an extract from the head master of the Leeds School of Art on this subject: "I know nothing of the difference between scientific and artistic geometry as we learn and teach them there is some quibbling difference, I suppose I know that I hold the mechanical certificate, and have sent in several students for the science examination, who have passed. I applied for payment; but I was told that I was certificated for art, and not for the Science Department, though I thought it was the same department, and my teaching was as good in one as in the other."

4421. But if he had passed as a science master there could have been no hesitation upon this subject?—Just so.

4422 You sat for examination during the last month?—Yes.

4423. You do not know whether you have passed or not?—No.

4424. When will the result be published?—suppose in a few weeks.

4425. Will you kindly communicate to the Committee the result of the examination with respect to yourself?—I will do so.

4426. I understand

4426. I understand you distinctly to say that, except as a matter of feeling, you think there is no obstacle whatever to an art master passing the science examination in these subjects?—Decidedly not

4427 Lord *Frederick Cavendish*.] What age are most of your pupils in mechanical and geometrical drawing?—From about 12 to 35

4428. Do you find that, in one session, they can learn enough to be practically useful?—No, indeed not

4429 Do many of them attend more than one session?—In some cases the student becomes interested in his work and he will attend regularly for considerably more than that.

4430 Do you find that a considerable number do take sufficient interest in the subject to do that?—Yes.

4431. Mr *Potter*] Did I understand you to state that you had 111 students under artistic

instruction in the school of art?—In Halifax altogether, not in the school of art.

4432. *Chairman*] Do you think it possible, advantageously, to introduce instruction in geometrical drawing in elementary schools?—I think it might be commenced there with great advantage, I would say, as a rule, that the want of an elementary knowledge of the first principles of geometrical drawing was a great barrier to the success of artizan students.

4433 And perhaps you would also say a want of mechanical facility?—Just so, the handling of instruments

4434. Would you say that children could begin to learn mechanical drawing almost as soon as they could begin to learn to write?—It would be quite possible, I think

4435. And would you add that the discipline of learning to draw would be equal to that of learning to write?—I would

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Mr. GEORGE JARMAIN, called in, and Examined

4436. *Chairman*] You are a Science Teacher, certificated by the Science and Art Department?—I am.

4437. How long have you been engaged in teaching science?—Since 1855

4438. What was your pursuit before you became a certificated teacher of science?—I was a national school master.

4439 Where?—At a village near Huddersfield, called Almondbury

4440. Mr. *Akroyd*] You reside at Huddersfield, although you have classes at both places?—Yes, I reside in Huddersfield, and have done so for some years

4441 Where are your classes?—There are some at Haley Hill, Halifax, at the Huddersfield Mechanics' Institute at Almondbury and at Elland, all these are under the Science and Art Department; in addition to these I have classes at the Huddersfield College and the Huddersfield Collegiate School, which are not under the department.

4442. Have you classes for organic and inorganic chemistry?—In both, at Haley Hill

4443 That is in connection with the Working Men's College evening classes?—It is

4444. Are your classes chiefly evening classes, or have you many day classes?—My classes, in connection with the Science and Art Department, are all evening classes, my other classes are held in the day time

4445. Will you state the various branches of science, as classified under the department in which you give lessons?—During last session I gave lessons in inorganic chemistry, organic chemistry, magnetism, and electricity; in former sessions I have given lessons in geology and vegetable physiology.

4446 What subjects are you certificated in by the Department of Science and Art?—Inorganic chemistry, organic chemistry, light and heat, magnetism, and electricity, geology, vegetable physiology and economic botany, six subjects, besides, having the elementary certificate from the Educational Department.

4447. What is the number of your pupils under the department?—The number of pupils under the department is 152, and the number of pupils not under the department is 37.

4448 What proportion of those under the de-

partment belongs to the wages or working class, and what proportion belongs to the middle class or upper middle class?—Of the 152 under the department, 99 are of the wages class, 46 of the middle class, and seven of the upper middle class

4449 Does the number of your pupils in the evening classes engaged in daily labour increase? Yes, very considerably

4450 Can you give, as an illustration, the employment of those pupils attending the Working Men's College at Halifax?—At Halifax, out of 35, there are six dyers, five druggists' apprentices and assistants, five apprentices at other trades, seven clerks, bookkeepers, cashiers, one woolstapler, one oil-cloth manufacturer, one dry-salter, five factory operatives, one boot and shoe maker, one colour mixer, one paper maker, and one gas-meter inspector. Out of those 35, 15 are in trades on which chemistry has a direct bearing

4451 Can you state any instances in which the knowledge of science has been of service to those who have been instructed by you, I mean, as regards their trade or occupation?—I could give many instances I sent out a list of questions to a great many of my old pupils, and I have had 114 answers from them The first question is, "What is your occupation?" The second question is, "Has the science instruction which you received at the Working Men's College been of any service to you in your daily employment?" and the third question, "Has your scientific information enabled you to obtain higher wages than you otherwise would have done?"—I have got 114 replies to those questions

4452 Without troubling you with too many individual instances, will you state generally the substance of those replies, and perhaps quote one or two special instances?—Seventy-one out of the 114 gave favourable replies to the second query; 16 gave qualified replies, and 26 unfavourable replies The unfavourable replies are chiefly from persons engaged in occupations on which chemistry has no bearing whatever. With regard to question No. 3—21 are favourable, 11 qualified, and 51 are unfavourable, those being chiefly from young men not in receipt of wages, and those not in occupations where chemistry

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was likely to be of any service; 28 out of the 114 are not in receipt of wages at all. An indigo dyer says, "I have found it of great use on many occasions since attending these science classes I have received a considerable increase in salary." A clerk says, "It has given me a knowledge of various processes used in our manufactory (carpet makers, dyers, and worsted spinners), which I should not have had but for that instruction, my knowledge of dyeing, and the principle involved in the washing of wool has enhanced the value of my services to my employers." Another is a manufacturer of the dyes of aniline colour, he was formerly, when he joined my class, a common dyer, but he begun the manufacture of aniline dyes, and now he supplies a considerable number of the Bradford manufacturers with aniline colour. He says, "The instruction has been of incomparable service to me, the manufacture in which I am engaged could not be carried on successfully without a knowledge of the laws of chemistry."

4453. Will you read one of the unfavourable instances?—The unfavourable ones are simply answered with a "No."

4454. Have you any direct negative explaining the reason of the "No?"—Yes, in many cases they say it has been of no service to them, because they are not in occupations where it is likely to be of any service to them.

4455. Are you of opinion that if the attention of the young men of the working class generally were awakened to the advantages to be derived from scientific teaching, you would have a large accession to the number of your pupils?—No doubt.

4456. Has the general talk of the advantages of technical education roused their interest and added to the number of your classes?—Very much, so much that I have had to open a class in Huddersfield, in connection with the Huddersfield Mechanics' Institution, a class for the chemistry of dyeing which promises to be very successful, so far as numbers go, we have 46 pupils, and we have only met three times. This is a circular which our committee issued, and which was sent to all the manufacturers in the district, and to all the employers of labour in the dye houses. (Vide Appendix)

4457. When was that circular sent out?—About a month ago, the result has been that 46 young men have come to the class; many of the young men are manufacturers' sons, out of the 46, 24 are dyers, 12 are woollen manufacturers, 3 factory operatives, 6 agents assistants and warehousemen, and 1 chemist, 42 out of the 46 are occupied in trades on which chemistry has a direct bearing.

4458. Have you given any public lectures on the advantages derived by chemical science?—I have given some three or four during the last winter in a district in the neighbourhood of Huddersfield. During the lectures I took occasion to point out the great advantages which the manufacturers of the country would derive from the study of science.

4459. What was the result of your lecture, did you find that they created very much attention?—The last lecture was at a village called Kirkburton, rather a large manufacturing village, in the neighbourhood of Huddersfield, and I have since had an application from the institution where I lectured, to undertake to teach a class there.

4460. You believe that if those lectures were

given systematically and generally they would have very beneficial effect in this direction?—I believe so. I believe they would tend generally to rouse a feeling among the working classes for scientific information, and would be more effective than anything else that could be devised.

4461-2. You have science classes in connection with the Huddersfield Mechanics' Institute?—Yes; the dyeing class is one, and during the winter I had one in inorganic chemistry.

4463. Do you find that previous elementary knowledge is essential to the progress of the students, and is it possible for those who are not possessed of previous elementary knowledge to derive much benefit from your course of instruction?—A young man who has very little elementary knowledge, can make but very little progress in the acquisition of scientific knowledge.

4464. Will you tell the Committee, shortly, what is your course of instruction?—I begin the session with explaining the elementary principles of chemistry; I illustrate the lessons plentifully with experiments; I describe the substances and their compounds during the first part of the lesson, and then I get the pupils to work experiments during the second half of the lessons, and I frequently examine them in the previous subjects, by giving them questions to work off.

4465. How often do your classes meet?—Once a week.

4466. For how many weeks do you expect the attendance of pupils, before they arrive at anything like adequate knowledge of the subject taught?—It depends a good deal on the knowledge of the young man; in the course of two winters, on an average, a young man will acquire sufficient knowledge to help him very much in his business.

4467. Do many pupils fall off after a few lessons, being unable or unwilling to devote the necessary time or attention to the complete course?—A number do fall off after a few lessons, finding that they cannot keep pace with the subject, their elementary knowledge having been insufficient, a number also fall off because they had imagined that learning chemistry, was that they were to sit still and watch a number of pleasing experiments, and when they find a little hard work required, they withdraw; a third number withdraw towards the close of the session when the examination is coming on.

4468. They are afraid that they will not pass the examination?—Yes.

4469. What proportion of failures have you among your pupils, by failures, I mean those who make no progress, and to whom their attainment of scientific knowledge is of very little use in after life?—Very few have failed in their examinations, I should say that at least one-fourth would make no use of their information on account of their withdrawing from the classes at an early stage, but all those who go through the course, and are employed in processes where a knowledge of science is requisite must derive some benefit.

4470. What are your fees?—The fees vary in the different classes.

4471. Take the chemical class at Haley Hill?—Five shillings for the session.

4472. And the one in connection with the Huddersfield Mechanics' Institution?—That is 5 s. for the chemical class fee, and they have also an institution fee, which would amount to 4 s.; that

is for artizans, for others, the chemical class fee is 15 s

4473 Five shillings for what term?—For the session, beginning in October and ending in May

4474. How many weeks will that be?—About 30 weeks

4475 That is your usual scale of fees for the artizan class?—Yes

4476 Do those cover the expenses of your classes, and make them self-supporting, with the addition of the grants from the Science and Art Department?—No

4477. How is the difference made up; I do not allude to the working man's college, but in connection with the Huddersfield Mechanics' Institution?—Out of the general funds of the institution

4478 Could you charge higher fees without causing diminution of the number of pupils?—It would not be safe to raise the fees much; a student has usually to buy a text book, which would cost him 4 s or 5 s, and he often buys a little apparatus to work out the experiments at home

4479. Do you think that the present mode of providing teachers of science for our working classes is satisfactory, if not, what course do you recommend?—The course pursued by the department at present is to enable any young man who takes a first or second class prize to become a teacher, I do not think that that is satisfactory?—I think that teachers should be of a different standing to that, they should have some previous preparation for the office; if it is necessary for an elementary teacher to undergo an apprenticeship, and subsequently to pass a certain period of time in a college, it is equally requisite that a science teacher should also have some previous training

4480 Do you not think that two or three neighbouring towns might unite in securing the services of a science teacher, to visit the towns in rotation?—As a temporary arrangement it would be a very good plan. Taking Halifax, Huddersfield and Bradford together, those three towns might engage the services of a staff of science teachers who could visit the towns in rotation

4481 Your own time is fully occupied in teaching, is it?—A good deal of it is occupied in teaching, but not altogether; I do a good deal of analytical and other work.

4482 If you had the paid assistance of one or two pupil teachers in science, could you extend the area of your teaching?—Yes, very much, I have many applications from surrounding villages and small institutions, which might very well be worked by means of pupil teachers under my care and training; I think it would be of very great service to me

4483. *Chairman*] You were formerly a teacher of an elementary school?—Yes.

4484. Was that school a half-time or a full-time school?—A full-time school, we had a few half-timers, about a dozen.

4485. But generally it was an ordinary elementary school?—Generally it was an ordinary national school.

4486. At what age did the pupils leave that school?—At from 10 to 12 years of age on an average.

4487 Do you think in respect of children remaining at school till 12 years of age, it would be possible to give any preliminary instruction in 0.72.

science?—I think it would as I tried the experiment during my last year or two in that school, I trained my first class in chemistry, I found they were pretty well up in arithmetic. All the first class were working decimals, and I found that they could understand the elementary principles, quite as well as the bulk of the young men who now present themselves for instruction in my evening classes

4488 What is the age of those children?—The age of the children in the upper class was from 12 to 15

4489 But had you many children above 13 years of age in that class?—I had about 10 who would be above 12 years of age.

4490. What was the entire number in the class?—About 10 or 12: it is so long ago that I really forget the exact number.

4491. Most of them were above 13 years of age?—Yes, during the time I tried to introduce chemistry

4492 That was before the change was made which was effected by the Revised Code?—Yes; when the revised code came into operation I left the profession

4493. Was there any connection between those two events?—Yes, a very close connection.

4494. When you first became a science teacher there was a payment on the certificate, was there not?—When I first became a science teacher under the department there was a payment on the certificate, but I was a science teacher before that

4495 Under the department?—No.

4496 Has the withdrawal certificate had any material effect in discouraging persons from devoting themselves to the profession of teachers of science?—I believe so.

4497. Assuming those payments still to exist, how much would they add to your income?—The difference in my payment is this: I received last year one-half of what I received the second year after I became a science teacher.

4498 Although the number of persons you have passed has very much increased?—Yes.

4499 Can you give me the receipts and the dates?—I fear not.

4500 Can you give them approximately?—In 1862 or 1863 I received 124 l; last year I received 59 l 10 s

4501. How many classes did you teach last year in connection with the department?—I had classes at Halifax, Elland, Huddersfield and Almondbury Those classes I have taught during the last session. At Halifax I have three classes, at Elland I have two classes, at Huddersfield I have one class, and at Almondbury I have one.

4502. What were your pupils' fees during last session?—My pupils' fees during the last session in Halifax amounted to 10 l

4503. Can you give us your entire income from fees and capitation grants for your classes in connection with the science and art department during the last session?—Yes, from Halifax I received 40 l, 5 l of which was spent in travelling expenses, that leaves 35 l From Almondbury I received 12 l 10 s, From Huddersfield I received 5 l 15 s., those are under the department, and all those sums are from the schools in addition to that sum of 59 l 10 s from the department.

4504 Were they sums received from the schools in fees, or were they in some cases in the nature

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Mr. nature of salaries paid by the managers?—At the
 G Jarmam. Huddersfield Institution they were fees; at
 8 June 1868. Haley Hill and Almondbury they were in the
 shape of salary.

4505 Was your entire income from fees and from Government under 130*l* during the last session?—Yes.

4506. And for that you gave instruction during how many hours?—I had seven classes, and to each class I gave one hour's instruction.

4507. How many times?—Once a week

4508. During how many weeks?—Thirty weeks

4509 That is to say you gave instruction 210 times for less than 130*l*?—Yes

4510 Yours is an instance, I believe, of successful science teaching, and what are called successful results to the teacher?—I suppose so; I have 22 per cent of the pupils under the department in Yorkshire.

4511. Can you recommend any mode by which the profession of a science teacher in connection with the Science and Art Department could be made more attractive without injustice to the taxpayers?—I think that the plan of enabling young men who have taken first and second class prizes to become teachers will simply disgust the teachers who are already in the profession, there is no minute which has done more harm to the teacher than that has.

4512. You speak of the minute which enables pupils to become teachers instead of the teachers being compelled to pass a special examination as was formerly the case?—Yes

4513 When did that minute first come into operation?—About 18 months or two years ago, I think

4514 It was only in May 1867 that pupils could qualify for the first time as teachers without a special examination?—Just so

4515 And the examination of 1868 is the first examination in which the pupils of such teachers will have been tested?—Yes, just so

4516. You are aware that the Science and Art Department has recently offered scholarships of 5*l*, 10*l*, and 25*l*, supplementary to a grant of a similar amount from the localities?—Yes

4517 Are you aware whether the localities of Yorkshire have availed themselves to any great extent of that minute?—I do not think they have in any instance, that I am acquainted with, not in any instance connected with my classes

4518 To the 10*l* scholarship a condition is attached that the pupil shall remain in an elementary school, do you think that that condition is likely to be advantageous to the pupil?—I think that a pupil to receive such a scholarship as that should have a pretty good foundation of elementary knowledge to begin with.

4519 And that consequently the further instruction that he might receive in an ordinary elementary school would not be of much benefit to him?—It would not be necessary.

4520. And that if he remained in the school, he would not be well employed?—No. I believe one reason why the institutions have not availed themselves of that minute, is the fact of its not being generally known

4521. You have also stated in answer to a question by Mr Akroyd, that you would consider it desirable that the attention of the working men should be awakened to the desirability of attending science classes. I conclude from those two answers that you believe sufficient

publicity is not given to such classes, and to the advantages connected with them?—I think not.

4522 In what way would you increase that publicity?—By giving public lectures, and by sending out circulars by the authorities of mechanics institutions; if the authorities of mechanics institutions would undertake to send out circulars to the employers in the district, as our institution did in Huddersfield, it would make the thing better known.

4523. It is by local action, and not by Government action that you would give greater publicity to those classes and the advantages of attending them?—It is.

4524 You have handed in a circular dated the 30th of April, with regard to technical education in connection with the Huddersfield Mechanics' Institution?—Yes

4525. Can you tell the Committee how the movement which led to the formation of the classes in dyeing originated?—It originated from the reports about the Paris Exhibition

4526. And did that induce the merchants and manufacturers to take any steps, or was it done by the officials of the Huddersfield Mechanics' Institution?—The officials are nearly all manufacturers and merchants in Huddersfield, some of the most prominent men in Huddersfield are members of the Committee, and they take the greatest interest in the institution and its classes. That circular may be regarded as emanating from some of the wealthiest and most prominent manufacturers of Huddersfield.

4527. It contains a recommendation "that the employers will assist the committee in their efforts to impart technical knowledge to the industrial classes of the neighbourhood," and it is suggested that they can do so, by sending one or more of the most promising youths in their employ to receive instruction, has that recommendation been responded to by the employers generally in Huddersfield, and the neighbourhood?—It has, I have a great many young men employed in the dye houses, who have been induced to come to attend the class by their employers.

4528. Altogether you would say that the state of feeling with regard to scientific instruction has undergone a rapid change in Huddersfield, and the neighbourhood?—It has certainly.

4529. Should you suppose that if a secondary school were established in that neighbourhood in which scientific instruction were made as prominent as classical instruction is now in grammar schools, such a school would be acceptable, and would be successful?—I am quite sure it would. Our institution authorities are about adding to the building of the mechanics institution, at the expense of 2,000*l* for the purpose of having art and science taught there, more generally than they have been hitherto.

4530 Do you mean in a day school?—No, in evening classes

4531 But I am speaking of secondary day schools?—I think we are hardly prepared yet for a day school in science, there are two day schools in Huddersfield already where chemistry is taught.

4532 Are mathematics taught to any great extent in those schools?—Yes.

4533. Are they large schools?—Both of them are pretty large, the college especially.

4534. Are they proprietary schools?—The college is a proprietary school.

4535. The

4535 The Collegiate School is what?—I do not understand the foundation of the Collegiate School exactly.

4536. But it is not a private school?—No, it is not.

4537 Lord *Frederick Cavendish*] You have stated that nothing more detrimental to the profession of science teachers has occurred of late years than the letting everyone have a certificate who possessed first and second class prizes?—Yes, I believe it has done great harm.

4538. In what manner?—It has thrown discredit on the position of the teacher.

4539 The examination being the same as was formerly passed by certificate?—Yes, by special examination at the Science and Art Department.

4540. The mere difference of the scene of the examination has not discredited the profession of the teacher, has it?—No, I think it is having the examination separate that is required. In the November examinations, in chemistry the student was required to pass an examination in analysis, in addition to the paper examination, that is now done away with.

4541. Is there any other difference between the examinations?—The second paper is quite as difficult now, under the present arrangement, as it was under the old.

4542. I suppose that holding a separate examination for a certificate is a very large additional expense?—I do not see why it should be.

4543. A separate set of examiners, printing the papers, and bringing candidates up to London, must be an additional expense?—It is no very great hardship, I think, the examiners are the same.

4544. You think, perhaps, that money cannot possibly be spent for science teaching in a more beneficial manner?—I think not.

4545. You said that it would be a great advantage if you could employ pupil teachers?—Yes.

4546. Would it not be possible for you now to employ one or two young men who had passed those first and second class examinations, and who would therefore receive a Government grant?—I do not see how I could claim any aid under that arrangement; they would not be my pupils, and if they got a second class prize, they would be entitled to the payment for any pupils taught by them and not the teacher.

4547. But supposing your general superintendence was of great advantage, would it not be of great use to any Mechanics' Institution who wanted a science teacher to request you to take in a young man who would act as your pupil teacher?—Undoubtedly, but how should I be benefited?

4548. I presume that a Mechanics' Institution would be ready to pay you more in that case?—That is altogether a question of salary to the teachers.

4549. We are referring here specially to the

advantages of science teaching, not to the profit of the teachers?—Teachers could very well undertake to do that, but I think they should be paid for it.

4550. You stated that the great difficulty in teaching science is the want of elementary teaching?—Yes.

4551. Have you found that difficulty has decreased since you first began science teaching or otherwise?—I have not observed much difference.

4552. Having had experience as a teacher of elementary education, and also as a science teacher, has any method occurred to you for getting over that difficulty?—As science teachers we have not to prepare young men, we must take them as they come, but it is extremely desirable that their primary education should be better attended to.

4553. You have not considered whether, by means of evening classes, or by extending the age under the half-time system, or by any other means that obstacle to the success of science teaching could be got over?—No, I have not turned my mind to that subject.

4554. Mr. *Read*] Chemistry appears to be the most useful science for the working men of your locality?—Yes.

4555. Is that in consequence of dyeing being such a large industry there?—Yes, dyeing and woollen manufacture, it is more applicable to the industry of the neighbourhood than any other science, but the Huddersfield Mechanics' Institution Committee are now looking for a teacher in applied and theoretical mechanics, they think that subject is very necessary.

4556. You think that some other kind of science teaching might be more successful in some other localities?—Yes, I think so.

4557. Mr. *Akroyd*] You were speaking of the scholarships granted by the Department of Science and Art. You are probably aware that they are granted to the elementary day schools, and that they are not open to your students of the evening classes?—I was not aware of that.

4558. Assuming that it is so, are you of opinion that, if those scholarships were open to students in night classes, they would have a stimulating effect on such classes generally?—I think so.

4559. Do you think it desirable, therefore, to hold out some scholarship or some grant to successful students in evening science classes?—Yes, I think so, decidedly. Although Huddersfield may not be at present prepared to open a day school for science, yet I think an opportunity should be given to the promising young men of the artisan classes in West Yorkshire to complete their education in some central school of industry where they might have the advantage of being trained in the scientific principles of the particular industry which they intended to be their future occupation.

4560. *Chairman*] Is there anything you wish to add to your evidence?—No.

Mr.
G. Jarman,
8 June 1868.

Thursday, 11th June 1868.

MEMBERS PRESENT.

Mr Akroyd.
Mr Bagnall.
Mr Bazley.
Mr Beecroft
Mr Henry Austin Bruce.
Lord Frederick Cavendish.
Mr Dixon

Mr. Graves.
Sir Charles Lanyon.
Mr William Lowther.
Mr. Edmund Potter.
Mr. Powell.
Mr. Samuelson.

BERNARD SAMUELSON, Esq., IN THE CHAIR.

Mr ANTHONY JOHN MUNDELLA, called in; and Examined.

Mr. A. J.
Mundella.
11 June
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4561 *Chairman* | You are the Chairman of the Nottingham Chamber of Commerce, I believe?—I am

4562 You were one of the jurors at the Paris Exhibition of 1867, were you not?—I was

4563 I believe you have taken a very active interest in questions of education?—Yes, I think so.

4564. You are generally acquainted with the manufactures of the midland counties?—I am, and with the corresponding manufactures on the Continent.

4565 When I speak of the manufactures of the midland counties, I mean the hosiery and lace trades, but not the iron trade?—I am more particularly acquainted with the hosiery trade than with any other; that is my trade

4566 You are one of the gentlemen who replied to a letter of the Secretary of the Schools Inquiry Commission on the subject of technical education, are you not?—Yes

4567. You have, no doubt, read the replies of the other gentlemen to whom a similar letter was addressed?—I have

4568 Are you of opinion that in any of the great manufactures, for which this country has hitherto been famous, the continental countries are now in advance of this country?—Judging from my own manufacture, I should say they are not in advance of us; certainly not in my own trade; there are some manufactures in which I think they are in advance of us a little; but as I consider they are not in advance in my own trade, I would rather not speak to that point

4569 Speaking of those trades with which you are conversant, would you say the continental manufactures have recently gained ground very rapidly?—Immensely, we have certainly not retrograded, we have made our full average rate of progress; but during the last ten or a dozen years, on the Continent, the progress has been so much greater in proportion than our own, that they are close on our heels in most of our products, and in some they are quite neck and neck with us

4570 To what do you attribute the great progress that has lately been made on the Continent?—They have been greatly stimulated by treaties of commerce, and they have succeeded by the

aid of our machinery and their greater intelligence in developing their manufactures much more rapidly than we have.

4571. By intelligence, do you mean greater natural intellectual power, or greater cultivation?—Certainly not greater natural intellectual powers, but cultivation; I may be prejudiced, but I have the conviction that our English workmen and artisans generally are superior in natural intelligence to almost any others. To the foreign artisans they are greatly superior in rapidity of work; with the same machine English workmen will produce more work in the same number of hours than French or German workmen; but the French head workmen, not the inferior workmen, but the foremen or overlookers, are exceedingly well educated. In Germany, they are all well educated, and it is to that fact that I attribute their greater progress. If I may give you an illustration, 10 years ago in France and Germany there was not a single machine in our trade working with steam power, they were all working the old hand looms.

4572. You are speaking now of the hosiery trade?—I am speaking of the hosiery trade; they have taken our machinery and adapted it to their own labour and improved it, and they are possibly making better work in some departments from our own patent machinery than we are. A patented machine in England must be at once patented in France, or it becomes common property, we have often patented machines in France, but we have only sent the model there, because the French law requires, that if the patent is to be affirmed the machine must be constructed there after the first model sent.

4573. By model, you mean a good working machine?—Yes; after that they must build the machine themselves. I have seen the machine shops spring up with wonderful rapidity, and those machines put in the hands of skilled and instructed mechanics; they are working them to a remarkable extent now, both in France and Germany. Their construction is fully equal to our own, and in some respects better.

4574 Is it the case that many improvements in the construction of machinery in your department are now introduced into this country from abroad

abroad?—We have had some important improvements introduced from abroad, but I believe our workmen are more inventive than the foreigners generally, and greater inventions are made at home. That may be accounted for on another ground, that there is more capital at home and more money to be spent in developing improvements than they have abroad.

4575. In trials you mean?—In enterprise and trials.

4576. Of which many must be necessarily unsuccessful?—An immense number of our improvements are failures simply through the ignorance of the men, who have good ideas, but from want of mechanical knowledge cannot carry them out properly. There is great waste in this respect.

4577. Are the foremen in the machine shops of the midland counties good draughtsmen?—Such a thing is almost unknown; some of our longest foremen can hardly sign their own name.

4578. That is to say, they are at a great disadvantage in explaining to the workmen what they wish to have executed?—Yes; it is almost entirely brought out by trial and errors, they make efforts, and if they fail they try again, our trade in the midland counties is 300 years old, upon the continent it is comparatively new in some parts of it. We have gone on improving from generation to generation in the old track.

4579. Do you think that the foremen and managers in your machine-shops generally have a competent knowledge of the strength of materials?—Nothing of the kind, it is entirely natural capacity, and the experience which they have gained in their trade.

4580. In point of experience there is no longer the disparity between our mechanics and those of the continent which formerly existed?—Certainly not.

4581. Would you say that there was any great disparity?—Our men are naturally more energetic and inventive.

4582. I speak now with regard to experience only?—With regard to experience on the continent, they have now nearly gained all that we know, it is every day becoming more and more a question of capital, skill, and science. The natural advantages which we possess seem to me to be gradually diminishing, the advantages we once possessed over them, in cheap labour for instance, is gradually diminishing; we are approximating to a position of equality which will, within the next 20 years, make it a mere question who is the most intelligent, and can best adapt means to ends.

4583. Do you mean that we are approximating to an equality in science?—No, I wish I could say that.

4584. They are gaining upon us in respect of experience?—Yes.

4585. And we are losing some of the advantages which we once had over them?—Yes.

4586. But we are not approaching them in scientific instruction?—That is it. With regard to my own trade, taking the cotton department, we have the advantage of Liverpool, as a great depot close at hand; we have Lancashire close at hand for spinning purposes; and we are within 70 miles of Manchester, for weaving and finishing. Then we have had the advantage of great prestige in the foreign market. The German manufacturer has had to buy his cotton in

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Liverpool and pay the freight to Hamburg and the carriage in the interior to the place of destination, and then, again, the carriage to the out ports, and he has not stood so well in the foreign markets, but he has had the advantage of cheaper labour. We shall still possess the advantage of having that great depot for our raw material, and if our workmen were only placed on an equality in point of culture with the continental workmen, I think we have nothing to fear.

4587. When you use the word workmen, are you alluding to ordinary artizans or to foremen and managers?—To foremen and managers; more particularly to those who have the conducting of the work, take the case of an intelligent workman who develops some talent in his business, first of all, that man ought to have a much better primary education than he would at present get, so that he would be made able to receive scientific education afterwards; the next step is, that we wish him to receive a scientific education, of which he might be able to make use in his daily avocation.

4588. Do you think that what would apply to foremen and managers would not apply in the same degree to manufacturers and proprietors of works?—I find it is very nearly as bad with regard to proprietors and manufacturers too. We have done without science a long time, and we have been equally indifferent to it; it is not the fault of the Government, it is rather that we are only now finding out that we require it. I have no doubt that one effect of this Committee will be to awaken people's minds on the question, but hitherto manufacturers have been as indifferent to scientific education as the workmen themselves.

4589. You have spoken of the want of scientific knowledge among the foremen and managers of machine shops, but how is it in the dyeing department of your trade?—In the dyeing, bleaching, dressing, and finishing departments, it is very bad, and there is no doubt that great losses result among the bleachers, dyers, and finishers from the want of intelligent men as chemists in those departments in the dyeing trade. At this moment there is a great deal of silk going from the midland counties to France to be dyed, and then coming back again into this country to be worked up. I am assured that tons of silk go regularly from Nottingham, Leicester, and Derby to Lyons to be dyed, simply on account of their possessing some chemical skill which our dyers do not possess, or some chemical skill in which they are exceedingly deficient. Even among our own manufacturers, I do not think we have a single dyer in our immediate neighbourhood who is a good chemist.

4590. Would you say then that there is not only a want of knowledge, but also some want of skill in dyeing?—It is remarkable how well we do, considering how little we know. Our men have had practical experience generation after generation, and by trying and trying again they keep up pretty well; but still we are undoubtedly behind both France and Germany in dyeing.

4591. Have you found that it is an easy matter when you have sent plain goods to be dyed to be sure that you will have the exact tint that you wish to have?—It is exceedingly difficult to secure uniformity in shade and tint.

4592. That difficulty, you think, arises from the

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the want of scientific knowledge and manipulative skill?—I think it is want of chemical knowledge and want of accuracy probably

4593 That is to say, that there is no inherent impossibility in the nature of the materials dealt with in securing uniformity?—Not at all; but the men are not acquainted with the nature of the materials, and cannot test their relative strength.

4594. You employ a great number of work-people in this country, do you not?—Yes.

4595. And you also employ a number of work-people on the Continent?—I do

4596. Where do you employ those people on the Continent?—I employ 700 or 800 in Saxony.

4597. And how many do you employ in this country?—Between 4,000 and 5,000.

4598. In what part of Saxony is your manufactory situated?—It is at Chemnitz, which is the centre of the manufactures at Poutza, which is in the Voightland.

4599. You are aware that in many of our manufacturing towns classes have been established in connection with the Science and Art Department of South Kensington?—I am.

4600 Are there such classes in Nottingham?—There are such classes in Nottingham.

4601. Then, there being such classes in Nottingham, has the primary education of your workmen been such as to enable them to avail themselves of the scientific education offered by those classes?—By the aid of the principals of large establishments, I have tested that, with regard to large numbers of the people employed in various trades in our locality, we had a uniform form, asking whether such and such people could, for example, read and write, or do any arithmetic; and with regard to their general intelligence, taking the most simple tests possible; and I can assure the Committee that the failures are almost incredible. I could not have believed it if I had not had the absolute facts before me.

4602 Are you speaking now of the large majority of such people?—I may say this: the ability to read a very simple paragraph is not possessed by nearly 50 per cent. of the people employed in our large establishments in Nottingham and the immediate neighbourhood, in the lace factories, in the hosiery factories, in the bleaching works, and in the dye works, in the brick yards it is an utter failure, the people cannot read at all. Two of our largest brick-makers returned only 12 people who were able to read, out of all who were in their employment, and they were the sons of foremen.

4603. Out of how many is that?—I should say that that firm employed 200 or 300 people. I am almost afraid to tell the Committee what is the state of things, because nobody believes these things when he is told. I believe that we are no worse off in these matters than our neighbours. We have made great efforts for getting up schools, and undoubtedly 50 per cent. of those who go to school can get a fair education; but any comparison between England and Germany cannot be made at all.

4604 But do not the Factory Acts apply to your neighbourhood?—We are all under the Factory Act, but in the hosiery trade we never see the labour of children under 13 years of age; in the doubling mills they use the labour of children, from eight years old upwards.

4605. How long has the half-time system

existed in the doubling mills?—Ever since the Factory Acts were introduced.

4606. Have you many half-timers in the doubling mills?—Yes.

4607. Have you instituted any examination into the state of education among the half-timers?—Yes

4608. What is the result?—The result is this: that the half-time system is an exceedingly good one where the children have been at school for a few years before, they go into the half-time school and to work, but if, when they go to it they are going to school for the first time, it is an utter failure, if they learn anything they forget it by the time they are 15 or 16 years old, and the utmost they get is an imperfect ability to read and write, which is tantamount to no knowledge at all.

4609 Is that the case when the children go to work and to school simultaneously, so early as at the age of eight years?—Yes, I have had that tested in a doubling mill, where there were 600 young persons employed, and it came out that 49 per cent. could not read, or could only read very imperfectly

4610. When they had become full-timers, you mean?—Yes, my inquiries at the bleaching yards, where they have had them on half-time, led me to this conclusion, that by the time they are 15 or 16 years old they have forgotten most of what they had learned; it is not as if they went to school at eight years of age, and kept on till 13 years of age regularly in one place, for they shift about and go to different occupations, and that irregular schooling really amounts to nothing.

4611. Before employing young people, do manufacturers inquire much into the state of their education when they come to them at first, whether as full-timers or as half-timers?—I should say, as a rule, it is a question never asked, what employers look at is their capacity for work. Still, I should not like to do any injustice to the masters, and there are undoubtedly a great many of them who are very anxious on this question, and who say that the half-time system amounts to nothing, unless the children have been to school before they came to work. I believe if you could get a child at school from five to ten years of age, so as to begin with regular schooling for five years, and then put him on the half-time system after 13 years of age, you would completely annihilate the state of things which exists in this respect in our present population.

4612. Then with regard to boys and girls going to work at 13 years of age for the first time as full-timers, do the same employers show the same want of solicitude?—I can only say that in my own establishment I find boys at 15 who can neither read nor write, and whose fathers have been earning 2*l.* a week for years consecutively. I can mention a case of a man who had been in my employment for six years, who had never lost a week's work, and had received on an average 2*l.* a week, that man had an only son 15 years old, and he was in the most deplorable state of ignorance that I ever found, which simply came from the apathy, neglect, and selfishness of his father.

4613. Had that boy worked as a half-timer?—No, he had run about the streets the best part of his time, I suppose.

4614. That is not very encouraging with regard to the establishment of schools by local taxation?—I think that if we establish schools by

local

local taxation we shall not pay the taxes without compelling them to come in by-and-bye; but for my own part, I would much rather begin by compelling them at once

4615 Now, in Saxony is there the same difficulty with regard to the necessary preliminary education?—No, on the contrary, in Saxony every child is well educated, its primary education is of a very superior kind indeed, very much better than that which is obtained by most of our young men who go to middle-class schools for primary education in England.

4616 Is there any attempt at scientific instruction in the primary schools in Saxony?—Not in what are called the lower people's schools, but there are a great number of schools for teaching science in Saxony.

4617 Are you aware whether physical geography is taught in the primary schools at all?—Yes, and natural history.

4618. Invariably?—Invariably; in England you barely find a map of the county in any of your primary schools, a boy will know all about the wanderings of the Israelites, and the Red Sea, but nothing about the geography of his own country

4619 Then the preparation for scientific instruction among the working population is incomparably superior in the Saxony schools to what it is in our primary schools?—It is

4620 How is that primary education followed up?—If, when a boy goes to work he shows any capacity as a mechanic, or a bleacher, or a dyer, or anything of that kind, he has an opportunity of going to the best scientific school in Chemnitz. There is a polytechnic institution of the first class, of which I have here the prospectus, in a town of 50,000 inhabitants, 378 persons attended the courses last year, and there are a number of other scientific schools in addition to this one in the same town, attended by the sons of bleachers, dyers, apprentices, and superior workmen, and they get the very best class of scientific instruction. My manager in Chemnitz is very well acquainted with Mr. Hartmann, who is, as the Committee know, the largest machine builder but one in Germany, if not the very largest.

4621. Mr. Bazley.] Has he any establishment in Alsace?—I think not, he builds locomotive engines and spinning machinery of all classes, and he says in a letter which I have before me, that every man, before he can become overlooker or have the control of a number of men, must go through a course of instruction at the Polytechnic school, and anyone who develops any kind of ability, goes at once through a course of scientific instruction at that school, it is a course lasting 18 months or two years, and then he is in a position to become a master workman.

4622. Chairman.] That is not in consequence of any regulation upon the subject, but from the interest which Mr. Hartmann and I suppose other employers take in the scientific instruction of those whom they employ?—I believe, to speak the truth, the government in Saxony has taken the lead of the people, they have shown the advantages of scientific instruction to the people, and led them into the way of making use of these advantages. Mr. Hartmann says the same state of things did not exist formerly, and that the Government has contributed very largely to the progress of scientific education; the school in

Chemnitz has 20 professors and masters, and the Government grant amounts to about 20,000 thalers, which is just about 3,000 £ a year.

4623 Chemnitz being a provincial town?—Yes

4624. The Imperial Polytechnic School is situated at Dresden?—Yes, at Dresden. I have a list furnished by Dr. Hulse, privy councillor, and doctor of the Polytechnic school at Dresden, of all the institutions in Saxony, for teaching science; those schools are not under the minister of education, but under the home minister, and considering that Saxony has a population of only 2,400,000 people, it is perfectly marvellous what a number of pupils are receiving scientific instruction. I believe 13,000 receive it on Sunday afternoons, as the Lutheran church does not object to that.

4625. Those Sunday afternoon classes would correspond with our elementary science classes in this country, I suppose?—Yes, they are taught by a professor in the Polytechnic school, who gives two hours on a Sunday afternoon to the work, instructing them in geography, mechanics, and chemistry

4626. Is it a general condition attaching to the endowments of professorships in Saxony, that they should teach elementary science classes?—I cannot answer that question

4627. Your intercourse with manufacturers abroad has been very considerable, both in Germany and France?—Yes; for 20 years past.

4628 Have you found that any doubts exist in the minds of manufacturers abroad with regard to the utility of scientific instruction?—No, indeed, there is no longer any doubt abroad; they are satisfied that it is their strong point, I have here a letter from a friend in Barmen, near Elberfeldt, in which he says, "England must remain behind us so long as she does not adopt our school system; it is no use telling us that Germany is a giant still in her cradle, for I think you may be afraid that this giant will grow so fast that he will soon say *noli me tangere*. I do not say this from national pride, but I am sure that your country will remain behind Germany so long as you do not accept scientific education."

4629 He refers of course to our rate of progress, not absolutely, but relatively, with Germany?—Yes, but in some things they do boast that they are actually ahead of us

4630. You are still speaking of your own trade?—Yes, with reference to the yarns connected with our trade. I have had Germans calling upon me during the last year or two, to offer me articles of their own production, fancy printed woollen yarns, and they have boasted how well they can print them, and that they can do it better than we can in England, they say, "We are better instructed than you; and we do it better because we are more scientific."

4631. Are these yarns bought in England?—Yes

4632 Do you think the question of the payment of labour abroad enters to any great degree into the cost of those articles?—No; I think in those fancy goods it is not a question of wages, but of style, colour, and finish

4633. All that is done by hand labour, is it?—I should think not, but when once we investigate the subject, the cheapness of labour abroad does not amount to so much as is supposed. In the first place, suppose you have a plant of
G G 2 20,000!

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20,000 *l.* in England, and 20,000 *l.* in France, or Germany, you will not receive the same amount of production from the plant abroad as you get from the plant at home; you will get, probably, 30 per cent less abroad

4634. Through the want of activity on the part of the workmen?—I believe the difference between the workmen is much the same as the difference between a Dorsetshire labourer and a midland counties labourer, one is better fed than the other, and has more physical ability, and that habit and rapidity of work which we gain in this country by the extreme division of labour.

4635. In Nottingham, have you many classes in connection with the Science and Art Department?—Only two or three very small classes; you may call them elementary science classes; they are doing a good work, I dare say, but there is no comparison between them and the science instruction given abroad. The scientific instruction given abroad is really solid instruction, but what we give at our mechanics' institutes, in a chemical class attended by about 30 persons, which is the only class in science, is not instruction of the same order

4636. Who is your teacher?—Our teacher was a surgeon who died recently, after which one or two of his pupils took up the work.

4637. They are, I suppose, men of limited chemical knowledge?—The knowledge they possess is what they have acquired in three or four years' instruction under a local teacher.

4638. And you have no teaching of mechanics in Nottingham?—None, we cannot get anyone to teach mechanics

4639. An effort has been made to obtain superior teachers, and that effort has been unsuccessful?—One of the committee of the Mechanics' Institute told me a short time ago, that they had tried for years to get a good teacher of mechanics, and had not succeeded.

4640. What was the difficulty?—We had not such a man; they had not men capable of teaching mechanics.

4641. You mean not in your own locality?—Not in my own locality.

4642. You would have to go to London or Manchester for them, I suppose?—Suppose a bleacher wants his son to get a good scientific education, where he will attain such a knowledge of chemistry, that he shall be able to understand his work well, he cannot afford it, he cannot afford the expense of sending him to London; it would cost him hundreds of pounds, whereas in Germany the thing would be done for almost as many shillings at the man's own door

4643. Have you any grammar school in Nottingham?—Yes.

4644. Is that grammar school endowed?—Yes

4645. Is it numerously attended?—Yes, it has been just reorganised, and I hope, will soon commence the teaching of science; but no science is taught at the present time.

4646. Up to the present time there is no gentleman connected with that school qualified to give instruction in science?—I think not.

4647. So that in point of fact the main difficulty that you have in Nottingham is the want of teachers?—Yes, and also the want of interest in the part of both manufacturers and workmen; there is no doubt that they have been all behind us, as to the question of scientific training.

4648. Then until recently, if teachers of science had been there, probably their services would not have been required?—I am afraid that the classes would have languished as they did at first in art; that seemed to be about to be a complete failure at first, and yet the classes in art have been a great success. I was told that it was just the same in Germany, and that when they commenced teaching science with a view to trade, it seemed as if they could not get pupils, but as soon as ever the manufacturers began to see the superiority of the workmen who had received this instruction, the principle of competition induced them to take care that their own sons should receive it.

4649. Do you not think that the principle of competition between this country and other countries will have the same effect with regard to our own manufacturers?—I hope it will, and I think it must; but our Government is hardly so appreciative as the Governments of our neighbours. I believe in France the Government have led the way and fostered science, and the teaching of science, with a view to manufacturers, and it is quite the same in Germany; the intelligent mind of Germany has, in fact, governed the less intelligent.

4650. But you have manufacturers in the midland counties who are becoming aware of our wants in that respect?—Yes.

4651. Do you not think that such manufacturers would promote local efforts intended to supply those wants?—Yes; I believe if the Government would find us teachers, and could develop a system of scientific instruction, and encourage it in the same way as they have done in the art schools, a response would be made on the part of the public to the teaching of science, and we should very soon have science schools quite as good as our art schools

4652. Supposing 10,000 *l.* were required for the building of a superior science school in Nottingham, and that the people had a reasonable assurance that the sum of 3,000 *l.* or 3,500 *l.* would be contributed by the central Government do you think the remaining 6,000 *l.* or 7,000 *l.* would be raised by the locality?—I do. I can illustrate that by what we have done in the art schools; we had 750 *l.* from the Government, and the school cost us 7,000 *l.*, besides 2,000 *l.* which were given us in land by the corporation.

4653. So that out of a total cost of 9,000 *l.*, the Government has given you 750 *l.*?—Yes

4654. With regard to the endowment of professorships, do you think if the Government were willing to contribute 200 *l.* or 300 *l.*, the town would raise a similar sum, or perhaps more?—Yes, I think a town should have the power of rating itself. It is very difficult to be always going round with the hat for these institutions, because you have always only just the same set of people to call upon, and those who ought to be the most responsible, are often the most unwilling to contribute.

4655. Are you not aware that under the Libraries Act the municipalities have the power to tax themselves for the payment of persons to deliver public lectures?—Yes; we adopted the Libraries Act, and we expended our money in the library, so that we have none to spare.

4656. You would have to increase the rate if you had a science school?—Yes.

4657. You are not able to do that within the limits of the Act?—No.

4658. Are

4658. Are you aware how the expense of the secondary schools is ordinarily borne in Germany?—I believe one-third is borne by the Government, and the remainder by the fees of the pupils and local taxation; it is remarkable how gladly they pay the local taxes for education in Germany.

4659. About one-third of the annual expense is contributed by the Government, and the remaining two-thirds by the municipality and by the fees of the school?—Yes, some scholars are admitted free if it can be shown that they are persons of merit, and have not the means of getting on. I believe that 15 per cent. of the scholars in Chemnitz who went through the course last year in the Polytechnic school, went through it without paying anything.

4660. That school is a school corresponding in rank with what are called the Gewerbe Schulen in Prussia?—Yes.

4661. What you would call a secondary school?—Yes; the Polytechnic school of the first rank is at Dresden, then there is the Imperial Mining academy at Freiberg, and the Imperial Forest Agricultural academy at Taurand, and the Imperial Technical school at Chemnitz, and there are many schools which are called mercantile schools, for youths who distinguish themselves at the primary schools, and at those mercantile schools they can acquire languages, drawing, and some other matters; there is the foremen and overlookers' school at Chemnitz, which was opened in 1855; and there are six builders' schools, one at Chemnitz, one at Dresden, and four at other places.

4662. Have you found that in this country there is considerable misapprehension as to what is understood under the term technical education?—Yes, it is a great puzzle to many people.

4663. Will you inform the Committee what you yourself understand by technical education?—The impression on many people's minds is, that those who advocate technical education want to instruct apprentices in their trades instead of teaching them in their workshops, while, what we want is, simply to teach them the technical principles of chemistry, mechanics, or geometry, in order that when they get into the workshop they may know the *rationale* of their work, and apply it to practice in their business.

4664. Lord *Frederick Cavendish*] Do you think it is necessary, in order to enable us to maintain competition with other countries, that all persons employed in our manufactures should have some scientific education, or that such scientific education is chiefly necessary for manufacturers, managers, and foremen?—I think it is necessary simply for manufacturers, managers, and foremen.

4665. You do not think it is necessary that ordinary mill hands and mechanics should receive such instruction?—It is not necessary, certainly.

4666. Are you anxious for it?—I should be very glad to see such people have a little scientific instruction in our primary schools, as it is done in Germany.

4667. Of course you would be glad that they should all have an opportunity of rising in life?—Yes, and if they had, in the first instance, good primary education, you would develop out of our common mill hands people who would

ultimately become overlookers and masters, that is the case in Germany, manufacturers tell me that their managers rise daily now from the poorest ranks of the people.

4668. Have you attended to the details of the present system under the Science and Art Department?—I really confess that I have not gone very much into those details. The minutes are rather puzzling. I have a letter from the secretary of our classes in Nottingham, which I can put in, in which he suggests what he thinks would be desirable.

4669. Can you state on your own authority, or on that of any gentleman conversant with the subject, what additions or alterations you consider are necessary in the present system of the Science and Art Department?—I cannot do that, but I will hand in this letter from Mr. Thurlow. (*Vide Appendix.*)

4670. *Chairman*] You are not acquainted with the details of the present system of the Science and Art Department, but you may have paid some attention to some of their late minutes?—Yes.

4671. Has there been any response in Nottingham to the offer of scholarships of 5*l*, 10*l*, and 25*l*?—Not yet, but we are keeping the matter before us in the hope of bringing science teaching into connection with our splendid art school, where we have more room than we need, and we trust, when this Committee has done its work, and Government has done something to encourage scientific instruction, we shall be able to use that institution as an institution for science and art.

4672. The condition attached to the 10*l* scholarship is, that the person holding it shall be a poor scholar, and shall remain in an elementary school during the time that he holds it, the time at which he can commence to hold it being 12 or 13 years of age?—Yes.

4673. Do you think, as our primary schools are now constituted, that it would be any advantage to a boy, having sufficient instruction, to hold that scholarship, that he should remain in such a school?—There are very few primary schools in which it would be any advantage to such a boy.

4674. Mr *Lowther*] Do you consider the system of dyeing in England is inferior to that of France?—Yes.

4675. You think we are not able to do what they can do in that respect?—I think not, otherwise our material for being dyed would not go from England to France to be dyed. It is always asserted by our foreign buyers that the French colours are better than our own, especially in silks.

4676. To what do you attribute that superiority?—I have seen reports from the Lyons Chamber of Commerce, in which they attribute it entirely to the establishment of their chemical schools in Lyons; they say "the foreigner thinks it is our water, and our sunshine, but we say it is our chemistry." Last year in talking over this matter with the Paris jurors, I found they attributed it entirely to the instruction given in their schools.

4677. And, therefore, that we cannot compete with them now in dyeing?—Just so, and in dyeing silks more especially.

4678. Mr *Bazley*] There have been very signal discoveries made in the English hosiery trade during the last 14 years, I believe?—

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During the last 15 or 20 years there has been a complete revolution in our machinery

4679. Do you think that those discoveries are more or less important than what has been done in the foreign manufactures?—The first great discovery was the introduction of the circular frame, and that came from France, I believe. Then in England we made great improvements in it, so much that our machines were greatly superior to those in France, and the French re-imported our machinery

4680. Are you aware that Mr Whitworth, of Manchester, some years ago invented a new knitting machine?—I am aware of it.

4681. It never came into operation, did it?—It never came into operation

4682. Whereas the education of the people on the continent is very much superior to ours, it would appear that the craft intelligence of the people in this country, and their energy and industry together, still enable the manufacturers of this country to surpass those on the continent; is not that so?—I will say this that in point of quantity of production, there are no workmen in the world except, perhaps, those of America who can compete with ours, but with regard to skill and manipulation, I would not say as much as that.

4683. But as a master manufacturer, you are aware that the total quantity of produce in the manufacture of any article more essentially determines the economical cost of that article than any other element of the case?—Yes, and that is why I maintain that the disparity of wages is not so great as it appears, because the same plant abroad does not produce the same return as the same plant at home

4684. While it is your interest to employ 700 or 800 people in Saxony, you find it still to be of more paramount interest, to employ 4,000 or 5,000 people in this country?—Yes, but I do not know whether that is quite the right way of putting it; it was an adventitious circumstance which gave us that plant in Saxony; we took it rather because we were devious of seeing what our competitors were doing, and were anxious to put Saxon products on the counter, to prevent our customers going to Germany, I do not think that there are such great advantages in it as is generally supposed.

4685. In the Saxon products?—Not in the question of labour

4686. Are you aware that in any instances the reputed superiority of continental manufactures has been injurious to the manufactures of this country?—In our own trade there are certain classes of their goods sold in London which come in very sharp competition with us; and there are certain other classes of goods, of which I have heard in Yorkshire that they were making the goods in Saxony, and taking the trade from us

4687. But you are aware that there have been general statements made that the continental manufactures are superior to the English manufactures?—I do not believe that

4688. You are aware of such reports existing?—Yes; and I always maintain that that is a mistake. I think we have kept up our usual rate of progress, but that they have taken advantage of our machinery, and with their skill and culture they have made rather a more rapid rate of progress than they had formerly done.

4689. But do you not think that those reports

have on the ignorant public mind an effect injurious to the manufactures of our own country?—I think the buyer will go where he can buy cheapest and best, whatever reports are in circulation

4690. Therefore we fall back upon the question of economy; so long as the British manufacturer can supply goods cheaper and better than any other manufacturer, the British manufacturer will have the trade?—No doubt that is so, and I believe he has an advantage over every other manufacturer in everything but this question of intelligence and the rate of wages; the rate of wages abroad is fast approximating to our own; in Saxony, during the last five years, wages have advanced fully six per cent., and they are steadily advancing.

4691. You gave a very lamentable description of the state of education in Nottingham; I think you stated that 50 per cent. of the workpeople were ignorant of reading and writing?—The people employed in our own mills and factories

4692. Are you aware of any employers of labour who distinctly decline to employ children under 13 years of age because they do not like to grapple with the difficulties of giving instruction to those children, my question referring to children who would be under the Factory Act?—In our own works, for 20 years past, I have objected to receiving children under 13 years of age, because I do not think their labour as cheap as that of any other children, and because we would not have the trouble of having a few of those children sent backwards and forwards to school.

4693. From the ignorance prevailing in those classes in Nottingham, does it not occur to you that preparatory elementary instruction should precede technical or scientific instruction?—Preparatory instruction must precede technical or scientific instruction, but there are large numbers of persons who are now ready to receive scientific instruction, and who are badly in need of it. For instance, I find the want of it myself, and should have been very glad to get it 20 years ago. Some of our best mechanics, dyers, and bleachers, say they want it for their sons, but that they cannot afford the immense expense of sending them 100 miles away, and keeping them in London for three years; but on the continent the manufacturer gets this scientific instruction cheaper at his own door

4694. You spoke of the superiority of the French dyes in Lyons; of course that is silk?—Yes

4695. Do the French increase the weight of the silk sent to them?—Yes, that is a result of their chemical knowledge which enables them to give the greatest weight to the greatest gloss

4696. Their chemical knowledge enables them to give that greater weight?—Yes, the English dyer can give the weight, but he cannot give the same finish with the weight.

4697. You stated that you did not think the half-time system was very effective in increasing the knowledge of the children?—Where the children have not previously had some instruction, but it is quite different if the children had previously been to school and acquired some amount of reading, writing, and arithmetic there, which they can follow up when they become half-timers; if they had not had that previous instruction, the half-time instruction is almost lost

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upon them; but when they have had four or five years previous instruction, the half-time instruction is undoubtedly an advantage.

1698. Are you aware that Mr. Edwin Chadwick has published a statement to the effect that children who are working half-time, and being taught half-time, make greater proficiency than children who are at school during the whole of the day?—Yes, I am aware of that, but I know it in our own neighbourhood: that system has been thoroughly tried, by Mr. Charles Paget on his farms, he is a great agriculturist, and a thoroughly practical man, he has tried the system for more than 20 years, but he has been forced to give up receiving children who have had no previous education, because it is in their case a failure. He assures that when they come at nine or ten years of age, they shall have a certificate of being able to read, say a plain chapter in the Testament, and to write a little, and then, when he puts them on the half-time system, he finds the result is excellent, he can trace the history of 40 boys who were no longer agricultural labourers, and one of them is employed at the Reform Club.

1699. From your own experience, then, you do not confirm the assertion of Mr. Chadwick fully with regard to those who, when they go on half-time, are not going to school for the first time. With regard to those who have had previous instruction for four or five years, I can confirm it; Mr. Paget tells me the same thing; and he has statistics which show that that is so.

1700. Are you aware of how much has been granted for educational purposes by the Privy Council to Nottingham, in all the schools together?—No, I cannot tell you that; but I can give you the total number of children under inspection in the district, and that is 8,000.

1701. Would you suppose that you receive less money in contribution from the Government, in the case of education, than you pay in taxes generally?—Supposing, for example, you are receiving 1,000 £ a year in public grants for the purpose of promoting education in Nottingham, are you aware at your share of contribution to the public revenue for that express purpose, divided by the number of people in Nottingham, would be greater than what you are receiving?—It is quite possible it might be so, but we go in for benefiting the State, and not the particular locality.

1702. But would not that lead fairly to this inference, that you had better have a system of local taxation, for education to be under your own management, than press the Government to make grants which would be very much diminished by the expenses of the central establishment?—I am not at all indisposed to anything which would accomplish the end, so long as the end is accomplished.

1703. I thought you had stated your wish that you might receive some increased grant from the Government of the country?—I was referring to purely local taxation. I am quite willing that there should be local taxation, and I know that throughout Germany the Imperial taxation is less than it is in England.

1704. Are you aware that only about two-thirds of the sums granted for educational purposes are really disposed of for those purposes, the rest being absorbed in the staff of the establishment?—It is not to be wondered at, if you look at our inspection, we have three or four classes of inspectors, when one would do the work.

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1705. You have been a self-taught people with regard to anything that has been profitable to you hitherto, do you not think it would be more economical to be a self-taught people now, with regard to all the principles of education?—That is very likely.

1706. *Chairman*.] Apart from the question of how the inspection should be conducted, do you not think that inspection by a central authority is useful?—I think it is very useful and desirable.

1707. Would that apply, in your opinion, to primary education alone, or to scientific instruction also?—Yes. In Germany even private schools must be inspected by the Government inspector, who has to see that no quack assumes the office of teacher of middle-class schools, and the result of this system of inspection is, that the inspection in Germany is first-rate.

1708. *Mr. Potter*.] You have stated that in the continental States the Government have taken the lead in education for the purpose of benefiting trade?—Yes.

1709. And the trades in those continental States have been highly protected, have they not?—Undoubtedly, they have been under a protective system for a long time.

1710. And that would seem, under a protective system, to be the only course by which trade could succeed?—I would not say that. I think they are mistaken there, for Germany, of all countries, least needs a protective system, because their manufactures are cheaper, they even go the length of a small tax upon the raw material, or cotton, which they are forced to import, and nothing can be more suicidal than a policy of that kind. I do not think that their fiscal regulations are good by any means.

1711. You stated that you had an establishment in Saxony, what class of goods do you make there chiefly?—Cotton hosiery.

1712. Chiefly by hand?—Chiefly by hand-machines.

1713. I suppose it was the cheapness of labour which tempted you there?—No, I bought a plant which had already been in existence, but that plant was established originally with that idea, and the labour is, in fact, cheaper, but when you consider the expenses of the establishment, and the smallness of the production, it is not so cheap as is generally supposed; in fact, we shall, by-and-bye, be pretty much on an equality in that respect.

1714. Is the cotton yarn which you take to Chemnitz English yarn?—No, they spin cotton yarn, and they spin it excellently. I have imported yarn from Chemnitz which will bear a very favourable comparison with English yarn.

1715. But that was not the case a few years ago?—No; a few years ago they imported all their yarns, and now they spin it all themselves.

1716. You have expressed a strong opinion in favour of compulsory education?—Yes.

1717. You think that is a prime necessity for any efficient step in the way of technical education?—In order to technical education, undoubtedly so; because we have many mechanics who are clever men, but who have not sufficient primary education to avail themselves of technical education. I have been the means of sending a good many workmen to America to friends who have asked for them, and I have had reports

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of them. My friends say, "So-and-so is a clever inventive man, and a good workman, and very industrious, and if he could only read and write, he would be able to command his own price." I have seen that over and over again. I saw a workman brought up to sign a contract to superintend a large number of mines in Russia, and he signed it with a cross. I said, "Cannot you write your own name?" and he said, "No, I cannot." I myself engaged a workman at 2*l.* 10*s* a week last year to go to Germany; he was quite a clever man, and 2*l.* 10*s* there is a good salary, because living is much cheaper than in England; he could not write his name, and could not read a letter from his wife, and, of course, could not send one to her; he came back at last, because he could not correspond with his family. As to his learning the German language, that was a complete failure.

4718. He was a Nottingham man, I suppose? Yes, he was a Nottingham man.

4719. Are these establishments in Nottingham large establishments?—Yes.

4720. What might be the turnover of a bleaching establishment, for instance?—I cannot answer that question; some of them may employ 300 or 400 people.

4721. You spoke of silk being sent to Lyons to be dyed; is there a sufficient quantity of silk used in the Nottingham district to tempt large capitalists to go into the trade?—Yes, we have silk dyers in abundance.

4722. But can you tell me what the capital of those establishments is?—Many of them are held by men of very good means indeed.

4723. Of course the smaller an establishment is, the less can a proprietor afford to get the best scientific workmen?—Yes, but we have two or three dyeing establishments on a very large scale.

4724. To what extent of capital should you say?—I know the principals have made large fortunes, and have been very generous with those fortunes.

4725. What kind of fortune should you say?—I know that one establishment employs 69 people in dyeing, and that is not the largest by any means.

4726. But, of course, you are aware that that is comparatively a very small establishment?—Bleaching is a much larger trade with us than dyeing.

4727. What I mean is, that it would not be profitable for a comparatively small dyer in Nottingham to pay for a high class scientific foreman?—You could not get such a man.

4728. Therefore it would practically be cheaper to send the silk to large dyers in Lyons?—I do not think it is on that ground that the silk is sent away, it is that they have not mastered the art so thoroughly as the Lyons men have mastered it.

4729. But, no doubt, you are aware that the silk trade is centred in France?—Yes.

4730. And this market is almost entirely supplied with French silks coming free of duty?—Yes.

4731. The English silk trade has been practically extinguished by the French trade?—I am aware of that. Our silk throwsters tell me that their continental accounts increase every year, and that their home accounts diminish every year.

4732. You are aware that the import of French silk is large?—Yes, very large.

4733. You would not perhaps conceive that, even with the technical or scientific education which you recommend, we should possibly remove that trade from France?—I cannot say that, for England is the *dépôt*, after all, for oriental silk, and when our throwsters succeed in throwing silk as well as they do, and throw it largely for continental people, and while we are the *dépôt* for the raw material, I do not see why we should not carry it out with the other processes.

4734. The English capitalists have the control of all the eastern silk, have they not?—Undoubtedly.

4734. We, in fact, supply the continent with that silk?—Undoubtedly.

4735. With regard to competition and cheapness in the trade, is it not your opinion that free trade would undoubtedly distribute certain trades in the best localities for those trades?—Certainly, there are certain trades which are, so to speak, indigenous to the country, and that will remain there, and others that will remain with us.

4736. Which would naturally increase in this country?—Yes. I am not at all apprehensive about the English trade. I think that if the English workman is as well taught as the continental workman, he will do better work, and that we shall hold our own, but with regard to wages and machinery, we are becoming more and more on an equality throughout Europe. If an invention were brought out to-day in England, it would be found, so to speak, in France and Germany to-morrow, so that it is now becoming a question of skill, science, and manipulation.

4737. Then the only aid which you would ask from the Government would be a broad system of compulsory education for the entire population?—I should be very happy to see that carried out, and I think it would be the very greatest boon that could be conferred on this country.

4738. But beyond that, you would, perhaps be in favour of some slight measure of scientific education for the artisan class, who cannot supply it for themselves?—Yes.

4739. Would you go any further up in society?—Yes, I would do what is done with our art schools, I would open them to all classes, so that all classes might avail themselves of the instruction.

4740. Are you aware to what extent artisans do avail themselves of that art instruction?—I know that it is not so largely done as is desirable, but for this very reason, that they do not get this primary instruction to begin with, but still they do it to a much larger extent than they did a few years ago, there is a certain amount of elementary instruction in art given now in a great many primary schools which is followed up in after years.

4741. Are you aware that there has been a decrease in the amount of art education amongst the artisans class in those schools?—I am sorry to hear it, but I have seen some very good work from those schools; the other day I watched some men at work who were decorating a house, who were doing their work admirably, and in a manner which 20 years ago would have been unknown in England, and those young men were taught in our school of art in Nottingham.

4742. I

4742. Is that building of yours solely devoted to the purposes of the art school?—We let off one part for the present to the Library and Philosophical Society.

4743. Are you aware of the amount of subscriptions in Nottingham?—They are very small; they are difficult to get.

4744. Do they amount to 60*l*. or 70*l* a year?—More than that, I think; more than double that.

4745. In 1866 it was only 75*l*., I think?—Perhaps so.

4746. The artizan pupils of the school do not exceed 100, do they?—There are 300 odd pupils at the school, and there are 1,500 people in the town who are being taught elementary drawing at primary schools, and perhaps out of those 300 pupils, not more than 100 would be artizans, but even that is a great result, which has told considerably upon art.

4747. I think you spoke rather deprecatingly of the education of the Nottingham manufacturers; are they worse educated than other classes in that district?—I am not aware that I spoke deprecatingly of their education. I said that they did not get education in science, but they cannot help that.

4748. Do you not think that capitalists should be able to find scientific education for themselves?—It is rather difficult to know where to get it, and what is more, people do not generally begin as capitalists, I did not myself; my education was completed before I was 10 years old, as far as what was given to me was concerned.

4749 Mr. Dixon.] You have said that the Government contributed towards the erection of that school of art about 10 per cent., I think?—They proposed in the first instance to give 25 per cent., and we proposed that the school should cost us 3,000*l*., but when the Government granted us 750*l*., Mr Fowke made several suggestions and alterations, and before we were out of the wood we were in for 7,000*l*.

4750. Did that contribution make the difference between the erection of the school or its non-erection?—I think the Government aid induced the public to come forward and give more liberally.

4751. And you erected science schools; do you think a Government contribution of 10 per cent. would be sufficient?—No; 25 or 30 per cent. would be, but then you must always bear in mind that there is the after encouragement of the assistance of the masters and the assistance of the pupils, and the assistance in furniture, and so on, which are great helps.

4752. And you would advocate all that assistance being given by the Government?—Certainly.

4753. Did I understand you to say that on the continent generally the advantage derived from the cheapness of labour was fully balanced by the smaller amount of production which was got out of the general plant?—No, I did not say that it was fully balanced; I only said that it was an abatement of the apparent advantages; no doubt continental labour is cheaper than English labour.

4754. Can you inform the Committee whether the manufacturers in Saxony, or the Government in Saxony, led the way in the effort to give scientific instruction; did the manufacturers first operate on the Government, or did the Government first operate on the manufacturers?—I have

been assured by the manufacturers themselves that both in primary and scientific education it was the Government that led the way.

4755. Will you inform the Committee on what principle State aid is given to scientific education in Saxony, whether it is wholly arbitrary, or whether they proceed on some recognised rule?—I cannot do that, but you will get the information you want in the reports from the Legations.

4756. Can you say whether, supposing in any district it was desired to establish a science school, they could count upon Government aid in Saxony?—Undoubtedly; if they open a school they get a grant from the Government, and a grant from the locality, and the fees from the pupils.

4757 I think you said that the Government grant to the school at Chemnitz was about 3,000*l*. a year?—Yes, to one school only.

4758. Do you mean that the total cost of that school is covered by that grant?—About one-third of it.

4759. Is that a contribution towards the whole expense of the school, or is it given in salaries to the teachers solely?—I cannot say precisely, as I simply asked what amount they received from the Government, and the answer was, about 20,000 thalers a year.

4760 Should you say that throughout Saxony generally, the Government contributions reached to as much as one-third of the total cost of the science schools?—I have no doubt that the same principle would prevail throughout.

4761. Do you think it would be advisable that the Government in England should make grants to the same extent?—I think it would be found in the long run both cheap and desirable.

4762 Mr. Akroyd.] Besides your establishment in Nottingham, you have in this country also establishments at Loughborough and at Derby?—Yes.

4763 Have you compared the degree of education there among the work people in those two towns with their degree of education in Nottingham?—In Derby it is domestic labour, and there are not above 100 of them, at Loughborough it is very similar, but they are rather worse than they are in Nottingham in point of education.

4764. Are the people you employ out-door workers?—At Derby, but not at Loughborough, most of them are in-door workers.

4765. Have you yourself had much experience of factory education?—Only by examining other factories, it has not come directly to my own experience, that is to say, with regard to half-time labour.

4766. Were those which you examined full or half time establishments?—Some were half time and some were full time; but I got from the half time establishments statistics of the education of the young people when they had reached 15 or 16 years of age.

4767. But the half time system ceases at 13 years of age, therefore those who were examined at 15 or 16 years of age must have been two or three years without education?—Yes.

4768. And they may have forgotten a good deal of what they had learned?—Undoubtedly, that is what I am saying.

4769. Would there be any difficulty in a young person between 8 to 13 years of age learning to read and write, supposing they attended full time for the five years?—It depends very much on the character of the school. I should think that

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a person attending five years regularly at a half time school would undoubtedly learn to read and write very well, but they do not attend regularly and consecutively, they fluctuate about from one class of work to another, in our own district especially there is an immense amount of domestic labour for children; 100 to 1 of them are employed in domestic labour compared with those who are employed in the mills.

4770 So that those young persons, instead of remaining at one school for a length of time, change about during the half-time period?—Yes; but it is very rarely that children go at eight years old to the mill; they go at 10 or 11, without having received any education at all, and at 13 years of age they have only had two years of half time; so that they have learned but little, and at 15 or 16 they have forgotten even that little.

4771 Have you any infant schools at Nottingham?—Infant schools, as good as in any town whatever; there is no town where there is more voluntary effort for purposes of education.

4772. Suppose you had an examination for short-timers, like Mr Paget's examination, and that children who worked half time should previously have learned to read at an infant school, you would secure a better starting-point for your primary schools for children above eight years of age?—Yes. If children could be sent to school, which they very well might do, from five to 10 years of age, without any encroachment on the rights of labour or the condition of the labour market in England, then the half-time system, for three years more, would produce a complete change in the educational condition of our population.

4773. Suppose, for argument's sake, that the full-timer was not allowed to work full time, unless he had passed a previous examination, and had a certificate that he could read and write, and do accounts a little, would not a supplementary provision of that kind, to the Factory Act, tend to overcome the evils of which you have been speaking?—That might do with regard to factory labour, but that is only a very small number of the whole; in Nottingham it is a very small proportion. There are not more than 50,000 children, all over the country, working in factories.

4774 But, under the recent Act, must not all children whatever come under that provision, except those in the rural districts?—The Act of Parliament says so, but they never will.

4775. Why?—Because in every stocking-making house throughout the midland counties you will see a loom in one corner of the room, and the child turns the wheel, or seams the stocking. Nobody can tell whether that child is at work or not, the people do not even know that there is such an Act of Parliament. I told them the inspector will be down upon them some day, but it is all in vain.

4776 At present, your system of inspection seems to be rather lax?—Everybody's system of inspection is lax; you cannot have an inspector at every cottage door.

4777 If the employer and parent were liable to a penalty for evasion of the Act, how would that act?—The employer is the parent of the child; the child works in the family; there are thousands and thousands of children in Leicestershire, Nottingham, and Derbyshire who are so employed; and the effect of our labour regulations

has been, in the meantime, in some of the lace warehouses, to disperse those children from the mills into private houses where they break the law every day.

4778 Some of those children would be working in the country, I suppose?—Yes; in villages of 4,000 or 8,000, or 10,000 inhabitants.

4779 If you provide for the education of children outside the boroughs, would you do so out of the poor-rates, or how would you do it?—There must be some sort of local or county rate by which the village children should be educated as well as the town children.

4780. And the ratepayers would, no doubt, be chary of anything of the kind?—Yes, they always are.

4781 I believe at the French Exhibition you came in contact with a great many of the French manufacturers?—Yes.

4782 Comparing their intelligence with the intelligence of the men of the same standing in England, what conclusion would you draw?—I should not draw any inference unfavourable to the English manufacturer, intelligence is a very broad word.

4783 Then let me confine my question to scientific knowledge?—I think the scientific knowledge of the French is comparatively recent; I believe that, after all, the French manufacturers get their superior scientific knowledge out of their foremen and overlookers rather than out of themselves, as a rule.

4784. You do not know where to look for qualified teachers of mechanics in Nottingham?—Certainly. One of the committees of the Mechanics' Institution, who has taken great interest in the question, assured me that for years he has been trying to get a good teacher of mechanics in Nottingham.

4785. Have you applied to the department of Science and Art?—I cannot tell whether they have or not, because I am not connected with the Mechanics' Institution, but without speaking derogatorily of mechanics' institutions, I think the kind of science instruction given there one hour, or one hour-and-a-half, in a week or a fortnight, will never compare with what is done abroad.

4786. Suppose you had a systematic course of instruction by evening classes, that would do a great deal of good, would it not?—Yes, if you had a systematic course of scientific instruction, but a course in Germany would be attendance two hours a day for a year or two, or three years for eight months in the year.

4787. You were comparing the progress of the British with the foreign manufacturers, and you said that the rate of progress among the foreign manufacturers was greater than among the English manufacturers; now, assuming that rate of progress to go on for the next five years, do you think the foreign manufacturers would be a-head of the English manufacturers?—There is a point beyond which progress can hardly go. I am inclined to think that the skill in science, which is so much cultivated abroad, will be the greatest source of competition to us during the next 20 years. I do not at all fear the question of cheap labour; our capital and our energy are superior to those of foreigners, and also our rapidity of labour.

4788. I think you stated that the Saxon manufacturers supply the home market with certain articles

articles of hosiery, and rather had the advantage of British manufacturers?—Sometimes.

4789. Have you had to meet them in neutral markets, such as the United States?—Yes, and in neutral markets there is as much Saxon hosiery sold as English hosiery, it is a fair battle between us, and sometimes one gets the advantage, and sometimes the other, we are often improving our machinery, and then they get hold of it.

4790. Are you aware that in some branches of manufacture the English yarns are sent into Germany, and woven into fancy goods, and sent out to America, where they compete successfully with the English manufactures?—That is very possible, especially in fancy woollen goods.

4791. What you would wish is that the English manufacturer should have the same advantage as the foreign manufacturer in scientific education?—Yes; and if he has those advantages, I am sure he would hold his own.

4792. *Chairman*] Is there anything you wish to add to your evidence?—I should be very sorry

it should be understood I had said anything depreciatory of the intelligence or the capacity of our own workpeople; on the contrary, I think they are the best workpeople in the world. I only want that they should have the same opportunities as other workmen.

4793. When you say workmen, you speak of foremen and managers?—With reference to scientific education, I certainly do.

4794. *Mr Graves*] Is there any inspector in Nottingham who sees to the carrying out of "The Workshop Regulation Act of 1867"?—Yes, and he is doing his utmost to carry it out, but the difficulty is not in the workshop where you have large numbers of children together, it is in private houses, both in town and country.

4795. Is the trade of Nottingham peculiar in that respect?—No; it is just the same as the trade in Leicestershire or Derbyshire; wherever there is a manufacturer, for instance, of pillow lace which can be done on a cushion at home, the facts are just the same.

Mr HENRY ASHWELL and Mr. THOMAS ISAAC BIRKIN, called in; and Examined.

4796. *Chairman* (to *Mr Ashwell*)] You are a Bleacher at Nottingham, I believe?—I am.

4797. (To *Mr Birkin*) You are a lace manufacturer, I believe?—Yes.

4798. Are you both members of the Nottingham Chamber of Commerce?—(*Mr. Ashwell.*) I am not.—(*Mr. Birkin.*) I am.

4799. *Chairman*] You have heard a portion of the evidence which has been given by Mr. Mundella?—Yes.

4800. Do you generally concur in the statements which he has made?—(*Mr. Ashwell.*) It is rather a serious question to endorse another man's evidence in that way.

4801. Then with regard to the want of scientific instruction among your foremen and managers, do you think that its absence is as serious and as detrimental as it has been generally represented to be by the reports of the jurors who attended the French exhibition?—I think so.

4802. In your own particular trade, as a bleacher, do you believe that much better results would be obtained if your foremen and managers were acquainted with the principles on which their operations should be conducted?—I think it must lead to greater economy, and equally good, if not better results; I do not complain so much of the results, as of the great prejudice of the workmen against all alterations, a hindrance arising in that way to better methods of work.

4803. You would call that a much better result if you were to get the same finish at a lower cost?—Yes.

4804. Is it the case that your managers and foremen generally are without any scientific instruction whatever?—Almost nil.

4805. Speaking of your own factory?—Yes.

4806. And the factories of your neighbours?—Yes.

4807. Have you ever questioned your managers and foremen with regard to the amount of knowledge of scientific principles which they possessed?—I have questioned some of my foremen, but not my manager.

4808. With regard to the constitution of the materials with which they deal?—Yes.

4809. What has been the result?—The most utter ignorance in the majority of cases.

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4810. Can you illustrate that at all?—One man is using constantly solutions of soda, I asked him the meaning of the word "alkali," he did not appear to understand that. I asked him further, the operation of alkali on cotton in a boiling solution, and also its action on wool, he did not know; he simply answered, "It fetches the dirt out of the cotton." I asked him what would be the action on wool, and he could not give an answer.

4811. Had he been in the habit of using it on wool?—No, he had not.

4812. I believe there is a variety of strengths of your alkaline solutions used for different processes?—Yes.

4813. Are these men able to control the strength of those solutions?—Not by themselves; it has to be done for them.

4814. Did you ever ask any of them how they would test the strength of the solutions?—I asked one man how he would test a solution of chloride of lime; and he said by introducing the hydrometer; of course if you stirred so much mud and water the hydrometer would give precisely the same indication.

4815. Had he any other test?—None whatever.

4816. What did he say with regard to the strength of acids?—He said he would test them in a similar way.

4817. This man, of course, had no knowledge whatever of chemical analysis?—None.

4818. And that, in many instances, leads to waste?—Yes, and frequently, from their want of scientific knowledge, to error. Suppose a man was ill, another man must take his place; and that man having been at a different part of the work, is not conversant with the materials, perhaps, and introduces the goods at an improper stage. In many instances we have had goods damaged the stripes on the tops of stockings being partially taken out, is an instance of carelessness of that kind.

4819. How would you remedy this state of things?—First of all, we must have better primary education; technical education would be of very little use otherwise, except to a very limited number at present. Persons from 14 to

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18 are not able to avail themselves of any facilities of that kind, even if they existed.

4820 Owing to the want of primary education?—Yes, they have lost in the main what little knowledge they had got during their earlier years

4821. That is, with regard to the workmen?—Yes.

4822 The foremen are generally derived from the class of workmen?—Yes.

4823 And hence their primary education has not been carried further than that of the workmen?—Just so

4824. If science schools were established in Nottingham, the workmen and foremen in your trade, owing to their want of elementary knowledge, would scarcely be able to avail themselves of it?—To a very slight extent only

4825. Do you think, on the whole, that there has been any advance in the elementary education of the working people in your district?—Very slightly.

4826. (To Mr *Burkin*.) In the lace trade is it the case that the competition of other countries has become seriously felt?—That is so.

4827. What countries compete with you?—France, more especially Calais, in France.

4828 Is it the case that many English manufacturers have established themselves in Calais, and are now carrying on works there?—Probably half the manufacturers in Calais are Nottingham men who have taken machinery over, and established works there.

4829. Do they still send for their machinery from England?—Three-fourths of the machinery that is now being constructed for fancy lace manufacturers in Calais is made in England

4830 And the remaining fourth would be made in France?—Yes, the remaining fourth would be made in France, the French manufacturers prefer good English machinery when they can get it; it fetches a higher price

4831 Are you acquainted with the lace trade in Calais?—Somewhat, we are just now establishing a business there.

4832. Are you sending over machines from England for your French factory?—Yes.

4833 Would you say that there has been any great improvement generally in the manufacture of lace machinery in France?—With regard to machinery, I should say this, in Nottingham, during the last 15 or 20 years, it has improved at a great rate, because Nottingham is essentially the birth place of the fancy lace machine, and until within a few years there was no lace establishment of any magnitude whatever in Calais, the trade being almost entirely confined to Nottingham, of course the whole of the construction was in Nottingham, and the building only comparatively recent in Calais.

4834. That is to say, the major proportion of the improvements in lace machinery is still made in England?—Just so

4835 Do you find that the foreign artisans, the workmen and managers, quickly comprehend any improvement which has been made, and are they able to utilise it?—They copy the machinery that is sent over

4836 And they do it effectively?—Of course there is no difficulty in copying

4837. But have not some of the improvements in the lace machinery emanated from French mechanics?—There have been a few, but the

majority of such improvements are made in Nottingham; and when improvements have taken place in Calais, they are principally, if not entirely, made by Nottingham men who have gone over there.

4838 Do you think that those improvements would be facilitated, that the time and labour employed over them would be much less if the managers and foremen of your lace machine factories were men having received some scientific instruction?—Undoubtedly; I think it has been a very great drawback to the success of Nottingham that there has been no means of educating men for that purpose; it has cost a large sum of money in making gradual experiments; whereas, if we had had men who could make mechanical drawings accurately, the thing would have been attained directly.

4839 You would have attained the same results with greater certainty, and in a much shorter time?—Just so.

4840 Do you think it desirable therefore that your superior mechanics and foremen in lace machine shops should, at all events, have a competent knowledge of mechanical drawing, and some knowledge of mechanics?—Yes, every foreman should have some knowledge of mechanics and mechanical drawing.

4841. Are there any classes or schools at all for teaching those subjects in Nottingham?—Not any that I am aware of, except our School of Art, which is mainly limited to the teaching of design

4842. Mechanical drawing is not taught to any great extent in the art school?—Not that I am aware of.

4843 You are aware that art masters may give instruction in mechanical drawing?—I am aware of that, but I do not think that attention has been generally drawn to it.

4844 So that if you should have a master willing and able to give instruction in mechanical drawing, the population would not avail themselves of such instruction to any great extent?—I do not say so I think if attention were drawn to the fact, that instruction would be given, a great many young artisans would avail themselves of it; probably not on their own account so much as from the recommendation of the masters themselves, who would do it in their own interest, but I think it has been almost a dead-letter as to the amount of mechanical education that an art master has been able to give; his attention having been specially directed to artistic studies.

4845. Do you agree with Mr Mundella, that if a good school, in which science was systematically taught, were established in Nottingham, it would now receive considerable support from the inhabitants of Nottingham?—I think it would receive a fair amount of support from the manufacturers themselves. Of course the number of manufacturers is not very large, but, considering the number, I think it would receive very good support; but I think that if a master were attached to the existing School of Art, who could teach mechanics and chemistry thoroughly, that would do all which we require. If it was known that there was a competent person to give instruction in these sciences, I think the better and more enterprising of our artisans would take advantage of it, and it would enable us to select foremen out of them; but at present it is almost impossible for you to put your finger upon a man who can make accurate mechanical working

working drawings. We have great difficulty in replacing our foremen, and the same remarks apply to the dyeing of silks

4846. Mr. *Bazley*.] As to the exportation of machinery, what is the extent of the machinery now at work in Calais, as compared with the machinery at work in Nottingham?—There are two or three distinct classes of lace machinery; the machinery I am speaking of is the fancy lace machinery, we have also curtain lace machinery and plain lace machinery. Now, Calais has become the centre of the fancy lace trade, very few plain machines have gone there at all, what few there are are in Lyons and Cambrai, in fancy machinery, at this moment, there are probably as many machines in Calais, and the neighbourhood, as there are in Nottingham, perhaps not quite as many, but very near it, 45 per cent.

4847. What is the duty upon lace exported from this country into France, at the present time?—There is no duty on silk lace goods

4848. Is there any duty on cotton lace goods?—On cotton lace goods I believe there is a duty of 15 per cent.

4849. Is not that a great motive to the exportation of machinery to Calais?—Yes, and there was a like duty on silk goods for four or five years after the treaty. Up to that time lace was prohibited in France, hence the original causes of English manufacturers going there.

4850. You showed very clearly that the Nottingham machinery is greatly superior to the French machinery, can you work Nottingham machinery, in Calais, at a less cost than you can work it in Nottingham?—Yes, it can be worked at Calais, at probably 10 per cent. less cost, I do not think there is the great difference that you seem to indicate; that it is superior is shown by the very fact of their importing it at a considerable cost in addition to the duty

4851. Is machinery cheaper or dearer in France than in England?—You could get machinery made in France at rather a less rate than the English, with the duty and the expenses added.

4852. But still it is more economical for the manufacturer to use English machinery than the French machinery?—Yes, the production being larger, and it being more accurate in work.

4853. Do you dye silk in Lyons for your own manufacture?—No, we dye the whole of our silk at our own manufactory.

4854. Do you dye your silk in Nottingham or in France?—In Nottingham.

4855. Are the workpeople in Calais more skilful and industrious than the workpeople in Nottingham?—I think not, a very considerable proportion of the workpeople in Calais are Nottingham men, who have gone over with the machinery; they are employed by the masters who have gone over there; but they have this advantage, that there is no restriction on labour, and they can work all night if they wish.

4856. I believe the great inducement to send machinery to Calais and work it at Calais has been to get free access to the French market?—Originally that undoubtedly was the case

4857. Mr. *Potter*.] The Calais fancy lace manufacturer has two profits instead of one, because his goods can come over here free?—Yes

4858. The English goods cannot return free?
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—Silk goods can, but cotton goods cannot, silk lace is the principal manufacture, as far as the fancy trade is concerned

4859. However, the fancy lace manufacturer at Calais has a double profit?—Yes, but still, notwithstanding that, I think the great reason that Calais is rising in notoriety and taking away our trade, probably is its geographical position, and that Paris has become the centre of fashion, lace is essentially an article of fashion, and French work and manufactures are preferred and get encouraged in Paris more than what are manufactured in England

4860. (To Mr. *Ashwell*.) With regard to the want of scientific knowledge in your work, what wages do you give that class of men that you refer to?—About 25 s. a week on an average

4861. I presume, in their childhood, those people had worked six or seven days a week, six days, at all events, in establishments like yours?—Yes

4862. Was there any chance of their getting any scientific education?—None, and there is none now.

4863. Would you be willing to pay double that rate of wages for a man of scientific education if you could get him?—Yes, I should think we would

4864. Mr. *Dixon* (to Mr. *Birkm*.)] With regard to the lace manufactures at Calais, you mentioned three reasons why trade is prosperous there one reason was the geographical position of Calais?—Yes, it is so near to London, practically, it is nearer than Nottingham.

4865. Is that so?—Yes

4866. Is there any difference in the cost of conveying lace from Calais to London and from Nottingham to London?—There is no material difference, but being between the two places, it has the great advantage of having a far readier access to Paris than Nottingham has, and it is equally near to London, Nottingham being 120 miles from London, and Calais being about 100 miles from London

4867. But it takes less time to get from Nottingham to London than from Calais to London?—Rather less, but Calais being between the two places gives them an advantage over Nottingham.

4868. The other two reasons which you gave, were first, that the labour was about 10 per cent. cheaper in Calais, and in the third place, that the restrictions by trades unions on labour were less?—Yes

4869. Are there any other reasons?—Yes; the operation of the Factory Act has something to do with it. Many employers have gone over because they are there without any restriction, and the lace trade is a fancy trade, and greatly in demand two or three times a year, so that it is a great point to be able to produce as much as possible during the season, because after the season is over, you are, perhaps, doing nothing

4870. Probably you would attach more importance to that last reason than to the other reasons which you have given?—No, I would not attach more importance to it, the greatest reason is the fact that Paris having become so much more a centre of fashion than London, any article produced in Calais gets more encouragement in Paris than in London; whatever is established in Paris is ultimately adopted in London, as all our leading milliners go over there to get the cue for the fashions.

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4871. Do you think that the lace made in Calais has a greater reputation in England as being French made, and therefore sells at a higher price?—I think so, somewhat.

4872. Do you think that those workmen in Calais are a better educated set of men than the workmen in Nottingham?—I do not think so. I do not think that French workmen are so good as English workmen. English workmen are constantly engaged by French manufacturers to go over, one reason of the present pre-eminence of the fancy lace manufacture in France may be this, that in the Exhibition of 1851, it being a new thing with us, we were all very anxious to send up the best and the newest of our machinery (both machinists and manufacturers), (at that time the lace trade was in its infancy in France), and they came over and saw the very best of our machinery, and had it copied pretty accurately; so, of course, in future they were able to make their goods from a superior class of machinery to what the great bulk of the machinery was in Nottingham, we still having at that time the nucleus of the old machinery upon us, which has not even now been all replaced, it being too costly to do quickly.

4873. You do not think that the French workmen handle those machines any better than the Nottingham workmen?—Certainly not, not as well.

4874. Have they not more scientific knowledge?—Not in Calais, but that does not apply to France generally.

4875. Mr. Akroyd (to Mr. Ashwell) Have you had the advantages of scientific education yourself, or have you picked up your knowledge from practice and observation conjoined with self study?—Partly both; I had the advantage of school lectures in science twice a week when I was at school.

4876. That was an unusual advantage in a day school, was it not?—It was at a boarding school.

4877. But even at a boarding school it was an unusual advantage?—Yes.

4878. In selecting your foremen, you like generally, I suppose, to promote an industrious and attentive young man, and would often do so if he were able by attending evening classes to acquire some scientific knowledge?—Yes, I have now a man whose wages I should like to raise by 1 l. a week if he could only write fairly.

4879. And that would be a much better plan than selecting a young man or two, and sending them to a distance and paying for their education, with the risk of finding out after all the time, trouble, and money had been expended, that they had not got the practical knowledge you were anxious that they should acquire?—Yes.

4880. (To Mr. Burkitt.) Do you know in the Nottingham machine trade any inventors personally?—Yes, as far as machinery is concerned the improvement has been gradual from time to time, small sections of the machines being improved first, and then added to; there has been no great invention in the trade for some time past.

4881. Have the inventors been usually workpeople, or people of the middle class?—They have nearly all of them been workpeople.

4882. And if they had had some knowledge of mechanical drawing, it would have saved them a good deal of trouble and expense in perfecting their inventions?—Yes, certainly; we should have attained the position which we have attained

much earlier if that knowledge had been possessed.

4883. And that is an advantage which you wish to hold out to the inventive workman at Nottingham?—Yes.

4884. In that fancy lace manufacture at Calais, beauty of design is a very important element, have you in Calais any advantage in that respect, in being able to obtain superior designers to what can be obtained in Nottingham?—No doubt the French designers as a rule are better than the English ones, but we get over that difficulty by importing French designers into Nottingham.

4885. Where do you get your patterns from for the articles which you produce at Calais?—They are patterns from original designs obtained by employing designers.

4886. French designers?—We have always employed a French designer; but the designers in Nottingham are rapidly improving by means of the school of art, and now we have got a class of designers which we could not have got a few years ago.

4887. Do you send any of your products at Calais to neutral markets, or are they entirely confined to the French and English markets?—A great many of the French blonds and cotton goods go from Calais to America.

4888. And compete successfully with the English manufacture?—They do.

4889. For what hours do you work in Calais?—The engines start at six or seven on Monday morning, and they continue working till seven or eight on Saturday night without intermission, and some engines work on Sunday.

4890. That is done by relays, I suppose?—Yes, giving 12 hours to each workman.

4891. Have you a night shift and a day shift?—No, it is done by equal shifts of six hours.

4892. Mr. Bazley.] Do not the American merchants prefer goods manufactured in Calais to those manufactured in Nottingham, merely because they are French?—I cannot say that that prejudice goes to that length, but no doubt there is a little of that. But, inasmuch as the goods that are made in Calais get introduced into the Paris market first (the Americans follow strictly the Paris fashions), and if they see a thing adopted in Paris they purchase it, because it is then preferred in America.

4893. Mr. Powell.] You were speaking of the relative development of the fine arts in your department of industry in Calais and Nottingham, can you state the comparative wages which are paid to the higher class of designers in each place?—I cannot do that, because a good many of the designers make their designs at home and sell them to the manufacturers, but in other cases, where the designers are employed by the manufacturers, I should think that the rate of wages is tolerably equal.

4894. You think that so far as the inducements to become a skilful designer are concerned, the inducements at Nottingham are not inferior to the inducements held out at Calais?—Undoubtedly not.

4895. Do you think that there is any difference in the value which is attached to that kind of skill in the community, or, in other words, would a skilled designer in Calais be more thought of than a skilled designer at Nottingham?—There are sufficient good manufacturers in Nottingham to appreciate skilled designers.

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4896 I am speaking rather of the value attached to skilled designers, as a class, by the community generally?—There would be more manufacturers who would appreciate a good designer in Calais than in Nottingham, and the designs would get readier access into the Paris market, from the fact of the Paris houses encouraging their own manufactures more than they do the manufactures of other countries, which I suppose arises from natural national feeling.

4897 Have you found cases in which Calais artists come to Nottingham, and settle there, and find a sphere for their knowledge?—Yes, we have a good many French designers living in Nottingham.

4898. Do you find that their number increases?—Yes

4899. Can they speak English?—Very imperfectly, at first, as a rule, they cannot do so.

4900 *Chairman.*] Is there anything which you wish to add to your evidence?—I may add that we employ also silk dyers and stainers, and that it is almost impossible for us to find a man who has any knowledge whatever of the constituent parts of the colours which he uses, or the most outside knowledge of chemistry, it is all done by guess-work, and we suffer in that respect, because the colours are obtained by a process of matching, putting on a little more or less where it seems wanted, instead of coming directly to the result, as the men would do if they had a good chemical education.

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Mr. JAMES KITSON, JUNIOR, called in; and Examined.

4901 *Chairman*] You are an Ironmaster, at Leeds, I believe?—I am

4902. You are interested in, or are well acquainted with, the large locomotive manufactory of Messrs Kitson & Company?—My father is a large locomotive manufacturer in Leeds, I myself being a partner in the iron manufacture and steel-making business.

4903 I believe you were educated at University College?—I was educated at University College, London.

4904. I believe you visited the Exhibition of 1867, at Paris?—I did.

4905. And you examined it in very considerable detail?—I am one of the honorary secretaries of the Yorkshire Union of Mechanics Institutions, and I was asked to give some consideration to the observations in the letter of Dr Lyon Playfair with regard to the question of technical education, which was brought before our committee, and I was requested to examine particularly our own branches of manufacture at Paris. I made a few notes which I have here, and which were read at the meeting of the Yorkshire Union of Mechanics Institution at Castleford. I may perhaps say that I did not take the same gloomy view of the state of English manufactures that was taken by Dr. Lyon Playfair. I am not prepared to admit that in iron making or locomotive building, or in tool making, England has yet been equalled.

4906 Dr Lyon Playfair speaks of the want of inventiveness of Englishmen; would you look upon that as a somewhat hazarded expression?—I think all the great inventions in mechanics have proceeded from England, and all the locomotive establishments which I visited in France are worked in a great measure with tools made in England.

4907. At the same time, did you convince yourself that very great progress had been made abroad?—Very great progress. I have attributed that in a great degree to the better education that the managers of the works there possess. I have had occasion to visit Messrs. Schneider's works at Creusot, I have some acquaintance with some of the managers there, and also with managers of other works in France, and I invariably found that the managers were men of better education, and of a superior stamp altogether, to the men that we have. Some few years ago we had occasion to take up a new process of manufacture of steel tyres, which was then

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almost entirely in the hands of Mr Krupp. In looking about for a manager we found it necessary to go to France, we got a pupil of *l'École des Arts et Métiers*, a man who was educated at the Aix school, and we have been very highly satisfied with the result of his work. His scientific acquirements have enabled him to push on certain processes without the same amount of experiments and groping about which would have been necessary if we had employed an English manager.

4908 Before you engaged this gentleman you endeavoured to find an English manager capable of rendering you the same service, I suppose?—We should have preferred an English manager if we had found one with the same attainments.

4909 And there was nothing in the process which should make the Frenchman more familiar with it than the Englishman?—No.

4910 It was as new to him as it would have been to any English manager?—Certain parts were as new to him, and others were not.

4911 Still all the essential parts of the operation were new, and they were all founded on a combination of practical and scientific considerations?—Yes.

4912 And you found you could get a better man for the purpose in France than you could in this country?—We did. I also learned from the managers of works that I have spoken to in France, that when the first pupils of *l'École des Arts et Métiers* were introduced into workshops, there was a prejudice against them that they were merely theorists, and would not be able to compete with the good practical foremen who were chosen as we choose ours, but that prejudice is vanishing, and at Creusot old foremen and other practical men are making considerable efforts to send their children to these schools, which is a very good testimony to the value of scientific education.

4913 Would you say that in France it is the exception to find a manager who has not received some scientific education?—It is in the works with which I am acquainted.

4914 And you are acquainted with several of the principal works, are you not?—I am acquainted with several of the principal works.

4915. Are you acquainted with the degree of instruction of the workmen in France?—Yes; I have made frequent inquiries, last year particularly when I was looking into the question,

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from the managers of railway workshops, who come in contact, of course, with all the managers of other workshops in other parts of France, so as to be fully cognisant of the condition of other works, and I should say that our own workmen are quite equal, if not superior, to the French workmen in education.

4916 You are now speaking of ordinary workmen?—Yes, the rank and file

4917 Mechanics?—Mechanics and iron workers, I may also say that in 1864 we had a very serious dispute with our workmen in Leeds, and I went to Belgium and engaged a considerable number of Belgium workmen, a number of whom we employ at this time (though some of them went home to their own country), they are scarcely as intelligent as our own workmen, at the same time we had also some few Frenchmen, and I can make the same remark as to them; with regard to the workmen's education, we stand quite on a par, if not superior, to the French

4918. You are speaking of French and Belgium workmen, but not of German workmen?—I have no direct acquaintance with German workmen

4919 Would you say that it would be of equal importance that the rank and file should receive a scientific education, as that the managers and foremen should receive it?—As a manufacturer, I should say that it was not, the great need that we have is some superior scientific education for the foremen, it would be useless to attempt to give scientific education to the general mass of our workpeople, it would be of no value to us in our works

4920 Except perhaps as increasing the area from which you might draw your foremen?—As increasing the area from which we might draw our foremen, and enabling us to advance those who showed any special intelligence or scientific skill.

4921 You are acquainted, of course, with the classes established in various localities in connection with the Science and Art Department of South Kensington?—I am sorry to say I am not. We have no science school in Leeds, and only one science class, and that a small one, in the whole borough, that is connected with the Science and Art Department Mr Sales will tell you that there is not one properly qualified science teacher in Yorkshire who devotes the whole of his time to his profession

4922. But if you have felt the want of scientific instruction among your foremen and managers, I should suppose that other manufacturers have felt the same want, how is it then that no efforts have been made in Leeds for the establishment of such classes?—Because the question is so extensive that individual manufacturers are not able to grapple with it, and if they went to immense trouble to establish schools they would only be doing it in order that others might reap the benefit, and we do not do that in Yorkshire.

4923 Then how would you proceed, feeling the want of this superior scientific instruction for your foremen and managers, in order to supply that want?—I think that we ought to have great central scientific schools in the different centres of industry in this country, and that these schools should be of a character similar to the schools which have been established in France, *l'Ecole des Arts et Métiers* I would take as the model.

They take a boy in at an early age, and he has practical work, as well as scientific instruction; and the lads are sent away from the school at an age when they are forced to go into the workshop, so that they get practical knowledge, and they ultimately rise (from having this regular training) to superior positions.

4924. Those schools were established 60 years ago, when there were scarcely any factories?—They were established about that time.

4925. If you were to establish similar schools in England at the present day, would you propose that the instruction of the workshops to any great extent should be connected with the instruction of the school?—To a considerable extent, I should; it would be very easy, for instance, in Leeds, if you established a school for training a certain number of youths for mechanical occupations, to find means in the various workshops there to give them practical instruction

4926. You would let the two things go on together?—I would let them go on together.

4927. But you would not consider the instruction which they would receive in manipulation during their school hours should be a substitute for an apprenticeship in a factory afterwards?—No, certainly not, but I think that practical instruction would enable them to enter with greater facility into the workshop, and it would save them a great amount of routine work.

4928. Are you acquainted at all with the Scientific Department of King's College?—I am not.

4929. Are you acquainted with the Mining School, in Jermyn-street?—I have been there, and I have known some of the pupils who have come from it.

4930. Are you aware that the number of pupils who follow the courses there, with a view of getting a diploma, is very small indeed?—Yes, I understand so I do not know a single pupil of that school who has afterwards become connected with ironworks in Yorkshire.

4931. In that sense, you would look upon the Mining School in Jermyn-street as not being successful?—Certainly not; men go there who have not got to work for their living with their hands, and the men that are to be made managers must be obliged afterwards to go into the workshop, and work with their hands, they are a different stamp of men altogether in Jermyn-street.

4932. You do not consider that the Mining School in Jermyn-street will ever be available, to any great extent, as a school for the scientific instruction of manufacturers, unless they be very rich men?—Certainly not.

4933. Why do you think that?—For one reason, it is too far from the centres of industry. London is not a manufacturing community, strictly speaking, that is to say, with regard to the iron trade, and the sons of foremen and so on, cannot afford to leave their homes and come to London.

4934. You would advocate a great central school, for instance, at Leeds?—Yes, I would recommend central schools in Leeds, Manchester, Birmingham, and South Wales.

4935. Who should, in your opinion, pay for that school?—I think that the subsistence of the pupils should be paid for by their parents, and that the educational staff should be paid for by the central authority and by local rating combined. I represent here the Chamber of Com-

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merce of Leeds, and this question was considered there, and it was the opinion of the Chamber that a local rating might be available for defraying a portion of the expenses.

4936 Are you aware that under the Libraries' and Museums' Act, municipalities have the power now of paying for scientific lectures at all events?—I am. The Public Libraries' Act has been adopted for Leeds by a public meeting, but it is at present suspended, owing to the great opposition at the meeting and after it, although a resolution to adopt the Act was carried.

4937 Would you expect encouragement from the central Government, so long as there is that amount of apathy, or rather opposition, on the part of the locality itself?—I do not think it could be carried out without.

4938. You mean that if people were led to hope that the Government would give assistance, the tone of public feeling in the locality would become altered?—Yes, and we want direction and instruction from the central authority. We have an idea of what we want, but very few manufacturers are competent to lay out a scheme.

4939 But you are aware that with regard to elementary science classes that direction and instruction, and also pecuniary aid, have been offered by the Government, and it appears that notwithstanding those offers Leeds has not availed itself of them?—I could answer that question; but Mr Sales, who will follow me, will be able to answer it better.

4940 But, perhaps, you will kindly say whether you think a want of interest upon the subject contributes to any extent to the fact of no such classes having been established?—I have no doubt it does.

4941 You have expressed an opinion that in spite of the great scientific education on the Continent, taking the manufacture of iron and machinery, and I suppose I may add steel, on the whole they are not inferior in England to what they are abroad?—I think they are not inferior.

4942. Mr *Bazley*] Have you found that the English workmen are less or more skilled in manual dexterity than the French?—I think they are on an equality with French and Belgian workmen with regard to the manufacture of iron. In machinery and locomotive and pure mechanical work, I should say that the English workmen are superior.

4943 They are better mechanics, and equally good for iron work?—Yes.

4944 What are their wages in both countries?—Their wages are much lower in France.

4945. Mr *Bruce*] Do I understand you to say that you contemplate two different schools, one for the education of those who remain long at school, and another for the working classes?—No, I do not propose anything with regard to a school for working men, my remarks applied simply to the education of managers and the better class of workmen, who can defray some part of the expense.

4946 For the purpose of obtaining for them a better education, you suggest that schools should be founded in our principal centres of manufacturing populations. Do you believe that Leeds would subscribe liberally towards the foundation of such a school?—Yes, I think so. We have in Leeds, at this moment, our new mechanics' institution on the point of completion on which

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20,000 l. has been expended, and that would supply the necessary room at once, I believe.

4947. But in the school that you contemplate, would you make no provision for boarders, from a distance?—No.

4948 But then the establishment would be very different from a mechanics' institute?—Yes.

4949 The mechanics' institute, though it might subserve the purposes of a higher education, is also, to a considerable extent, intended for the working classes, whose time is mainly occupied by manual labour?—Yes. I do not think manufacturers would subscribe largely to the building of such an establishment.

4950. Do you think, if they had a prospect of being substantially assisted by the Government, that prospect would evoke a good deal of liberality?—Yes, it would.

4951 And then the school, once founded, you think that all, in fact, which would be required which was not paid for by the pupils would be supplied by Imperial and local rates?—Yes.

4952. Do you anticipate much objection to the application of local rates to the education of what may be called the easier classes?—I do, judging from the opposition that has been made to the introduction of the Free Libraries Act. There has been a very strong feeling evinced against that rating for educational purposes, and a very strong opposition from the working classes themselves.

4953 On what grounds?—On the ground that they are already sufficiently burdened.

4954 They object to any addition to their rates?—They object to any addition to their rates, they are not sufficiently interested to make that sacrifice.

4955. What in Leeds is the amount of the rates in the pound sterling?—In the township of Leeds it is about 8s. in the pound sterling.

4956. That includes the poor rates, does it not?—It does.

4957 Although your evidence has been mainly directed to the improvement of the education of those who are destined to become managers, would you wish to see an improvement in the opportunities given for scientific education to the working classes?—Yes, it would be very important to have some simple scientific course added to the ordinary instruction in day schools.

4958 You would anticipate great general advantage from such instruction?—Yes, I should, I have known instances of our foremen wishing to send their sons to get some simple scientific education, and they cannot get it, because there are no such schools in the district.

4959 Lord *Frederick Cavendish*] You said that in your class of work your foremen and manager were generally taken from those who had been day-labourers?—Yes, ordinary workmen.

4960. At what age would you propose to send those who are destined to be foremen to the new central school?—I should say, from about 14 to 16.

4961 Do you think sons of the better class of workmen have generally got sufficient preliminary education to benefit by a real scientific training?—Yes, I think they have, those who have a disposition to go.

4962. Do the sons of such workmen generally attend ordinary primary day schools, or superior ones?—Ordinary primary day schools. They have ordinary middle-class schools, mechanic

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stitution schools, and private schools in the district, and there they get education which, I think, will qualify them to enter on such a course

4963 How long should you propose they should continue their education from 14 years of age?—Not less than two years, and I should prefer three years

4964 You think, generally, their parents would be ready to sacrifice their labour up to 15 or 16?—Yes, many of them are in a position to do so

4965 Do you consider that it would be expedient that the employers of manufacturers themselves should have more scientific education?—I do.

4966 Have you considered the means of supplying such an education to them?—I look for additional scientific teaching in the universities

4967. You would not propose that they should also attend this new central school?—I think they would not do so

4968 You propose that solely for the higher classes of our skilled labourers and foreman in large works?—I think the nature of such an establishment would cause only that class to go there.

4969. *Chairman.*] You have an endowed grammar school at Leeds, have you not?—We have

4970 What is the number of the scholars in that school?—I do not know.

4971 It is a very large school, is it not?—Very large and flourishing school

4972 The funds are large?—Yes

4973. It is a classical school?—It is.

4974 Is any science taught there?—Yes, there is a course of science teaching there, of which I have a syllabus; and the master tells me that besides these special classes, all the boys in the school have to go through a course of instruction on two scientific subjects, which hitherto have been botany, and mechanics or elementary chemistry, at the option of the parents, they have this year had prizes founded for the special encouragement of those studies. The head master requires that every pupil shall go through two of the three courses.

4975 Do you know how long that has been the case?—For some years; the class of boys that go there, are the sons of shopkeepers and upper tradesmen, and not the class that goes into the workshop, they are not the class that would ever reach our manufactories

4976 But is it not a place for the education of the sons of the proprietors of the small mechanical workshops in Leeds?—I do not think that many of them go there.

4977 I suppose the proprietors of those works generally consist of two classes, either of large capitalists or men who have risen from the labouring class?—Yes

4978. Mr *Bagnell*] Did I understand you to say that you thought the school in Jernyn-street was not a very successful institution?—Yes

4979 Would you discontinue it, or reform it?—I should be sorry to see it discontinued until something better was established.

4980 What reform would you suggest to make it more useful?—I do not think it is in the proper locality to enable a large number of pupils to avail themselves of the instruction.

4981. Would not any school in the provinces be at a great disadvantage with regard to pro-

fessors?—That we look to the Government to supply

4982. Mr. *Graves*] I understand from you that you do not fear the competition of any other country in regard to locomotives?—I will not say that. I was speaking with regard to the excellence of the manufacture as shown in the Paris Exhibition. The competition in the manufacture of locomotives is very severe at the present moment. France is competing successfully against England in contracts for Russia, two or three large contracts have been carried away in open competition by the French from England.

4983. Is that generally owing to their being lower in price or the superiority of the manufacture?—It is owing to a lower price.

4984. Do you think that is a competition which is likely to increase?—Yes, I do, in that branch of the manufacture.

4985. Do you see any way in which it might be stopped?—I think the superior education of our managers will assist us, because I see that the French have educated their men so that they are able to acquire information easily. They read for themselves and visit England, and acquire the information which has been worked out for them here, and by that instruction they are able more quickly to appreciate the improvements, and to pick up what is done here, and use our own weapons against us.

4986. In Russia do you think that the Germans or French, as a rule, carry off large numbers of orders in competition with us?—France took an order last year for 80 locomotives at a quarter of a million of money, for which my father's house among others competed

4987 Did the Germans compete for that?—I have no doubt they did.

4988 Is it your impression that France, as a rule, is able to underbid Germany as well as England in those competitions?—I would not say that

4989. Is there any other means which occurred to avert these results?—Some of their power of competition arises from their having their workmen under better control, a difficulty which has been raised by the trades' unions here with regard to adopting improvements, and making modifications in working. They have interfered very often with English manufactures, and the French have not got that to contend with.

4990. Do you see any indication in these foreign countries as the work increases of the same evils which you have now pointed out with regard to the English market, extending to other countries?—Yes, I do, French workmen are less easy to manage than they were a few years ago

4991. *Chairman*] Do you find, on the other hand, that in consequence of the experience which English workmen have gained, they are beginning to be more ready to abandon some of the extreme trade rules than they formerly were?—They have suffered very much lately from bad trade, and they are at present more amenable, but when a prosperous time returns I think the lessons of the past will be very soon forgotten.

4992 If their education were superior, do you think the same state of things would arise?—No I think they would be able to understand better the danger of foreign competition, and the difficulties which they raise themselves.

4993. Mr. *Beecroft*.] Do you think the French and German workmen are on a par with the English

English workmen?—I said that I thought that as iron workers the English workmen were on an equality with the Belgian and French workmen, but as mechanics, I have not the least hesitation in saying that the English workmen are very much superior

4994 Wages in France and Belgium being so much lower, would not that interfere with the competition between England, France, and Belgium?—The wages in the iron manufacture in Belgium are very much lower, and in consequence the Belgian manufacturers can undersell the English makers in neutral markets, and other markets beyond our own shores

4995 In neutral markets we have very little chance of getting orders?—At the present time

4996. Mr. *Akroyd*] In what respect had the manager whom you obtained from France, who was a pupil at the *Ecole des Arts et Métiers*, superior scientific attainments to an English foreman of the same standing?—He was a good mathematician and a good chemist, he understood the theory of mechanics as well as the practice of it, and he was a thorough draughtsman.

4997. As a metallurgist, I presume he was superior to any one you had?—As a metallurgist he was superior, and also in his chemical knowledge, which other managers of ironworks have not got. I do not know a single manager of ironworks in Yorkshire who understands the simple elements of chemistry.

4998. Those qualifications would be of great advantage?—Yes, I am speaking of the West Riding of Yorkshire only.

4999. You spoke of the scientific education required for managers as being superior to that required for foremen, at what salary would a manager be able to send his son to receive scientific education?—A man who was receiving from 3*l.* upwards, very few receive less.

5000. What would be your wages to the foremen?—The wages of the foremen would be 50*s.* to 60*s.* a week, but there is no regular scale.

5001. Then the education for foremen you

might easily get in connection with the local science classes, perhaps?—No, I do not think so

5002. You were also alluding to a local rating, as furnishing the means of support for those schools, you have a very large mechanics' institution in Leeds, and the funds are supplied by local subscription, are they not?—Yes, by the subscriptions of the members

5003. You never had much difficulty in raising the funds you require, independently of rating?—No, none.

5004. You have a school of art in Leeds, and you have been able to raise the required funds in some way or other?—There has been a difficulty

5005. The support has been rather scanty?—Yes

5006. *Chairman*] Is there anything further that you would like to add to your evidence?—Yes, with regard to my opinion of the education of managers. I had a conversation with Mr Ramsbottom, who is the chief locomotive engineer of the London and North Western Railway, he is at the head of many thousands of workmen, he coincides with me in the opinion I have expressed as to the education of managers, and also with reference to the fact that it is not specially the want of education in the rank and file of the workmen which retards British manufacturing industry

5007. The education of the rank and file of the workmen among mechanics in England?—Yes

5008. Mr. *Potter*] Of your own class of work, you mean?—Yes.

5009. Mr. *Akroyd*] You have found the education of Belgian workmen not superior, but very far from it to that of English workmen?—I have.

5010. Do you mean by that that their knowledge was inferior in science, or in reading, writing, and arithmetic?—In elementary knowledge

5011. In science there is no superiority?—No.

Mr. HENRY H. SALES, was called in, and Examined.

5012. *Chairman*] You are the Agent of the Yorkshire Union of Mechanics' Institutes, I believe?—I am.

5013. And as such, you are acquainted with the state of the elementary education in science in Yorkshire?—I am.

5014. How many mechanics' institutes are there in the union?—One hundred and twenty-two.

5015. Is it the case that in the majority of those institutions there are any classes for teaching science?—In the majority of those institutions there are no classes for teaching science

5016. Can you state to the Committee in how many of those institutions there are classes for teaching science?—There are only 16 science classes in the whole of Yorkshire, and a few are simply science classes unconnected with institutions

5017. But they are connected with the Science and Art Department of South Kensington, I suppose?—Yes.

5018. When you speak of science classes, do you mean science schools, some of which may

comprise more than one class, or, absolutely, that there are only 16 science classes in Yorkshire?—There are 16 places in Yorkshire in which there are science classes in connection with the Department of Science and Art.

5019. In some of those places I suppose there are several classes?—Yes

5020. Can you state what are the subjects of instruction in those schools and classes?—Almost without exception, chemistry

5021. I suppose, with few exceptions, inorganic chemistry?—Both organic and inorganic chemistry.

5022. But is it not the case that most of the chemistry classes are in inorganic chemistry?—It is so

5023. Can you state how many classes there are in mechanical drawing?—I do not know of the existence of any science classes for teaching mechanical and machine drawing.

5024. Are you acquainted with the classes in mechanical drawing in art schools?—Yes

5025. Do you know whether they resemble, in their general scope, the classes in the science schools?—The art-master at Leeds presents candidates

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didates for examination in science successfully, although he is not a recognised teacher of mechanical drawing in connection with the Science Department, but is certified by the Art Department. Three certificates for proficiency in machine drawing are held by masters in the Leeds School of Art, but although they teach the subject, and their pupils take high positions in the science examinations, and by so doing become themselves science teachers, the art masters are unrecognised by the department.

5026. Are you able to state how many classes there are in Yorkshire in art schools in which mechanical drawing is taught?—There are six art schools in Yorkshire, in each of which mechanical drawing is taught.

5027. Then the entire number of classes in Yorkshire connected with the Science and Art Department, in which mechanical drawing is taught, is six?—I believe so.

5028. How many classes are there in which theoretical or applied mechanics, or both, are taught?—I am not aware of any.

5029. Are there any classes in Yorkshire in which building construction is taught?—None, apart from those in the schools of art to which I have already referred.

5030. And in metallurgy or mining, are there any classes?—None.

5031. I believe there is a navigation school at Hull, in which steam is taught?—Yes.

5032. Is there any other school in which the theory of the steam-engine is taught?—I am not aware of any.

5033. Do you know the Navigation School at Hull?—That being a special school, it does not come under my cognizance to visit it, and I have only seen it.

5034. You would say that the instruction in science, in connection with the Science and Art Department in Yorkshire, is extremely scanty?—I do say so.

5035. Is there any other instruction in science, in Yorkshire, of a similar character not in connection with the Science and Art Department?—There are classes established at the Philosophical Society at Bradford. I will quote from a letter sent me by Mr Louis C. Miall, the curator of that society: "The success of the chemical class has been quite unexpected. I believe we could increase the attendance indefinitely if we had more space. The geological class uses the fossils, minerals, diagrams, microscope, &c., of the society's museum. All the classes are most successful, being well attended by the young people of Bradford."

5036. Is that the only institution not in connection with South Kensington, in which science is taught in Yorkshire, to your knowledge?—Apart from a few private schools it is.

5037. You are aware, no doubt, that the number of science classes, in Lancashire, is considerable?—I am.

5038. You are aware also that in the metropolis, and more especially in the neighbourhood of the metropolis, there are science classes attended by a very great number of pupils?—I am.

5039. To what do you attribute the absence to any great extent of similar classes in Yorkshire?—To my mind there are three causes: first, the strong opposition which has existed on the part of prominent educationists to State aid; and the effects of that opposition still remain, and are seen in the apathy and indifference manifested

by the managers of many educational institutions to the Government scheme. The second cause, I think, is the scarcity of duly qualified science teachers. During the past year I have had several applications from institutions to recommend them science teachers, but we have had none to recommend, there is only one teacher who devotes a great portion of his time to science teaching. I must add another most important cause, namely, the indifference of the working population to intellectual pursuits. I will quote from the report of the Middlesborough Mechanics' Institute: "Only one member applied to join the chemical class in October, so that for the present this valuable class has to be discontinued, a circumstance not very creditable to the young men of this town, where a knowledge of chemistry is of such great value." Then, from my notes of a conversation with the committee of the Wakefield Mechanics' Institute, Wakefield: "Artisans would be very lukewarm in the pursuit of technical education. They are unable to carry on their education owing to their deficiency of primary education." I bring these two things forward because they express my own views founded upon an extensive experience, that there is great lukewarmness on the part of the labouring population of Yorkshire, which I attribute to the defective state of primary education.

5040. But the science classes are available to persons above the grade of the manual labour population?—For the purposes of tuition but not recipients of State aid.

5041. You are in this position, that there are no teachers for those who might be willing to be taught, because those upon whose acquirements they would receive the Government grant are unprepared to receive the education offered?—I should like the latter remark to be regarded as now referring to the past. I believe if science classes were established throughout the length and breadth of Yorkshire, far greater results would be obtained than have been obtained hitherto, but I attribute this as one of the causes that have led to the non-establishment of science classes in Yorkshire.

5042. Then there would be a certain degree of risk attending the establishment of classes, because the teachers wish to be assured of a remuneration which from past experience they would scarcely be entitled to expect?—I do not think there would be any risk in the introduction of science teaching to a great extent. The payments of the Science and Art Department, and the fees of the pupils would be enough to remunerate the teachers if a well arranged scheme was placed before the managers.

5043. Then, in fact, there are persons prepared to engage science teachers, and they cannot find qualified persons?—That is the case; at this time there are four classes ready for teachers. The Yorkshire Board of Education, of which I am honorary secretary, have under consideration the introduction of teachers into Yorkshire if we cannot get native talent for that purpose.

5044. You are taking steps to introduce science teachers from other localities?—Yes.

5045. Do you think any difficulty will arise in finding teachers elsewhere?—That remains to be seen, but we think, on eligible terms, we shall be able to draw teachers from other places.

5046. That is to say that the localities would supplement, by some guarantee or some salary the

the payment from pupils and the payment on results by the State?—It is proposed that the institution should provide a room, fire, and light, and guarantee a certain number of pupils for the class, the teacher to take the receipts from the class.

5047. And in that way you hope to succeed?—Yes.

5048. Is there any method which occurs to you by which the State might render you further assistance than that which is now offered, without injustice to the ratepayers?—I am opposed to the present restrictions of the department respecting the class of people for whom payments for science instruction should be made. There is a strong feeling prevailing in the minds of the manufacturers of Yorkshire that they are called upon to pay for the scientific education of the mechanic and artisan, but that the teacher receives no payment for the instruction which is given to the sons of manufacturers, and foremen.

5049. That is to say that they pay in two ways; first of all through the taxes, and also by subscription?—Yes, and they must pay higher fees to the class.

5050. And in addition to that they must incur some responsibility or pay some subscription towards the school?—Generally they are solicited to do so.

5051. In return for which they get no advantage?—They get the advantage of the scientific teaching after having paid double for it.

5052. Do you think any modification is required in the constitution of mechanics institutions, in order that science classes might be more extensively established in Yorkshire?—The mechanics' institutions have gone away from the purposes for which they were established, but they are now returning to those purposes, and for the work of elementary science teaching, I believe, mechanics' institutions are fully qualified, and could be easily adapted for the purpose of teaching the rank and file of the working classes.

5053. Aid is given by the State to primary schools?—Yes.

5054. And the teaching of art is paid for in those schools on results?—Yes.

5055. Do you believe it would be possible to introduce the teaching of science into our primary schools?—I think it is not only possible, but that it is absolutely necessary, not only in the interest of science, but also in the interest of primary education itself. I have recently consulted a large number of the principal masters of primary schools in London and other parts of England; and their unanimous opinion is that the working of the Revised Code is now producing merely mechanical results, and that there is an absence of that intelligence in the schools which formerly existed in them, I believe that if you introduce elementary science on the same or a similar basis to that upon which you have introduced art into the primary schools, you will raise the standard of intelligence therein, and that the children will acquire even reading, writing, and arithmetic with greater facility, while the teachers themselves will feel more interested in their work.

5056. You are now speaking of children who remain at school until they are 13 or 14 years old?—Yes.

5057. But with regard to adult classes, are there any restrictions besides the one which 0.72.

applies to social status that stand in the way of good results?—The absence of science teachers is a great bar to the development of science classes, and also the inability of science teachers to impart the knowledge which they themselves possess, by which I mean that science teachers are not trained in the art of teaching, although they may be sound scientific men themselves. I could illustrate what I am saying by cases which I should not like to bring before the Committee by name, though I am basing my remarks upon such cases, namely, instances in which the teachers, though men of high scientific attainments do not possess the art of teaching.

5058. But you are aware that the teaching of science has been introduced into some of our training schools for teachers?—Yes.

5059. And that you would desire to see done in all training schools, would you?—Yes, most decidedly.

5060. Now, many children having left school at a very early age, with a very imperfect education, afterwards attend night schools and having got the rudiments of elementary education there, they might go forward into science schools?—Yes.

5061. Are there any restrictions with regard to payment on results in night schools, which are, in your opinion, an impediment to their usefulness?—Most decidedly, the present minutes of the department at Whitehall are acting very injuriously to classes of all kinds being established in our mechanics' institutions. The restricting of payment for night classes to those classes which are held in connection with day schools is very injurious; in many places, Bingley, near Skipton, occurs to me as an instance, the managers are most anxious to promote classes in their institution, but the Church and the Non-conformists have opened evening classes, and are able to secure the services of more highly efficient teachers, because they receive payment from the Government, while the mechanics' institutions, which has other advantages, and which would naturally draw pupils to it, does not do so, because it cannot compete with State-aided classes outside.

5062. You would like to extend aid to secular night classes?—Yes, a minute extending the present conditions to night classes would materially benefit mechanics' institutions, and would have its effect on science classes.

5063. But inasmuch as mechanics' institutions are secular institutions and not denominational institutions, that would involve the principle of giving aid to secular schools so far as night schools are concerned?—In the present State-aided night schools, no examination is made respecting religious teaching. In fact night schools, as distinguished from day schools, in every respect, saving the building in which they are held, are secular schools.

5064. With regard to scientific education, do you think it desirable that State aid should be limited to elementary science classes, or would you ask the State in any way to encourage superior schools of science in the provinces?—I would ask the State to supply a portion of the funds that would be necessary to establish and maintain industrial colleges in the provinces, not depending entirely upon local effort.

5065. But, on the other hand, you would not have the Government go down of its own mere motion into the provinces to establish the schools?

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—I think the State should aid those districts only which showed an interest in the subject, and which were ready to establish industrial colleges themselves

5066 Mr. Bruce] You accounted for the superior success of science classes in Yorkshire as compared with Lancashire by three reasons. one of them was the indifference of the manual-labour population, which you connected with defective primary education; have you any reason to think that primary education flourishes less in the West Riding of Yorkshire than it does in Lancashire?—I am not in a position to compare the two counties, but the standard in Yorkshire is very low.

5067. Would you argue that the superior success of science classes in Lancashire was owing to their having a better elementary education there?—I think the Lancashire people are more anxious for education than the Yorkshire people.

5068 Do you mean that the Lancashire people are, as a race, more intellectual than the Yorkshire people, or that they have had better advantages?—I think that their occupations require greater exercise of intelligence

5069 But surely a great number of your occupations in Yorkshire are those which develop thought and talent?—We have a great deal of the woollen and shoddy trade in Yorkshire

5070 But surely, at Sheffield and Leeds, there are a great number of trades which require the exercise of considerable mechanical ingenuity?—At Sheffield, I find that the work which should proceed from knowledge of science is done by rule of thumb. The father has taught the son, from generation to generation, no scientific principle being thought of in doing the work. I again quote from my note-book of information given me by the managers of the Sheffield Mechanics' Institution. "The working man cares nothing about technical education in the manufacture of bronzes, he knows nothing of the scientific composition of the electric bath, all is left to chance. The apathy respecting scientific teaching is not due to want of money but want of intelligence"

5071. You spoke of the opposition or indifference of employers to education, assisted by the State, but that feeling is subsiding in Yorkshire, is it not?—It is.

5072 And we may look forward to the probability of its growing still less?—Yes.

5073. Your third reason was the scarcity of science teachers are you able to say whether that is peculiar to Yorkshire, or is it felt in other places?—Through the efforts of Sir James Kay Shuttleworth, in the East Lancashire Union, itinerant teachers were engaged. It is to his efforts that the great success of science classes in Lancashire is due. I quote the following from a letter to me from Mr Shore, the organizing master of the East Lancashire Union: "Burnley and this district possessed an organization for instruction in science even before the Science Minute of 1859 was passed. The East Lancashire Union has had an organization for scientific instruction not possessed by any other part of the county, and no inconsiderable amount of the total results have been produced in this district."

5074 Are you aware that there are several towns in Lancashire, by no means towns of the first class, which have three, four, five, or six separate science classes?—Yes.

5075. And all taught by separate scientific teachers?—Yes.

5076. There, therefore, does not appear to be any scarcity of science teachers in Lancashire?—No

5077 Then it is not clear to my mind why there should be any special scarcity in Yorkshire, perhaps you can explain that?—I can explain it generally only by the indifference which has been shown to the state of education in Yorkshire, and also from the circumstance that the matter has not been put before the public in the way in which it has been put before them in Lancashire

5078 In Bradford, I think, you said there was a very remarkable success in the classes of the Philosophical Society?—Yes.

5079. Those classes being very similar to the science classes connected with the State?—Yes in all respects; but I believe that the pupils are of a higher social grade than those that are contemplated by the science minutes.

5080. Do you think that at Bradford the science classes as we generally understand them, would not have the same success?—The voluntary system still prevails to a larger extent in Bradford.

5081 I think you also stated that one reason why science classes did not flourish, was, that there was felt in Yorkshire a dissatisfaction at the payment of a higher fee for those who were not included in the rather wide definition of the word artisan?—Yes

5082 But what is the payment made by those on whose account no payment would be made by the State?—At Leeds Mechanics' Institution the payment made by the pupil is, in elementary chemistry, 1*l* 15*s*. per session, or 1*l* 1*s* per session exclusive of material, for one lesson weekly

5083 That is a payment for the class on whose account no payment would be made by the State?—Yes.

5084 Is that a rate of payment which falls very seriously upon the classes above the artisan class, bearing in mind the very liberal interpretation which is put on the word artisan by the Minutes of Council?—The hard-and-fast line, although it is liberally interpreted, shuts out just that class from the recipients of State aid whom we desire to benefit, I mean the children of foremen, and men of that stamp, in the receipt of 200*l* or 150*l* a-year, whose children it is most desirable we should get hold of, and we do, in fact, feel a difficulty on that account

5085. The paying of even that small sum creates a difficulty?—It is paying in two ways

5086. You would admit that it would be the introduction of quite a new principle if the Government were to make payment on behalf of a class higher than those whom we usually define as the working classes?—Yes. I am not now advocating the principle as a principle, but only as a necessity for the maintenance of the science classes.

5087. Chairman] You want to remove a number of small obstacles out of the way, which together create a considerable hindrance?—Exactly.

5088 Mr. Bruce] You stated that the evening schools, in connection with mechanics' institutions, suffered from the fact that they were not admitted to State aid under the Revised Code?—Yes.

5089. Would

5089 Would you generally give assistance to all schools of any description, however they were taught, upon a mere bare payment by results?—I would not require that schools should be under any particular set of managers, and I think the payment should be made, irrespective of the locality in which they were held.

5090. But the question really arises on the fact, that the State declines to make any payment except to certificated masters, does it not?—I do not ask that the restriction with regard to certificated masters should be removed, I ask that the restriction refusing to recognise classes held in any institution where there is no day school should be removed.

5091 You do not propose to extend the aid to schools taught by uncertificated masters?—No.

5092 Mr. *Potter*] You compared the Yorkshire population somewhat unfavourably with Lancashire, I think?—I was only comparing my own impression from my intercourse with the population of the two counties

5093. You are aware that the wages in Lancashire are considerably higher than they are in Yorkshire?—Yes.

5094 *Chairman*] Have you considered the Minutes of Council, which offers scholarships of 5*l*, 10*l*, and 25*l*, in connection with grants from the localities?—Yes

5095 Have those minutes been availed of to any extent in Yorkshire?—The Yorkshire Board propose to offer three scholarships of 50*l*, but my own opinion is, that that will affect very little the question of the scientific education of the county, and that there will not be any very appreciable increase in the number of science pupils, it is, however, a step in the right direction, which we have all cordially approved of

5096. With regard to the condition attached to the 10*l* scholarship, that the pupil should remain in an elementary school, do you approve of that condition?—Not unless the standard of education in the elementary school is improved.

5097. With regard to the minute of February of last year, abolishing examinations for teachers in science classes, what is your opinion of the probable results of that minute?—I do not approve of it.

5098 For what reason do you disapprove of it?—The regulation admitting a person as master who passes the second class, to some extent influences those who are already teachers, and the minute has had a very prejudicial effect upon them.

5099. You mean that qualified masters have considered themselves to be degraded by the admission of mere pupils to the status of science teachers?—I do. Moreover, the regulation is most unsound in principle. A candidate who succeeds in obtaining a position in the second class is not thereby qualified to teach a science class. A teacher must have a vast amount of knowledge of his subject beyond that he is required to teach, especially in scientific matters, otherwise his instruction will in many cases be not only unsound but positively prejudicial

5100. Mr *Bagnall*.] You think it very important that scientific education should be introduced into primary schools; how would you begin to introduce it?—By a Minute of Council, requiring the subject to be taught.

5101 You would begin by making it part of the requirement, previous to the giving a certificate to a master, that he should be qualified to give such scientific instruction in the school?—Certainly.

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Monday, 15th June 1868

MEMBERS PRESENT.

Mr. Acland
Mr. Akroyd.
Mr. Bagnall
Mr. Bazley
Mr. Dixon
Mr. William Lowther.

Mr. M'Lagan
Mr. Edmund Potter
Mr. Powell.
Mr. Read.
Mr. Samuelson

BERNHARD SAMUELSON, Esq., IN THE CHAIR.

MR. JOHN WATTS, PH. D., called in; and Examined.

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5102 *Chairman*] YOU are a Doctor of Philosophy of the University of Geissen, I believe?—I am.

5103 You have for a long time taken an interest in matters connected with education, have you not?—Yes, for 35 years.

5104 Your connection has been chiefly with mechanics' institutes, I believe?—In a great measure with mechanics' institutes, but I spent about 14 years in the agitation for the repeal of the taxes on knowledge, including the advertisement duty, stamp duty on newspapers and the excise on paper. I was for about five years connected with the National Public School Association which was commenced in Manchester for the establishment of a secular system of instruction, and I was examined in this House on that matter in 1853. I have been connected with mechanics' institutes for 35 years. I commenced with the institute at Coventry, I was afterwards a member of the Glasgow, and latterly of the Manchester, Institute.

5105 At present you are secretary of the committee for the extension of Owens' College, are you not?—Yes

5106 You are also a member of the committee conducting the affairs of the Lancashire Union of Mechanics' Institutes, I believe?—I am, in my early relations with mechanics' institutes, I saw and listened to the desultory lectures on science, which were then common. When I got to the Glasgow Institute I listened there to consecutive lectures by the professors of the Andersonian University on chemistry and on natural philosophy, and from that time I made up my mind as to what a mechanics' institute ought to be, and concluded that, although desultory lectures might now and then excite wonder, and, where there was a peculiar aptness, stimulate the student, that nothing less than consecutive teaching would be permanently beneficial to any great extent.

5107 That view you have endeavoured to carry out in the Mechanics' Institutes in Union in Lancashire and Cheshire, have you not?—Yes; before I was connected with the Union of Institutes, it was conducted in a very desultory manner, and, as soon as the excise on paper was repealed, so as to allow me to adopt another hobby, I went into this Union with a determination to make it much more useful than it had been hitherto.

5108 What has been your plan of proceeding?—At that time the Government science depart-

ment was very little known, and it occurred to me (and I introduced the matter to my colleagues) that if we could get the loan from the Science Department of Mr. Buckmaster, we might by using him for lectures, three, four, or five times a week, and following him up by our own visiting agent, Mr. Lawton, get a considerable number of science classes established. My plea to my colleagues, and to the institutes which I went to from time to time at their annual meetings and soirées, was: "Here is an offer on the part of the Government, by which you may get scientific instruction for nothing, for the Government payment on results will in most cases satisfy the teachers, so that you have nothing to do but to set up the classes and reap the benefit."

5109. In what year was that?—It would be 1864, before we got practically to work. In 1862 and 1863 was the agitation.

5110. That is to say four years after the minutes were first issued?—Yes

5111. But the system of payment on results in respect of those classes, is limited to working people and poor scholars, is it not?—Yes.

5112. Do you find that the working men have generally received a sufficient elementary education to enable them to avail themselves of these classes?—No, I may state that the Union of Institutes is composed of a president, vice-presidents, council, and delegates, the vice-presidents pay each two guineas a year, and this is the main fund on which we work. The delegates from the institutes once a year elect the council; the council employs a visiting agent, Mr. Lawton is the present agent. The duty of the agent is to go round to the different institutes, and we have about 123 of them in union in Lancashire and Cheshire; his task is to confer with the directors, to examine the classes, to consult with the teachers, and to induce the institutes to put themselves in connection with the Society of Arts, and also to get Government science classes established. And this latter task has to be done, first, by inducing the directors to consider the thing, then by looking about to find what qualified teachers there are in the neighbourhood, then to induce men who would otherwise be qualified to get certificates, or to arrange so as to send qualified teachers from Manchester for the special meetings of the classes. Then the Union of Institutes conducts every year three examinations, first, an elementary examination on papers supplied by the Society of

of Arts, but with local examiners. The elementary pass must be in two subjects, and as each examiner has only one subject, no certificate can be given by one examiner, and therefore we secure absolute fairness in the awards.

5113 What are the elementary subjects of examination in connection with the Society of Arts?—This is not a Society of Arts' examination, the papers are supplied through the Society of Arts, but the examination depends wholly on ourselves. The subjects are reading, writing, history, bible history, geography, arithmetic, and most of the ordinary elementary subjects which are common at the primary schools. The second examination is the Society of Arts' final examination, where the papers are returned to London for the awards. The third is the Government science examination, where also the papers are returned to London for the awards. Then, in addition to these examinations, the Union of Institutes gives various special prizes supplied by donors who are principally found among our vice-presidents. The special prizes are for free-hand drawing and for mechanical drawing in a specified department. For instance, a donor names a machine which he requires to be drawn to scale. Third, calculations in connection with carding, spinning, and weaving, sometimes called Mill arithmetic, fourth, biography from English history, fifth, social economy, sixth, photography, seventh, essays on economical subjects. The economical essays of last year would be a fair specimen. A. The effects of good and bad home and foreign harvests of corn on the trade and commerce of the United Kingdom, and the modifications produced thereon in the cotton districts by good or bad harvests of cotton. B. The best application of the principle of co-operation to the arts of production. C. The principal causes of disagreement between employers and employed, and the best means of prevention and of amicable adjustment. Arrangements are now being made to give exhibitions, to be held at Owens' College, in connection with the Union of Institutes. The progress of the union I will give in figures. In the elementary examinations in 1864 we issued 72 certificates, in 1865 we issued 171 certificates, in 1866 we issued 373 certificates, in 1867 we issued 477, and in 1868 we issued 588. We have examined into the primary instruction of those pupils who have taken the certificates, and the average time of attendance at day-school is three years, but it varies from an indefinite time up to 12 years, and the total number who presented themselves for the examination in the present year was 1,335, so that there are 747 failures in this elementary examination as compared with 588 prizes, which shows the state of elementary instruction. In the Society of Arts' examinations the certificates were, in 1864, 247, in 1865, 281, in 1866, 272, in 1867, 379; and in 1868, 414. In the Government science classes examinations the certificates issued were, in 1864, 518, in 1865, 786, in 1866, 633, and in 1867, 1,019. The 1868 returns are not yet out. I may here remark that the falling off in 1866 was consequent in a great measure upon a little misunderstanding among the officials of the Manchester mechanics' institutes, which is one of the large institutions, and in the Government science classes, partially from the very great activity just then of the calico-printing trade, which absolutely prevented the students from giving a proper number of attendances.

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5114 By misunderstanding, do you mean a false comprehension of what was required, or a little friction, a misunderstanding among the officials themselves?—A little friction among the officials only.

5115 Can you state the numbers who sat for examination in 1867 in connection with the Science and Art Department, and the numbers who sat for examination in 1868?—I can give the numbers under instruction in Lancashire and Cheshire. They were in 1867, 2,159, and in 1868, 2,769, showing an increase of over 700. Then, in one department, geometrical drawing, in Lancashire and Cheshire we have 1,388 under instruction. I think the whole of England is 2,846.

5116 So that you have nearly half of the whole?—Yes, and in mechanical drawing we have 1,344.

5117 In building construction was there an equally large proportion?—I think there was an equally large proportion, but not anything like so large a number. Another feature is, that out of 123 institutes in union in the year 1867, 51 sent in pupils for examination, and 75 of them in 1868.

5118 In connection with the Science and Art Department?—Yes, in connection with the Science and Art Department, showing the great activity of the visiting agent. Where institutes lie pretty conveniently together, because of the scarcity of teachers, and also to make the classes large in order to pay the teachers, we have grouped the institutes for science teaching, and brought pupils from two, three, or four institutes to one centre, and the science examinations are also conducted in the same manner so as to economise labour.

5119. You are still speaking of the classes in connection with the Science and Art Department, are you not?—Yes. Then, in order that there shall be no difficulty in getting information, the union prints in one sheet all the information which is necessary for all the examinations, this sheet is sent round to all the institutes and hung up, so that every one can apply to it and get information as to his own speciality.

5120 You have spoken of three examinations, first, the elementary examination on papers issued by the Society of Arts, but not in connection otherwise with the society; secondly, the examinations directly in connection with the Society of Arts, and, thirdly, the examinations in connection with the Science and Art Department of South Kensington, and you have spoken of them in such a manner that they might be regarded as being consecutive. Is that so?—They have no absolute connection with each other. The elementary examination is in some degree connected with the Society of Arts examination, because no person who has not passed the elementary examination can go into the Society of Arts' final examination.

5121. Is that by a regulation of the Society of Arts, or by a regulation of your union?—By a regulation of the Society of Arts, which has what is called a preliminary examination, the Society take our elementary examination instead of their ordinary preliminary examination, but there is no connection whatever between either of those examinations and the Government science examination. My impression is that, since the two examinations, namely, that of the Government science classes and that of the Society of Arts

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cover pretty much the same subjects, it would be as well if the two could be conducted together; it would save both time and money. The special subjects in which they differ are these: in the Government science classes there are building construction, and naval architecture, geology, mineralogy, and steam, none of which subjects are covered by the Society of Arts examinations. Then the subjects of the Society of Arts examinations, which are not included in the Government science classes, are book-keeping, political, social and domestic economy, music, freehand drawing, logic, and mental science, English history and literature, and modern languages. All the other subjects are common to the two examinations.

5122 You have stated that a considerable saving of time and money would result from the consolidation of those two examinations?—I think that would be the case.

5123 Now, if a society like the Society of Arts is willing to incur the expense of conducting such examinations, do you consider that the Government is justified at all in continuing to give aid out of the revenue for a similar object?—It is not an absolute necessity, and if the Government were to drop these subjects, they might possibly take up other subjects, and spend their money so as to widen the field of examination, but, of course, the stimulus is greater if a young man sees his way to two certificates and two prizes, than if he sees his way to only one. Those are the two sides of the question.

5124 But is there no difference between the scope and limits of the examination in the two cases, although the subjects may be nominally the same?—So far as I know, there is very little difference in the calibre of the examinations; the difference is in the different subjects which I have mentioned.

5125 Where the subjects are identical the standard is not very different?—Just so.

5126 Now, do you find it to be the case that many of those who have passed your elementary examination proceed to receive instruction in the classes of the science and art department?—I cannot trace the individuals, but, from the increase which is constantly taking place under the Government science classes, I have no doubt that many of those who have received the elementary instruction do go on.

5127 Is it the case that those who receive instruction in the classes of the science and art department are for the most part working men, or of the class of working men?—In the small country towns they are almost entirely so; in the large towns they comprise clerks, warehousemen, and bookkeepers, in addition to the artisans.

5128 Are they generally boys growing up or more frequently adults?—They vary from 13 to 30 years of age, the larger proportion would be from 13 to 20 years of age.

5129 I believe you have at Manchester a day-school in connection with the mechanics' institute in which some scientific instruction is given?—Yes, Mr Angell will give you full information upon that subject.

5130 Are you aware whether there are any similar schools within the union?—No there are none to my knowledge.

5131. Will you now proceed with your statement?—I have endeavoured to show the Committee the position as to education of the pupils who have

obtained certificates, and I think we may safely assume that the pupils who attend literary institutes are the select of the working classes, because none other would feel the inclination to continue the education which they had received in elementary schools. Our first great difficulty is the great deficiency of elementary instruction, and that is tested easily. The visiting agent in his rounds has undertaken an examination in writing from dictation, and he gives us a return over the union of 3,217 pupils who had presented themselves for such an examination, one fifth of them being females, the lesson has been from 30 to 40 words of about the ordinary newspaper paragraph calibre, and out of 3,217 pupils 786 completed the task without error, 595 gave up in despair, and 86 made more than 10 errors each. This is the condition of pupils at the various institutes in union. In an inquiry which I made in Manchester a little time ago for the late Educational Conference, and which inquiry extended over 92,000 inhabitants in one block, the youths from 14 up to 20 years of age were found in this condition, namely, 24.8 per cent. unable to read, and 58.4 unable to write.

5132 Were many of them half-timers?—Very few.

5133 Had they been half-timers?—I cannot say whether they had been half-timers, but, taking the children below the age of 14 years, a very small proportion of those who were at school were half-timers. The operation of the half-time movement, as far as Manchester is concerned, has been rather to prevent children being employed than to send employed children to school.

5134 Would you say that that is still the case, notwithstanding the change which has recently taken place in factory legislation?—I am unable to say, it has not been in operation long enough.

5135. Mr. Potter] Have you an idea of the total number of half-timers in the mills?—As nearly as I can remember, from the inquiry which I made, which covered 92,000 inhabitants, of the children who were at work between the ages of six and 14 years, not more than 1-10th were half-timers.

5136 Chairman] But that result would be very much modified by recent legislation, would it not?—No doubt of it.

5137 Have you had any opportunity of ascertaining what was the value of the education acquired by the half-timers?—I have had no general opportunity for that, but individual cases have come before me which point to this conclusion, that where the spirit of the Factory Act is well understood and appreciated, the half-time instruction is of very great value, but since only the name of a school is necessary in order to fulfil the demands of the Act, and only the name of a schoolmaster is necessary to give a certificate wherever the employer has the inclination, he can entirely prevent the intention of the Act being carried out.

5138 Or rather, you would say, the converse, that unless he is anxious that the Act of Parliament should be carried out, it will probably fail?—Yes, that follows as a matter of course, and is probably the more frequent state of the case. The conclusion I draw from these facts is, that general technical education is out of the question until primary instruction is rate-supported, and attendance is made compulsory.

5139. That

5139. That is your individual opinion?—That is only my individual opinion, of course.

5140. But from that you would not by any means conclude, I suppose, that the efforts which are being made to give scientific instruction are thrown away?—Not at all, far from it, I have shown that in the history of the union of institutes; and it would very greatly facilitate the work if more encouragement were given by the Government to the training of pupil teachers as was done under the old code.

5141. You mean training pupil teachers for elementary schools?—Training pupil teachers for elementary schools.

5142. In what way do you think that would influence the extension of scientific instruction?—It would manufacture better schoolmasters, and if the elements of scientific knowledge, together with what to my mind is of very great importance, a thorough knowledge of social economy, was made a portion of the course in the normal college, I think it would be of the utmost value in preparing the elementary school pupils for science classes, or for any scientific instruction which might follow.

5143. By the training of pupil teachers, do you mean their actual instruction in the elementary schools, or do you speak of the number of pupil teachers whom you would wish to raise up, in order to receive instruction in the normal schools?—My intention was double, I was aiming both at the encouragement to engage more pupil teachers and at the greater numbers of those who should pass through normal schools in order to become teachers, and suggesting also that additional subjects should be given in the normal schools, so as to prepare them to communicate elementary scientific knowledge in the common schools.

5144. That you would do in elementary schools, as well as in normal schools?—Yes, as far as possible, in fact, I was in some measure instrumental a little while ago in connection with the Cobden Memorial at Manchester in endowing a chair of political economy in Owens' College, on condition that the class should be open free to all the primary school teachers and pupil teachers of Manchester and Salford. That chair is now established, and is likely to work very well.

5145. Then upon the whole you think we may say, that the encouragement given as well by the Society of Arts as by the Science and Art Department of South Kensington has made but a very small impression upon the lower section of the working class population, and probably no great impression upon the upper section of that population?—I am sorry to say that is so, especially the former part, namely, that it has made no impression on the lower portion of the working class population. I think we have shown in Lancashire and Cheshire, that if there are individuals who will take advantage of the appliances which do exist, not many years need pass before a very considerable impression is made upon the upper portion of the working class population.

5146. Will you show how you think it could be done?—I think it would be desirable that in every endowed or free grammar school scientific teaching should be introduced, and for that purpose an Act of Parliament should be passed, giving power to the trustees of endowed and free grammar schools to introduce the teaching of science, and giving power also either to the Charity

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Commissioners, or to the Committee of the Privy Council, or to the Minister of Instruction (should such a minister be appointed), to require scientific training where it appears desirable. The trustees of the Manchester Free Grammar School have been in Chancery upon this subject, and after a three years' suit they have succeeded in obtaining the power which they are now using. The fees of 66 paying pupils, at twelve guineas a year, enables them to give instruction in science to over 300 pupils, 250 of whom are free scholars. This scheme was my own proposition, and is now in operation, and I look forward, within a few years, to seeing the grammar school with a thousand pupils instead of 250, and, as a large proportion of them would be paying pupils, the teaching staff would be extended by means of their fees, and the free scholars would get the advantage of it.

5147. From what class do you expect that great increase of pupils to be drawn?—The paying pupils from the middle class, and the free scholars from the better portion of the working class, from the children of decayed middle class people, and perhaps with a small addition from the children of the clergy, of course I include the children of small shopkeepers. The trustees have power by their new scheme to consider the condition of the pupils who present themselves as candidates for admission, and they have power to introduce the poor in preference to those who can afford to pay. It seems to me that if an Act of Parliament generalised such a power it would be of immense use, the Committee are doubtless aware that the legal definition of a grammar school as a school which teaches the classics, and a great many conductors of grammar schools think themselves bound to observe that definition, and thus the endowments are wasted.

5148. Mr. Acland.] When you spoke of the poor you intended not to confine that expression to the labouring poor, but to include under the word "poor" the children of poor professional men, or those whose circumstances were poor relatively to their condition?—Yes, I would take the widest definition of the word "poor," but at the same time my idea would be to have a kind of ladder from the primary school through the grammar school up to the high science school, which I hope the Government will establish, so that we might take off the very apt pupils from each stage and carry them up to the final positions for which they are most fitted, and thus utilise the best intellects of the whole country.

5149. Chairman.] You have not yet stated to what extent you thought science teaching might be introduced into elementary schools, although the tendency of one of your replies was to show that it might be so introduced?—I think a large amount of teaching on common things, that is to say, the objects by which we are surrounded, and which teaching involves a considerable amount of elementary scientific knowledge, might be introduced into every elementary school, social economy, introducing the elements of political economy is very effectively taught in the Free School at Manchester, which is supported by voluntary contributions, and where the conditions of admission are that the parent is unable to pay anything whatever for the education of the child. Mr. Angell will show that a very large amount of scientific knowledge can be given and is given in his school, and I am of opinion that such teaching might be generalised if we had teachers properly prepared.

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5150 Do you think that could be done even in respect of children leaving school in order to go to work at 11 or 12 years of age?—Not half so effectively as if they could be kept at school up to 13 or 14 years of age; but still I think it might be done so as to give the apt pupils the means of self-cultivation.

5151 The means of self-cultivation, or else the means of instruction in the night science classes afterwards?—Yes

5152 To revert to your science classes, you were speaking of certain difficulties in the way of making them useful, will you kindly proceed with the enumeration of those difficulties?—With regard to science classes, at the present time the Department of Science at South Kensington waits until ignorant people find out their own ignorance, and find also, by some accident, that there is a body of persons at South Kensington, who, if they are respectfully asked, will tell them the terms on which they may be instructed; but it seems to me that the Department of Science, if Government really feels an interest in the spread of scientific instruction, should become a propaganda. If I was at the head of the Science and Art Department at South Kensington, my scheme would be to have before me a science class map of the country, to look continually at the blanks and see where science instruction was most needed, and then by myself or by my agents, I would come to this House and address one of the Members for the blank locality, stating that there was no science class at the place that he represented, and that it was most important, for the industry of the place, that such classes should be set up. I should ask for introductions to the neighbourhood in question, and then I should go or send to that neighbourhood, and look out the men who were likely to be interested in the progress of scientific education, and the individuals who were fit to take charge of classes as teachers, and I should not leave the place till I saw my way to the establishment of a model class, and then I think the messengers might fitly enough point to the Union of Institutes in Lancashire and Cheshire, and show how that has worked, and what progress has been secured, and ask the locality in question either to follow in that course or to inaugurate a still more successful one. It seems to me that a very few years, if that plan were adopted, would suffice to cover the country with science classes.

5153. The difficulty you now speak of is a difficulty which has arisen elsewhere rather than in Lancashire?—Yes; the accident in Lancashire has been, that we have had a few individuals who have been thoroughly devoted to the educational question, and who have been determined to seize every opportunity in order to advance that question, and as soon as they have learnt of the Department of Science and Art, they have made the best possible use of it. Our own difficulty is the getting of teachers. In our work, we have found it very difficult to secure competent teachers; the work of the agent was first to find the men who were capable of teaching, and to induce those men to sit through examination, and get themselves certified by the Science and Art Department, and the uncertainty of the results, and the fact that men who have already achieved a position in society will not submit themselves to an examination, was a very great difficulty indeed, and is still a great difficulty; we could multiply the classes very much if the teachers were multiplied, and it seems to me that

in that respect the plan of the department might be re-arranged. I think that if the Government were to say, "We will not abolish the certificate, but since we pay for results only, we will pay whoever produces those results," the effect would be very good; for instance, in the early part of the history of this subject, it was the rule of the department that if an elementary teacher had pupil teachers under him, they would not pay him if he conducted a science class. We, in Manchester, represented the difficulty we had, and that in many cases we could get elementary teachers who would be the best teachers we could lay hold of, but the Government interfered, and said, "No; if these men teach they shall teach for nothing." After our representation the Department gave way in that particular, and the result has been a considerable increase of science teachers. I should propose that the necessity of the science teacher holding a certificate from the department should be done away with; but it would be advisable to secure the best teacher who could be obtained, and I should not like to abolish the examination for the certificate, though I think that, to induce better teachers to come forward, the difficulty might be got over, and progress secured, if the Government said to the person who held a certificate, "We will attach a small conditional salary to this certificate, provided the teacher passes a certain number of pupils in his speciality every year." Then, if the teacher did not pass pupils, there would be nothing to pay, while, if he passed a good number of pupils, there would be something to pay. I think, then, the scope of the examination for certificates might be widened; and that, instead of there being an examination in a certain speciality only, the examination might include rather a wider range of subjects; say, for instance, that a man wants to be certified for building construction, the examination ought to include not only the matter of building construction, but also some mathematics; say, algebra, up to quadratic equations, with plane geometry and trigonometry. That plan, I think, would increase the number and improve the quality of teachers very considerably, and in our efforts to spread science classes over the country it would give us a much wider range of choice.

5154 You are aware that by the Minute issued in February, last year, persons who have taken a second class certificate in the examinations of the pupils are now allowed to take payments as teachers on results?—I was not aware of that Minute, but it will to a considerable extent remedy the difficulty; still it will not give us the command of men who have already attained a position in society, and who would take classes, but will not sit at an examination, either local or in London. Those men are ready-made teachers whom we cannot have because of this difficulty.

5155 Are you aware that graduates of universities can obtain payments on results without having passed an examination?—Yes, but graduates of universities are generally men who are so placed that it is not worth their while to become teachers of science classes.

5156. But that is the principle of exemption which you would wish to extend?—Yes, the Yorkshire Union Report of last year says "Several institutes have applied for science teachers, but we have none to recommend, whilst qualified teachers are very few, and only one in Yorkshire holds a certificate." At a meeting of science

science teachers held in Manchester last year this resolution was passed. "That in the opinion of this conference the practice of payment on results ought to be modified so as to include payment for the average attendance of the classes." I do not quite agree with that, however, and I think a conditional salary on the certificate would be a very much better plan, and would probably satisfy the teachers.

5157. You are aware that there was formerly a payment on the certificate, are you not?—There was in the art schools

5158. But in the science schools also, though it was abolished five or six years ago?—If it was abolished at that time, it was abolished before proper experience of its working had been acquired, because the science classes were then very few. My plan would be a conditional salary—not an absolute salary—on the certificate. I would not pay the salary unless a certain number of pupils were passed every year.

5159. You would pay a salary on the certificate, in consideration of the passing of a minimum number of pupils, and a minimum attendance?—Yes.

5160. Are there any other difficulties in the way to which you wish to refer?—Yes, there is a difficulty attending the definition of the pupils. The definition of the pupil for whom the Government will pay is either a person who does not pay income tax, or the son of a person who does not pay income tax, and that just excludes the better part of the working classes. That is to say, the more highly paid artisans. It excludes also the sons of shopkeepers, and all above them.

5161. And you think that exclusion is unjust and impolitic?—I think it is very impolitic, if we look to the probable results in connection with the better scientific education of the country, it is very natural that the son of a foreman, who pays income tax, should himself, in time, become a foreman; and, in order to do that, he must first become an artisan, and I do not see why he should be excluded from the benefit of the science classes, for the country suffers by the shutting out of the very class from whom you would get the best results, and there is another thing connected with this definition which is immoral, for there is a continual temptation to evasion, the teacher will constantly feel that the more inquiries he makes about the position of his pupils, the worse it will be for him, and he will avoid inquiry by every means in his power.

5162. Would you propose that there should be any limitation whatever?—Yes; I think we might take the Society of Arts' definition, which is, "Persons who are not graduates, or undergraduates, or students of any university, or following, or intending to follow a liberal profession, or enjoying, or having enjoyed a liberal education." I think the introduction of that definition would be a very great improvement.

5163. You would then require, would you not, to define what is a liberal education?—I think that might safely be left to the department, and I would give the department a wide discretion.

5164. And what results would you expect from the relaxation of which you have just spoken?—In connection with the Union of Institutes, we should probably get 25 per cent. more pupils, and, taking the whole country, I think the increase of the science classes would be very large if this alteration were made and the propagandist system were adopted.

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5165 The 25 per cent of which you have spoken would chiefly arise, perhaps, in the class from which your foremen and managers would be likely to be drawn?—Decidedly

5166. Would you say, in an economical point of view, that the instruction of that class was of greater value per unit than the instruction of the working class properly so called?—I think, for the country, it would be decidedly more economical

5167 Will you now proceed with your evidence?—The Committee are probably aware that the science classes, even to the first-class certificate holders, are not sufficient to prepare the students for active business in life, where scientific knowledge is required, they are rather just sufficient to give a taste for science than to supply the want of those who require to apply science immediately in their occupations, and it seems to me that, if we are to achieve anything great in the matter of science teaching, we must have, above science classes, and above the teaching in the grammar schools, when science is introduced into grammar schools, a series of what I should call rather high-class science schools than technical schools, and I think those schools should be placed in the chief centres of industry all over the country, taking, for instance, such places as London, Manchester, Glasgow, Birmingham, Bristol, Leeds, Bradford, Norwich, and Dublin. On this subject the Council of the Union of Institutes, in their last report, say that, in their opinion, provision should be made for those who may have got a first-class certificate, and who desire to carry on to a higher point their scientific education

5168. You mean a first-class certificate of the Science and Art Department?—Yes

5169 How was it proposed that that provision should be made?—I think that if the Government was in a position to say that, for the purpose of the establishment of those high science schools, when the locality had been indicated, they would bear one moiety of the expense of the establishment, or if they would say that if the school were established they would bear a moiety of the expense of conducting it, the schools would then arise wherever they were needed in the course of a short time. I dare say the Committee are aware that in Manchester a subscription is now on foot to establish an engineering school in connection with Owens' College, and that the chair is really established although sufficient funds are not yet found for it. I have no doubt that similar movements would be made elsewhere if encouragement from the Government were given.

5170. You have spoken rather of a high science school than of a technical school, will you kindly state what you consider to be the distinction between the two terms?—The high science school would teach the theories of science, the theories which are carried out in practice in industrial employments. A technical school, to my mind, would teach the practical application of the theory, and would require a workshop. I think it would be very important in connection with the high science school to secure the entrée into a workshop and museum for the pupils, because then the theory of science would be combined with the practice. The Committee are, no doubt, aware that, taking the engineering, or rather the machine making trade, it is only a small proportion of what are called in the trade "gentlemen apprentices," who do very much good, and the

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reason is, that they are absolutely without theory, and wander about the workshop and see how machines are constructed, but without understanding it. and, as a rule, when they enter business for themselves, they provide the money while other people have to find the brains. If they had received theoretical teaching in a high science school, and had the entrée into a workshop also, in which they could see the theories taught by their professors carried out in practice, as Mr. Whitworth proposes with regard to his scholarships, it seems to me that the result would be very different.

5171. By a technical institute you mean an institute which would include a workshop?—Yes.

5172. And that you would object to?—That I should decidedly object to the Government establishing.

5173. Then what would you include in the theoretical instruction to be given in any engineering school, if you excluded the practical application?—I would include the higher mathematics, and, according to the destination of the pupils, chemistry, or physics, with the entrée into workshops which are already established, and which are carried on for a profit, I would have examinations at the end of each session in practical subjects, and I would make it the task of the pupils to go into the workshop and make themselves acquainted with the practice; and the examination at the end of the session should include the practical application of the theories.

5174. Would you have no courses, for instance, on the construction of steam engines?—Yes, certainly, but not a workshop in which to exemplify them in the school.

5175. You would have courses in which the pupils should be taught what are the different kinds of steam engines in use, why a particular form of construction has been adopted, and why another form of construction has been rejected?—Certainly, I would have a course giving the history of the steam engine, and its progressive development, and then I would send a pupil to the workshop, and let him study the current engine, and examine him in his knowledge of that at the end of the session, and also in the history of the subject.

5176. If such a school were established, for example, in Manchester, would you also have courses in the history of the cotton machinery?—Yes.

5177. And the current practice in the construction of cotton machinery?—Yes, certainly; and I have no doubt that the establishment of such a school would lead to the inclusion of models of the machinery, so as to show its history, either in the existing museums or else in museums formed for the purpose.

5178. Then as far as the construction of machinery went, you would give technical instruction?—In the manner spoken of, but without encumbering the school with the workshop.

5179. You would not confine yourself simply to instruction in the principles of science, but you would impart instruction in the application of those principles to actual construction?—Certainly; as far as that could be done without keeping up a workshop, I would do so.

5180. And with respect to chemical manufactures and mixed manufactures to which chemistry applies, you would also give courses in the

history and present state of those manufactures in any school established in a district in which such manufactures were greatly in use?—Decidedly; and in that case I would attach a laboratory such as that at Owens' College.

5181. Would you in that laboratory direct the attention of the pupils specially to subjects bearing on the industry of the district?—Certainly.

5182. With regard to the details of the instruction to be given in such a high science school as you contemplate, you have not perhaps gone into anything more than the outline?—No, I have not; but such a school as I have suggested might in some cases be attached to existing institutions. In London there would be no difficulty in having such a school in connection with the institution in Jersey-street, or in connection with the Museum at South Kensington. In Manchester there would be no difficulty in attaching it to Owens' College. In Glasgow there would be no difficulty in attaching it to the University; and in Dublin the same thing might be done. In Leeds, Bradford, Birmingham, Norwich, or Bristol such schools would have to be established independently, because there are no institutions existing to which they could be attached.

5183. You are aware that there is already a school of science in Dublin, are you not?—Yes.

5184. You have spoken of the establishment of these schools, but, taking the recipients of first-class certificates from the Science and Art Department, these recipients being probably young men of 18 or 19 years of age, and having to earn their livelihood, how would you propose to enable them to avail themselves of such high science schools?—In the course of a little time exhibitions would be established, which would provide for many of those young men, but I think it would be requisite that the admission to such schools should be either absolutely free after a stiff examination to show that the men were really select and fit men to be prepared a captains of industry, or else that the fee of admission should be merely nominal. In some localities, if a very bright youth were found, such means would be provided for his support. If evening classes were established, then it would ease the difficulty considerably; for instance, the evening classes at Owens' college are attended by clerks, warehousemen, schoolmasters, and people who could not by any possibility attend the day classes, both because they have to earn their livings, and because they are otherwise employed.

5185. Then, do you think that your science classes are, at this moment, feeders for the even science classes at Owens' College?—No, not at this moment, for the gap between them and Owens' College is too great, but I hope they will become so, in the same manner, the Whitworth Scholarships will not be very generally applicable to pupils of the science classes, because the requirements of the scholarships are such as the people we have to deal with now would hardly be up to.

5186. But, at the present time, what is there to prevent a pupil who has taken a first class certificate in the science classes from availing himself of evening instruction in Owens' College?—In Manchester there is no difficulty, if the fees are paid for him, but he could not matriculate; he could simply avail himself of the instruction in certain specialties, he could go to the chemical class, or any of the other classes, or to

two or three of them, but he could not avail himself of any honorary distinction, because matriculation requires the classics.

5187 Mr. Potter.] Are you aware that at the present time there are pupils from those evening classes matriculating at Owens' College?—They would be very few indeed; because they cannot matriculate without Latin and Greek.

5188 Chairman.] You do not speak absolutely, but only of the working class pupils, who are not likely to possess any classical knowledge?—Yes. I speak of working class pupils only.

5189 But you hold that the teaching of the classes in connection both with the Society of Arts and with the Science and Art Department, is not a substitute for such teaching as may be found in Owens' College, and in such similar institutions as you would wish to see established?—Decidedly not, and it never can be; the teaching which is given in the science classes follows closely our ordinary elementary school instruction, while the teaching at Owens' College, and in similar schools, such as I would wish to see established, would be very abstruse.

5190 Or, at least, much more advanced?—Much more advanced.

5191. You have said that the fees should be either low or nominal; would you apply that to the fees of all the pupils, or only to the fees of certain selected pupils, who should be put on better terms, in consideration of the aptitude which they have shown?—I would apply it to all pupils who come from the science classes, or from the grammar schools, supposing science to be introduced into grammar schools, except that they should be the children of the middle or upper classes, who could afford to pay; perhaps you might take the Society and Arts definition, and charge fees to them, but with the ordinary pupil, who would go to such schools, I think that the sacrifice of time which will be made would be quite sufficient, without the payment of fees.

5192. You think that the country would get a full equivalent for the expense incurred?—Yes, I think the country always gets an equivalent for science instruction, the object of scientific instruction is to stimulate the progress of industry, and if a man is ever so selfish and brings out an improvement and gets it patented the great beneficiary is the public, and not the patentee.

5193. Are you acquainted with a few instances in addition to that of Manchester in which science teaching is carried on in connection with the Science and Art Department; I speak now more especially of the trade school at Bristol, and the navigation school at Hull?—I am not personally acquainted with either of them; but taking the statistics of the department, the chief teaching seems to me to be in Lancashire, in the metropolis, and in the two colleges which you have named, the other portions of the country, so far as science teaching is concerned in connection with the department, are almost blank.

5194. I am now directing your attention to day schools, assuming that any delay or opposition should arise with respect to the introduction of science into grammar schools, do you think that the example of the Manchester mechanics' institute school, and the two other schools which I have named might be advantageously followed?—Yes, and I think you may add the Burbeck schools in London as examples of the same kind, especially the Burbeck school at Southampton Buildings, and the one at Peckham.

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5195. In those schools more attention has been paid to social and political economy than to experimental science, I believe?—Yes, no doubt; but there has been in them quite enough of science instruction to show its applicability, and the possibility of generalizing it.

5196. Can you state to the Committee why that example has not been followed in East Lancashire and Cheshire?—My answer would only be a speculative answer. I should say that the people who themselves have not received the benefit of a good education, do not value it for their children, and that that example could only be followed by an active propaganda being set up, and the expenditure of a considerable sum of money for a few years.

5197. Has the question of establishing such schools been considered by the authorities of your Union?—Never to my knowledge. We have taken the means which lay immediately before us, and applied them without the expenditure of more money than was absolutely necessary. The great bulk of our subscribed fund goes either in paying the salary of the visiting agent or in making prizes. We could not undertake work of the kind to which you refer without a very much larger amount of money than is at our disposal.

5198. You think that you are employing your income in the best way, all things considered?—Our income, which has increased from 250 £ to 400 £ a-year, could not, in my opinion, by any possibility, be better employed than as we are now employing it. Our progress is a proof of that.

5199. Is there anything you wish to add to your evidence?—Nothing, except that I have here some notes which Mr. Traice, who is practical science teacher to the Bridgewater night schools, has put into my hand, and which, if the Committee desire it, I will hand in.

5200. Being well acquainted with the contents of the paper which Mr. Traice has desired you to put in, do you generally agree with it?—In the main I do. There are a few things which I do not agree with.

5201. But Mr. Traice has been very successful as an organizer of schools, and his recommendations would carry very considerable weight to your mind, would they not?—I think so.

5202. Mr. Bazley.] Was the Union of Mechanics' Institutes, with which you are connected, originated without the suggestion or aid of the Government?—Yes, I think it was originated by Dr. Hodgson, formerly the principal of the Liverpool Institute, and after that the proprietor of Chorlton High School, Manchester.

5203. What is the total number of students connected with that union?—That is a question I cannot answer.

5204. In what year was it founded?—I should say about 1858, but it did very little work until I became connected with it, which was in 1862 or 1863. The number of pupils attending the elementary evening classes is 8,060, and 1,940 are attending the science classes. A few of those would be the same persons as the pupils of the ordinary evening classes.

5205. What amount of Government Grant have you received, say for last year?—I cannot tell that, the payment is made to the teachers on receipts. It would require a calculation, because the payment varies according to the pass on first, second, or third class certificates, but it can be given perhaps from the Science Directory.

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5206. Have you any idea of the future occupations pursued by the students after they leave the classes?—In some cases the students change their occupations in consequence of the instruction which they receive. There have been various instances of pupils who have got Queen's prizes, and who have advanced their positions very materially, but in the main the students go into artizan occupations, or they remain as clerks and book-keepers. It will happen frequently that an artizan will become a clerk, warehouseman, or bookkeeper as a consequence of the instruction received.

5207. Are you aware of any signal discoveries made by any of the pupils of your institutes?—No, I am not aware of any signal discoveries being made by them; but I am aware of one or two cases of great usefulness resulting.

5208. Perhaps you are aware of many of them who have improved their condition and circumstances in life?—That is a very frequent result of the education they receive.

5209. In reference to half-time education given under the Factory Act, are you aware of instances where large employers have distinctly declined to be troubled with children attending half-time schools?—I have heard from one or two persons that they preferred being without them altogether to being troubled with them. I have stated already in my evidence that, so far as I have seen, the general effect of that legislation has been to shut children out of employment rather than to send them to school.

5210. I think you have stated that there is a lamentable extent of ignorance in the labouring classes in Manchester?—That is so.

5211. I infer from that that you would advocate a system of municipal education by the aid of the rates?—Yes, decidedly.

5212. You are also willing to have a compulsory system attached to such education?—I believe it to be an absolute necessity for about one-tenth of the population. A compulsory law would apply only to about that one-tenth, but they are the black sheep who spoil the flock.

5213. Would you associate such a system with perfectly free teaching to the children?—I should be glad to do so. If it be impossible either on account of the cost or for any other reason, I should then like a rate in aid which would still allow the conductors of schools to remit the payment wherever it was impossible for the pupils to pay.

5214. What regulations would be necessary for the purpose of enforcing compulsory attendance at school?—That is a large question. To begin with, I would simply make it possible for the neighbours to inform, and would inflict a penalty; or the school inspector employed in the locality might have the power of getting at the information by any means, and reporting to the school committee, and then inflicting a penalty.

5215. And you think that primary education for the great mass of the children of the poor is the first necessity of the age?—Most decidedly; no children can be properly prepared for society without it.

5216. Now, if the Legislature were to grant half a million of money per annum in aid of education, would you apply that to the primary instruction of the ignorant classes, or would you give it for the purpose of scientific instruction among those who perhaps could get it for themselves?—If the Government would grant half a million of money per annum for education, and if

that were the total sum they would grant, I would divide it by applying the larger portion to primary instruction, so as to secure a considerable sum for scientific instruction.

5217. You think that the high class of science schools should be supported at the expense of the State, while even a considerable proportion of the lower classes might be kept in a state of ignorance?—I think it is so important that we should properly extend the science instruction of the country for the sake of our industry that I would submit to that condition of things, and I would do it on this principle, that if the captains of industry were well up to the mark they would be good directors of the others, but that if we have no such captains the army will be deficient.

5218. You have referred to workshop teaching, would that come strictly within science teaching?—It might come within the sciences instruction, my evidence was that I would teach theories in the high science schools, but I would endeavour to secure for the pupils admission into workshops in order to have the theories tested, and thus by combining theory and practice they would be made practical as well as learned men.

5219. You appear to be advocating scientific instruction with a view to getting profitable results connected with our industry?—Yes.

5220. Would it not be equitable that those who are to derive the benefit of it should themselves pay for the cost of that superior education?—Decidedly, if they are in a position to do it; but, at the same time, looking to the benefit of the country at large, I should say that whatever money we spend on scientific teaching, if properly applied, would be money well spent, because progress in science is not the property of the individual who has got a patent, but of the whole country. You know that if a manufacturer, for instance, brings out an improved machine, he may have the exclusive right of that improved machine for 14 years. That is a system with which I should like to dispense, but even as it exists now, the greatest beneficiary is the country in every case. The owner of the machine will, in a short time only get the ordinary profit on his investment and everything else will go to the public.

5221. Have you any practical acquaintance with the state of science as applied to industry on the continent of Europe?—None whatever except through books.

5222. But, with your knowledge of the industry of Lancashire, are you aware of any signal instances where science has directly benefited the great industry of that county?—Certainly.

5223. What would you refer to?—I would take prominently the matter of calico printing. The art of dyeing has been revolutionised within the last few years, and the consequent economy, I should think, must be immense.

5224. Has not that rather sprung from the enterprise of the capitalist who has needed it, than from any spontaneous contribution from science?—It never would have come from the enterprise of the capitalist, unless you had had the laboratory.

5225. Can you point to any such instances connected with the great mechanical establishments of Lancashire?—I think the best instance of that is the position of Mr. Whitworth, who has just given 100,000 *l.*, to establish scholarships; he was himself an artizan some 40 or 45 years ago, in London; he is now the most eminent maker of tools in the world, and he feels the importance

portance of scientific knowledge so much, as to devote a very large portion of his fortune to the spread of such knowledge.

5226. And you think that, if scientific instruction were more universal than it now is, the development would be very beneficial to the industry of the country?—A considerable portion of our inventions come from working men, or men who have been working men. It is very fair to assume that if they were better educated their progress would be much greater. I should think that, in the course of my experience, at least a dozen very intelligent working men have come across me who had found out perpetual motion, in some cases, they have been men who have been very ingenious mechanics, but absolutely at fault for theory, and therefore dreaming on for years that they were going to get a motive power, and pay nothing for it.

5227. The mechanics' institutions have been exceedingly useful in Lancashire, have they not?—Yes.

5228. Industry is very much indebted to men that have been educated in mechanics institutions?—Yes, decidedly. The Manchester institution, especially, has not only benefited Lancashire, but has sent pupils all over the world.

5229. Mr. Potter.] You have been asked whether there was any evidence of beneficial results from science to our manufacturers?—Yes.

5230. Would you not say that the residence of such men as Dalton, Thomson, and Angus Smith, and others, has been very useful to us in the Lancashire district?—Exceedingly; Dr. Angus Smith especially, who derived a great deal of his knowledge from the chemical schools on the continent.

5231. As far as mechanical science goes, you have mentioned Mr. Whitworth; you might, perhaps, add Messrs. Fairbairn?—Yes; and the late Mr. Roberts and Messrs. Sharp as being the first locomotive engine makers in the country. I think we cannot adequately estimate the value of those men at all. I have already stated that my impression is that any amount of money which may be spent to produce or to develop a few such men would be money exceedingly well spent.

5232. Do you think that any other district in Great Britain has benefited so much by the residence of first-class talent as our own?—No, I think not; but that is partly due to the accident that Lancashire has been the home of the cotton manufacture, and there are many circumstances which have developed that manufacture beyond any other industry in the country.

5233. Were not those names either directly or indirectly connected with the cotton trade?—I do not recollect any direct connection of Dr. Dalton with the cotton trade, but in every other case there was that connection. Dr. Dalton was a purely scientific man, who followed science for the love of it.

5234. Still Dr. Dalton was, during the whole time of his residence among us, specially connected with the calico printing?—Yes.

5235. With regard to the establishment of high science schools, have you any idea of the amount of expenditure which that would involve?—Not the slightest.

5236. Would it not involve an immense expenditure?—I should look at those schools rather as schools for the highest scientific education, than

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take any note of the expenditure. Expenditure on education is always justifiable, on these two grounds, first, that any well-devised expenditure on the education of a nation is profitable, and, secondly, that no child has a fair chance in society without education; and I want to see such a scheme as will enable us to utilise the best intellects of the whole country; to have a scheme by which the poorest child should be able to climb either into the Lord Chancellor's seat, or to the highest rank in science, if his brains were fitted for it.

5237. In that large expenditure you would give the largest share to the working, or perfectly uneducated class, by means of compulsory education?—Certainly.

5238. Mr. Arkroyd.] The results which you have supplied the Committee with have been furnished by the Union of the Lancashire and Cheshire Mechanics' Institutes?—Yes.

5239. Does that embrace the whole of Lancashire?—Yes; and of Cheshire also.

5240. How many of those institutions are in Lancashire, and how many in Cheshire?—I am not quite sure, but by far the larger proportion in Lancashire, there would be about 100 in Lancashire and the remainder, or about 20, in Cheshire.

5241. Chairman.] Is it not North Cheshire and East Lancashire?—No, we cover the whole of Lancashire. There is a sub-union in East Lancashire.

5242. Mr. Arkroyd.] Do you find much difference in the state of elementary education in Cheshire as compared with Lancashire?—We have not been able to work Cheshire nearly as well as Lancashire. Lancashire is our more fruitful field, and the probability is that it is owing to the less amount of elementary instruction in Cheshire.

5243. How do you account for that?—Cheshire is more an agricultural district and Lancashire is more a manufacturing district, in Cheshire where it has towns they are small towns; the Lancashire towns are large towns, and grouped, so that mental activity extends over the whole, they are more homogeneous.

5244. But factory education in some degree may account for that higher education in Lancashire than in Cheshire?—In some degree no doubt.

5245. The factory half-time system has not been carried out generally in Lancashire on account of the objections to the troublesome provisions of the educational clauses, has it?—I do not think they would be very troublesome if gentlemen went into them in the spirit of the Act, with a real desire to carry them out, but Mr. Bazley, one of your colleagues had, for some years one of the best factory schools in Lancashire; during his time and during the time of his successor I visited it, and on both occasions I put this question to the schoolmaster, and I have repeated it also at Mr. Henry Ashworth's school, "What is the difference between the progress of the half-timers and the whole-timers?" and the reply has been that the half-timers in a well conducted school are very little behind the whole-timers.

5246. Your observation leads you to conclude that where the employers are desirous of developing to the utmost the educational provisions of the Factory Act, and to improve upon them, the education given has been really, on the whole, of a superior practical character?—It has been very useful.

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useful indeed; I am no judge of the difficulties which gentlemen may experience with regard to the conduct of their trade in having children at work half-a-day and at school half-a-day. I should say that, theoretically, two sets of hands would be as convenient as one, but the practical result of the Factory Act has been to drive children out of the field of labour.

5247. Supposing the Factory Act to be well administered, it answers its purpose, does it not?—Yes.

5248. Supposing you had a rate in aid, and the system of education were perfectly administered, then, like other Acts, it might be almost inoperative?—Of course, anything badly administered is useless or worse than useless.

5249. You say that in many instances the children are not sent to short-time schools at all, so that they escape entirely the educational provisions of the Act?—Yes.

5250. Assuming that no full-timer was allowed to go to work, without passing a previous examination in reading, writing, and arithmetic, that would embrace all the children of the labouring population?—Yes, but I am afraid it would condemn a very large number of children to permanent vagabondism, if you made it imperative that the children should pass a certain educational examination before going to work, you could not generalise education by those means, and you would condemn an immense number of children to permanent vagabondism.

5251. Does vagabondism pay better than honest industry in Lancashire?—I am afraid it does in many instances.

5252. You say you have examinations now for your evening classes in elementary education, before the pupils have the advantage of scientific education?—We have elementary examinations before they are allowed to go into the Society of Arts' examinations, but any pupil can go into the

science examination without having passed an elementary examination, my impression is, that it would be an improvement to make an elementary pass necessary to the science examinations also.

5253. Speaking of the examinations of the Society of Arts, do you find them interfere to some extent with the Department of Science and Art?—The same educational ground is covered by both, but they do not interfere, except that the youths may have to go through two examinations instead of one, and may get two prizes instead of one, or two certificates instead of one.

5254. Then some amalgamation would be desirable, perhaps?—Yes.

5255. Most of these results which you have given us are supplied by evening classes in connection with the mechanics' institutes?—Almost entirely, with the exception of the Manchester mechanics' institutes, where the pupils of the day classes also compete.

5256. Are any fees paid by the attendants at these evening classes?—In the science classes they sometimes pay a nominal fee, but where there are classes in connection with the mechanics' institute, the same fee usually covers the whole.

5257. So that there is no extra fee for attending the evening classes in the institute?—There is not usually.

5258. *Chairman*] Referring to the utility of scientific instruction, I suppose you have no doubt whatever that our national progress is being benefited at every period by the labours of scientific men?—None whatever.

5259. You would say, for instance, that without the most strict theoretical investigations, Europe and America could never have been united by the electric cable?—There is no difficulty in answering that question.

5260. Is there anything further which you wish to suggest to the Committee?—No.

Mr. THOMAS LAWTON,

called in; and Examined

Mr.
T. Lawton.

5261. *Chairman*] You are the Agent of the Lancashire and Cheshire Union of Mechanics' Institutes, I believe?—I am.

5262. You have heard the evidence which has been given by Dr. Watts in reference to the operations of that union so far as scientific instruction is concerned?—Yes, I have.

5263. Have you any details which you wish to lay before the Committee to elucidate and develop the subject which is before us, and on which Dr. Watts has given us his evidence?—There is one matter which I should like to mention; viz., the constitution of the union; it is not merely a union of mechanics' institutes. Some years ago the name was changed; it is now known under the name of the Union of the Lancashire and Cheshire Institutes, and in that union we have working men's institutes, young men's societies, mutual improvement societies, ordinary evening schools, mechanics' institutes proper, and a few atheneums, making altogether 122. There are 12 mutual improvement societies where working men meet together for self-improvement, 15 young men's societies carried on on the same plan, 46 mechanics' institutes, three atheneums, 40 Educational institutes, a little different from common mechanics' institutes, and six evening schools. We have also in connection

with those institutes 50 science classes. Nineteen other institutions send in candidates to the central classes, making altogether classes connected with 59 institutions. In addition there are 13 institutes not in union and eight science classes in day schools, making the total number of science classes 71, together with the nine small institutes that send pupils in to the central classes.

5264. You are now speaking of the instruction given by the Science and Art Department?—For Lancashire and Cheshire.

5265. But in that list you mentioned classes that were not in connection with your union?—There are 21 not in union with us.

5266. What is the nature of the day schools in which the eight science classes are held?—Grammar schools, private commercial schools, and an ordinary day Government school.

5267. Can you state the subjects taught in those day schools?—In the private school, mathematics and drawing; in the common Government school, geometrical and mechanical drawing only.

5268. Where is that Government school situated?—The Government school is in Bolton.

5269. You mean that they give elementary instruction in connection with the Science and Art Department?—Yes.

5270. What has been the result so far as the pupil

pupils are concerned of the teaching in the day schools?—Can scarcely say, it has only been in operation for about one year.

5271. With regard to the central classes, has the attendance of the pupils from the neighbouring places been a source of any difficulty or expense?—Not at all, because we take in the institutes that are in union, and members are admitted exactly on the same terms as the members of the central institution.

5272. And the institutions whose members avail themselves of those central classes are situated at a very short distance, and connected by railway with the places in which the central classes are held, I suppose?—The rule is not to have a district where any institute is more than a mile or two miles from the centre, so that the pupils can easily walk there.

5273. In many cases the classes are situated in the same town, and where they are not situated in the same town they are in the immediate neighbourhood?—Yes.

5274. You have heard Dr Watts' opinion as to what difficulties must be removed in order to increase the operations of the Science and Art Department. Now speaking more especially of your own district, have you anything to add to his suggestions?—Nothing except in the matter of the teacher producing results; I think that is the only thing which he left out, viz., a teacher producing certain results to have a certificate.

5275. Will you give the Committee your view?—We have a case in point: a certain gentleman has for two or three years taken charge of a class in mechanical and geometrical drawing and building construction. It will scarcely pay him to submit to an examination as an ordinary pupil. He objects to going into the examinations as they are now carried on. He would not like to attend them from his position, so he goes on from year to year teaching in that class, and last year would have been entitled to receive 52*l* upon results, but as he has no certificate he could not claim payment. Last year he obtained four first-class certificates in his pupils, and if the department were to recognise certain large results by giving a certificate, I think it would be a very good thing.

5276. You think that in all cases certain large results should stand in place of the certificate?—Yes, or else the certificate should be granted as a recognition of the results, and then the teacher would be entitled to payment. There is one other matter which I should like to mention: if a pupil in a day-school, say, an ordinary factory-school, presents himself before the doctor and looks healthy and strong, but is only 11 or 12 years old, the doctor, I believe, can pass him, though he does not come up to the standard of 13 years of age. In the course of my inspection I have come across so many instances of boys under the age of 13 working full time that I have made inquiries in order to make a report. When I spoke to factory owners they alleged that it was within the Act. The teachers tell me in the district that they have no control in the matter, that their pupils are taken from them, and that they have little or no chance of showing results, and that if they complain very likely they will lose their scholars, and they say they should be very glad if some one in authority would undertake their cause. Dr. Watts has already pointed out that the greatest difficulty in the science classes is that when the pupil goes into them he goes in so imperfectly instructed in primary matters that he

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as unable to reproduce anything which he has been told.

5277. Have those persons told you that they have applied to the factory inspector of the district?—They say they do not like to do it. In one of the factory districts, last winter, I was so struck with the defective state of the elementary education that I now require every boy and girl to state at the foot of the examination paper what their age is.

5278. Is there anything which you wish to add?—I think that, except with regard to the points just mentioned, Dr. Watts has thoroughly exhausted the ground.

5279. Mr. Bazley.] I think you inspect or visit all the district schools in the general amalgamated body?—Yes.

5280. In your intercourse with the various institutes have you observed what enables you to confirm Dr. Watts' opinion, that the want of primary instruction retards the attainment of elementary scientific knowledge?—That is very seriously the case. I could give an instance in which an artisan, some time ago, submitted himself for examination at the May science examination (and he as a sample of a large number), and, after he had spent an hour and a-half in trying to write something that he wanted to say, he gave up in despair, and the secretary allowed him to retire. That sort of thing occurs on a very large scale; and with regard to adults, from 16 years old and upwards, the difficulties are immense.

5281. It is your duty, as it not, to advise all those separate institutions, and where you find them in error to set them right?—Yes.

5282. You give them directions when you find them in want of directions, with regard to the course of study?—Yes; first of all I go into the class with the secretary of the institution, and take the boys and girls who are present, without any selection (my examination is the only one conducted upon that plan), and give out to them a paper containing questions in elementary arithmetic, with a space for dictation; I then read out 30 or 40 words, equal in difficulty to the third standard in common day schools, and thus I find out how many of those persons, men and women as well as youths, can do the dictation, and, as a rule, a very large percentage, about 60 per cent., do the work badly. I get higher results from the youths who have just left the day schools; then I inquire if they have any science classes, and if not I put myself in communication with the committee, and explain the scheme of the Department of Science and Art. In very many of the districts we find gentlemen of high position who require to have that explained to them. In this last year I met with leading gentlemen who could not tell the difference between the Society of Arts and the Department of Science and Art. I heard a gentleman state a short time since that the great reason why he did not support the Society of Arts' examinations was, that the prize money came out of a Government department. As to the people of that class, and a large number of people among the middle and lower class, it cannot be expected that they should understand the working of a science school under the department. We have to go into the district and frequently to say very strong things, in order to call attention to the subject. A committee said to me, "We have been trying for years to get hold of the working classes." I said, "What have you done? Let them have an opportunity of learning science con-

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nected with their trade; establish science schools and you will find they will appreciate your efforts" Science classes were established, and the result was most satisfactory.

5283. Is it your opinion that many of the young people who have had scientific information communicated to them in those classes have found it useful?—Most decidedly. Three years ago a member of one of our classes was ignorant of the use of a pair of compasses; he had never had such a thing in his hands, and now he has been selected by his master as foreman of the mechanical workshop; and any little piece of work he requires in connection with his place of workshop, or in his own house, he fixes upon this man to do.

5284. Are you aware of any signal discoveries which have been made by any of those pupils?—Not in my five years' experience.

5285. What may be the total number of all the classes taught in all your schools?—As far as I can gather from my inspection last year, and noticing the large increase in the elementary classes, I should say we had not much less than 11,000 to 12,000 pupils attending classes of all kinds during last winter.

5286 Mr Dixon] Are you of opinion that science teaching is an advantage to ordinary workmen, putting on one side those workmen who rise to be foremen or managers?—Decidedly so, even taking a subject which has no bearing at all on his trade; it enables him to make greater progress; if we can get a man to go in for chemistry, we find it quickens him in other things.

5287. But of course that is especially the case if his trade be based upon that particular branch of knowledge?—No doubt; but I find it is better for him to go into some other branch of knowledge as well, for instance, if a man takes mechanical drawing, and can in addition be got to go into chemistry, he makes much greater progress in drawing than if he kept exclusively to the drawing.

5288. But if the man were devoting himself only to one study, you would of course select the one that was applicable to his trade?—Yes, we do that, and in establishing classes we ascertain the leading trade in the district, and try to give the class a teacher who is fitted to deal with that particular subject, at nearly all our classes we have mechanical drawing, geometrical drawing, and building construction.

5289. Have you known any instance in which an ordinary workman has received higher wages in consequence of having some scientific knowledge connected with his trade?—Yes, the man I mentioned is a case in point.

5290. But I mean purely as a workman; it is obvious, that if a man be so far instructed as to be able to rise out of his position, the instruction he has received must have been of value to him; but the question to which I direct your attention is this, whether ordinary workmen, who are not foremen or managers, receive benefit from the knowledge of science connected with their trade as artisans, which they may have received in those classes?—I have not come across any instance of that kind, because the masters generally promote men who show any particular aptitude, and then they get an increase of salary, which removes them from the class of ordinary workmen.

5291. Then, since you have no positive instances of the kind to quote, I will ask what your opinion is upon that point, we will assume that

education has been carried so far as that all foremen and managers are thoroughly instructed, and that it becomes a question of carrying that instruction farther, namely, as far as ordinary workmen; would it, in your opinion, be advisable to give scientific instruction to the lower class of workmen?—Most decidedly.

5292. Do you think a man's wages would increase in consequence of that scientific instruction?—Not necessarily so for some time; not at present. As far as our experience goes, it is that whenever a workman shows his employer that he has obtained certain results shown by examination, his employer seeks to get him promoted. We had a young man who attended one of our classes who obtained several certificates, and when his master heard of it, he sent for him, cancelled his indentures, and considerably increased his wages.

5293. Chairman] But the question is thus assuming that the want of scientific instruction in foremen and managers to be supplied, would you think that the economical results of ordinary workmen possessing scientific knowledge would be advantageous?—Decidedly. There is one other matter which I wish to refer to, and that is with regard to the teachers. We could open out now from five to six large districts if we could supply them with teachers. The reason why we cannot show a much larger number of pupils under instruction is, we cannot supply the demand for teachers. By next year, if my arrangements come out as I expect they will, every institution in the union will have facilities afforded, whereby a pupil can learn the principles of the most important trade of his district. I am trying to persuade one or two of our teachers to go and live out in the districts—to meet that want, we cannot at present get the districts to supply themselves with teachers, and we want men to go and itinerate. We have now 30 science teachers engaged; nine of them are artisans, four were formerly artisans, but their success as teachers has been so striking, that they have been able to withdraw from manual labour and become exclusively teachers, and they are most effective teachers in the union. We have 11 artisan teachers and 17 schoolmasters, or others from the professional class.

5294. Mr. Dixon.] Have you frequently found that the certificated masters are drawn off from teaching by the offer of more lucrative situation in factories?—We have not had a single instance of that kind in connection with our district, we had an offer made to a teacher by a large firm who had heard of his success in the drawing classes, they wanted him as a draftsman, and offered him a considerable sum, but the teacher declined to remove from his teaching, as he wished to go on with it to a much higher point. During the daytime he is attending a professional teacher in order that he may get private instruction in higher mathematics.

5295. Do you know how much that teacher was making a-year, when he refused the offer you speak of?—£. 150 a-year.

5296. But he expected to increase that sum considerably?—Yes.

5297. Chairman.] Have you in your union any special science schools; such schools, for instance, as the Navigation School, at Hull?—We have one or two that come near that, we have one at Bolton, and one at Oldham, called Schools

of Science, where the pupils meet in the evening for scientific instruction

5298 What is the special subject of instruction in those schools?—There are two subjects, physics and geometrical and mechanical drawing.

5299. My question, however, pointed to applied science?—We have nothing of that kind.

5300 Is the Wigan mining school in union with your organisation?—No, that has proved to be a total failure, but they are making efforts to reconstitute it

5301. Mr Acland.] Are you of opinion that the demand for science instruction is rising among artisans at the present time?—Very much so. Wherever we can send a good teacher into a district, it is responded to at once by the working people, of the 2,769 under instruction a very large proportion belong to the artisan class

5302. Do you think that among ordinary private day schools frequented by the sons of tradesmen and others, paying 1*l* 15*s* or 2*l* a-quarter, there is any science teaching given?—We have not many schools of that class outside of Manchester; we have very few, comparatively speaking, of the shop-keeping class attending such schools.

5303. I speak of ordinary private commercial schools, do you think that there is any science-

teaching growing up in those schools now?—We have in Southport, perhaps, the first real attempt to incorporate science-teaching with the regular routine of study in those schools, some of those private schools in Southport have engaged our science teachers.

5304 Part of your evidence and the evidence of Dr Watts seems to have gone on the supposition that this work must be done by the Government; but do you not think that, when the demand arises, ordinary private schoolmasters, if properly inspected and encouraged, would be able to supply a great deal of what is needed?—I do not think they would be for some years to come

5305. Why?—The great masses of the people do not appreciate scientific instruction, we have to create a taste for science among the masses, and that is where the money is wanted. I think it will be many years before they will be willing to pay for it themselves.

5306 You think that at present the urgent matter is for the Government to push the demand without discussing the question how far people must ultimately lean on the Government?—I think so.

5307 *Chairman.*] You are an advocate for the propaganda which Dr. Watts spoke of?—Just so.

Mr JOHN ANGELL, called in; and Examined.

5308. You are the Master of the Mechanics' Institute School at Manchester?—Yes, but I have had very considerable experience in connection with the general question of practical science teaching for the last 20 years I was connected with the London Mechanics' Institution as a student of the science classes, and as honorary secretary of the mutual improvement science classes. Subsequently to that I was honorary secretary to the Birkbeck School Committee From that time to the present I have continued to be an active propagandist in connection with practical science teaching

5309. How long have you been master of the Manchester Mechanics' Institute School?—Eleven years next September

5310 Were you educated in one of the training schools in connection with either of the two branches of the Science and Art Department?—No.

5311 Will you describe to the Committee what is the nature and what are the operations of the Mechanics' Institute School?—The present school was established as an ordinary commercial school, science being taught as an additional subject, not precisely as an accomplishment, but as an additional subject, and we very soon found that in it we had our best intellectual training ground.

5312. Are you also the teacher of some science classes in connection with the Science and Art Department, I mean evening classes?—Yes; and I have had considerable experience in teaching science at upper middle class schools.

5313. You have not told us yet what is the grade of your mechanics' institute school; is it a school which may be placed in the same rank with the primary schools in connection with the Committee of Council, or is it of a higher grade?—It is of a higher grade; it is self-supporting; the institution derives a profit of 200*l.* a-year, or 0.72.

more; the subscription is 17*s.* a quarter, including all subjects. It includes the children of parents whose incomes vary from 80*l.* or 90*l.* up to 400*l.* or 500*l.* a-year

5314 Does that payment include the use of materials in the school?—That is the total payment for teaching, but not for books and stationery consumed by the pupils, the payment is uniform, from the lowest up to the highest pupil.

5315. But does that payment cover the entire expenses of the school?—It covers the entire cost of the education

5316 But does not the general fund of the mechanics' institution bear any portion of the cost of the education?—They make a profit of 200*l.* a-year, or upwards

5317. The school leaves a surplus?—Yes, there is a slight surplus of 20*l.* or 30*l.* on the ordinary working expenses of the school, but in addition to that each pupil of the school is considered to be a member of the institution, and pays 5*s.* a-quarter to the institution, which goes direct to the institution, the 17*s.* includes that.

5318. The fees are 12*s.* to the school and 5*s.* to the institute?—It is so arranged in our book-keeping, but not in our prospectus

5319. At all events, the 17*s.* in question leave a net profit of 200*l.* a-year?—Yes, and rather more.

5320. That of course would be liable to a deduction for rent, if the school were not held in the mechanics' institute?—Yes

5321 Have you the balance-sheet of the school?—There is no special balance-sheet of the school, it is included in the general accounts of the institution.

5322 Can you give us the total receipts of the school, taking the payment as being 17*s.* a-quarter?—They do not keep the accounts quite

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disfract, and there is no separate financial statement published.

5323. But can you tell us the number of the pupils?—The number of the pupils at present is 235, but it varies at different times of the year. The next quarter after the vacation there will not be perhaps more than 180 pupils.

5324. Then, the average number of pupils on your books is about 200?—Yes.

5325. How many masters have you?—Four masters, including myself.

5326. Is there any grant from the Government in aid of this school?—No; but we have so registered our pupils within the last four or five years that I am enabled to take some advantage of the grant.

5327. That is to say, that in addition to the salary which you receive from the mechanics' institution, or the payments that you receive out of the fees of pupils, you receive payments on results from the Science and Art Department in respect of the pupils in your day schools?—From a small section of those pupils only; not above one-third in many cases.

5328. Are those classed separately from other pupils on whom payments are made in the mechanics' institute?—No, there is no distinction. I do not, in fact, know at present the number of pupils who have passed at the present examination, or what I may get, or in what section they may be.

5329. Are the classes in connection with the day school the same classes which are held in connection with the Science and Art Department in the evening?—No; they are distinct classes, but they are also science classes; all that is necessary is, that any day school in which the pupils are of the proper status shall place itself in connection with the department in order to receive payment.

5330. Are you speaking of your own school?—Yes.

5331. Your classes are held at a different time from the evening classes on the same subjects which belong to the mechanics' institute?—Yes.

5332. How many pupils have you learning science now in your school?—There are about 150 who receive occasional lessons; but, on an average, there are about 50 to 70 who receive systematic instruction.

5333. And of those, how many would ordinarily go in for the examination?—That I can scarcely say, there is one of the difficulties connected with the mode of examination and the mode of payment, the boys leave me in the afternoon, proposing to attend the examinations which are held in the evening, many of them living at some distance, and then, if a heavy shower comes on, 20 or 30 of the boys, very likely, stay away, which might make a difference to me of 50 $\frac{1}{2}$, 60 $\frac{1}{2}$, or 80 $\frac{1}{2}$, supposing those pupils were of that social grade on which payments are granted by the Department of Science and Art.

5334. And that difficulty you have really found to arise, have you?—On one occasion a heavy shower took place between six and seven o'clock in the evening, and more than 20 pupils were absent, 20 of whom were pupils on whom I should have received payment if they had been present.

5335. But this year, the weather having been very fine, how many pupils have sat for examination out of your day-school?—I should say that about 70 sat in physiology.

5336. In what other subjects did your boys sit?—Metallurgy, inorganic chemistry, light, heat, sound, magnetism, and electricity, but I cannot tell the number who sat after leaving me in the afternoon for I have no compulsory power over them; they feel that the examination is an evening's work instead of an evening's play, and the result is, that a great number of them do not turn up.

5337. You have no classes in mechanical drawing or geometrical drawing, have you?—No; I have passed some pupils from the school, and there are some in connection with the institute; but in connection with the day school we ceased to teach that, because the time is very limited, and also because the class of pupils who would pay for that teaching was so very small, it dwindled down to about five or six.

5338. Do you find that many of the boys attending your school, afterwards attend evening classes in connection with the Science and Art Department?—A few of them do, but as a rule the boys who are with me for any length of time pass in the first class, particularly the boys in the day school, who are prepared to pass very much higher than those in the evening classes.

5339. But still there are the subjects taught in the night school, so that they might avail themselves of that instruction, if they were willing?—Yes.

5340. But you find that is not the case to any great extent?—Just so, in fact I do not desire it; the instruction which we give at evening classes is of an inferior grade, because of the inferior capacity and habits and attendance of the class, they, however, get as much instruction as we can give them in those evening classes; and since those examinations have been instituted 833 pupils have passed those examinations from the day and evening classes, of whom 66 passed first class, 95 second class, and 233 third class those are getting Queen's prizes, and the remainder being simply passes, and during that time we also took seven silver and eight bronze medals and more pupils have passed at the Oxford examinations in the subject of chemistry from my teaching, and principally in connection with my school, than passed in Leeds, Birmingham, London, and Liverpool respectively, during a period of five years.

5341. Is there any examination on entering the day-school?—No.

5342. What is the average age at which the pupils enter?—Very few enter at less than eight years of age, but we are obliged to take young pupils in some cases, because the parent insists that the younger pupils shall go with the elder.

5343. But generally speaking your pupils are above eight years of age?—They are generally from eight years old up to 16 or 17, in fact sometimes we have young men and men of 4 also.

5344. What is the average age at which the pupils leave your schools?—I should say about 15, but we have them frequently at 17 and later. I find that the more attention we pay to them in the examinations, the later they stay.

5345. The more the instruction is improved the more willing are the parents of the children to keep them at school?—Yes; the greater the results in reputation that we afford them, the longer is the time they remain.

5346. Your school cannot at all be called a school

school for the children of working men, I suppose?—No, for the grade above that, there are a few workmen's sons there, but the majority of the pupils are perhaps the sons of shopkeepers.

5347. Have you many sons of foremen or managers?—A few, but not very many. I find that the sons of shopkeepers are the most difficult class to teach, especially to teach science, for the great difficulty in teaching science, although it is a very easy subject to teach, is that it requires sequential or consecutive treatment, and the sons of shopkeepers are very irregular in their attendance, because they appear to be required to attend in helping the business, and that is a serious difficulty in scientific teaching, especially the mathematical part of it, which requires consecutive attendance.

5348. Do you find the same difficulty among the artisans?—No, the artisans are among the best pupils in attendance and in progress. I find their attendance generally depends on the mother.

5349. But you would say that those children of the artisan class are the picked children of picked artisans, and it would scarcely be fair to compare them with the average of your tradesmen or tradesmen's children?—It would be unfair in that respect.

5350. With regard to your evening classes, you say the instruction given in them is inferior to that which is given in the day-school?—Very much inferior.

5351. Although the teachers are the same?—Yes.

5352. Does that arise from want of preparation on the part of the pupils?—To a very considerable extent it does, and also from the fact that the education afforded at ordinary day-schools, including Government schools, is almost useless as a preparation for scientific instruction. The three R's are taught so badly, especially arithmetic (which is the only *training* subject), as to be quite useless as a means of mental development. The scientific instruction that we wish to communicate is too difficult for them.

5353. That is from want of preparation?—Yes, and want of natural power too. At schools under the Revised Code the subjects of instruction are so taught that you have the utmost amount of information of a given character so communicated as to produce the least possible result with respect to mental training, so that when they come to the evening classes the effort required is too great for them, and they fall back upon a class of literature which is very inferior to that which they might otherwise take up.

5354. But does that apply to all the pupils who come to you from the elementary schools, or only to so large a number as to give a colour to the classes?—The experience I have had during the last three or four years, since the Revised Code has been adopted, has been very definite, a very large number of my pupils of the day schools came to me who have attended the school under the Revised Code; they came to us as a kind of finish. I find the most remarkable decadence in their intellectual power, as compared with those who came from Government schools prior to the adoption of the Revised Code.

5355. Have you found that to be the case more especially with the schools of any one denomination in particular?—No, it is general; they have no knowledge of the principles of arithmetic or of grammar; it is very difficult to

give them the least power of expression at a written examination.

5356. You are decidedly of opinion that they are more deficient than they formerly were in that respect?—I am perfectly satisfied about that.

5357. Do many of your pupils attend subsequently in the classes of Owens' College?—A few in the evening classes do; a few days ago prizes were distributed and there were three old pupils of mine successful. There is one point in which I differ from Dr. Watts; I think in a good day school you are capable of carrying scientific instruction quite as far as in any evening classes, such as those at Owens' College. I think also, though I quite agree that there should be some higher class schools, that those results can be produced through ordinary well conducted day schools, but I am satisfied that unless you give the teachers of such schools the opportunity of competing with others, you will take away the enthusiasm which is one of the conditions of success.

5358. For that purpose you do not consider that the examinations of the Science and Art Department are sufficient?—It would be fairer if Owens' College, for instance, would send their pupils to compete with ours at the Government science examinations.

5359. Or that you should be allowed to send in your pupils to their examination?—The Government examination is much fairer for such purpose than their examination. There is a college examination, set by a professor to his own class; if I set my questions to my class, or my own teaching in that class, I can enable my pupils to pass a good examination; but if you have a kind of university examination, such as the Government examination, in which a central body of examiners put questions altogether irrespective of any one particular class, you then have the fairest examination which is possible under the circumstances.

5360. You are aware that many of the pupils of Owens' College go in for the matriculation examination in the University of London, do you suppose that you would be able to prepare pupils to pass that examination in science?—I am speaking simply of science.

5361. I am also speaking simply of science?—I am quite satisfied that I could prepare pupils to pass the matriculation examination.

5362. But in the higher grades of examination in science would some of your pupils be able to pass?—The matriculation examination is not nearly so difficult as the Government science examination is, it is much below it in every respect; I mean the science portion of the matriculation examination in the University of London.

5363. Mr. Bayley.] Do you find that many of your pupils become useful members of the mechanics' institutes after they have left your schools?—The majority of those who leave the day schools are really much above anything we can do for them in the night classes, and they cease to belong to us.

5364. You would confirm the general opinion, that in almost all the schools of Manchester the education of the children is very inadequate for the reception of that class of education?—Yes, I believe a most serious mistake is made in this matter. It is a radical mistake with regard to scientific instruction to make it secondary. All

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education to be real must be essentially in scientific subjects in the first instance. Scientific instruction should be primary, and the literary instruction should be based on it; that is to say, I would give a much higher class of object lessons than are generally given, and I would base the literary education on that. It is the plan which I pursue, and by which I obtain my own results. The progress in scientific instruction would be very considerably increased if that plan were adopted. I find that in middle class schools the children were not more capable, because they have had elementary classical instruction, of taking in science instruction than those who come from mere elementary schools. There is a very great difficulty indeed in getting them to form accurate primary ideas, and the very power of language which they have frequently prevents them from looking at objects from a real or a scientific point of view. The great difficulty we have with regard to the real teaching of science, is not a difficulty arising from mere want of literary education, but because they have not gone through a proper course of mental training, and their natural powers of observation and reasoning have not been cultivated.

5365. But at the same time the mind must be sufficiently developed by preparatory education, to enable the children to comprehend something of what is said to them in the way of scientific instruction?—Yes, but I should require the science in the first instance. You must put objects before a child to enable him to develop his ideas, to teach him you must get ideas, not by words but by making experiments and by teaching him to observe, and when once you have got those ideas, it is the easiest thing in the world to develop the power of expression.

5366. Do you introduce object teaching after the German manner in your own school?—Yes, ordinary object teaching, as it is given in England generally, is quite useless, an object is placed before a child, and he is told that that is so—and so without the teachers seeing that the child has really recognised the object, the name is then put on the black board, but the black board simply supplemented the book, it became only a large black board-book in fact.

5367. You are aware that in the mechanics' institutes at Manchester the members presenting themselves for instruction are so lamentably taught that in the first instance they make but very little progress?—They would make much more progress if they had had object lesson teaching. With regard to the half-time system, if there is very little instruction the half-time system pupil will get on quite as well as the whole-time pupil, but if you have effective instruction the difference between two hours, four hours, three hours, and six hours is very great; the more effective the instruction the greater the progress during the additional time, within certain limits.

5368. But there must be some preliminary cultivation of the mind if you are to make any progress at all. Dr. Watts and Mr. Lawton have stated that they find the mechanics' institutes are not making the progress which they would make if there was better primary instruction given to all classes of children. Do you agree with that opinion?—I quite agree with that opinion, but what I consider essential with regard to good education is this, that primary education shall be more effectively given by being made more real. I would do it by the agency of objects and ex-

periments, that is, by basing it on elementary science teaching.

5369. Did I understand you to say that the attendance at the evening classes was regular?—No, not at the science schools, they are very irregular; we have three payments during the course; the September quarter, the Christmas quarter, and the March quarter, and the pupils fall off on the occasion of each of those payments, so that we very often have to begin again, to assume that we are commencing with the pupil.

5370. Do they fall off more in the spring than in the winter?—As we terminate in April or May I cannot say, but a considerable number leave us at Christmas when they know payment is wanted, and others at March, the next period of payment.

5371. What is the age at which the pupils come to you in the night classes?—From 11 years old up to 45.

5372. Mr. Louthier.] In your night classes, how many hours of instruction have you?—Each subject occupies one hour.

5373. How do you give that instruction; is it by lectures?—No, I am satisfied that for the purpose of teaching working classes generally the lecturing system is quite useless; I adopt what I call the Socratic system. Here again I should differ from other witnesses; with regard to the teaching of theory, I think we can teach theory in day schools, and in elementary schools even, almost as effectively, if not quite as effectively, as they would be able to teach it in the higher class of schools; I adopt precisely the same Socratic system as I call it in the night schools, I bring an object before the pupil, and ask him questions upon it and get him to explain his ideas. They never give me accurate answers in the first instance; they are in general perfectly unable to give me the least description of anything I put before them. Then I put an absurd question, I ask them, for instance, whether the object is a plum-pudding, &c. Then they begin to see distinctly that they ought to be able to describe it in some way, inasmuch as they can see what it is not, and so I lead up in that way to correct primary knowledge; we put different things together by a series of questions till at last we build up the various theories, either in chemistry, or physiology, or other sciences, in fact, I get the theory out of my class before have told it them myself. The nature of the questions depends entirely upon the circumstance and the occasion, but my plan is, that the pupil should build up the knowledge under my direction.

5374. How many hours are you occupied in the morning, and how many in the evening?—The day school devotes three hours to general instruction in the morning from nine to twelve, and in the afternoon two hours, from two to four.

5375. And in the evening?—In the evening we only have for each subject one lesson a week of an hour, but we meet towards the end of the course two hours, and sometimes three hours a week.

5376. Mr. Acland.] Do you consider that the fees paid by your pupils represent the market value of the education which you give?—I scarcely know what would be called the market value of education.

5377. Is it as high a fee as you could get for the

the education which you give?—Education has no market value, in some schools which I could mention, three or four guineas is paid for much less effective instruction than we give.

5378 But as a matter of fact, if you were to raise your fees, should you lose your pupils?—Our present pupils we might lose, but we should get a different class of pupils, we find parents are prepared to send their children to schools where there is a certain amount of exclusiveness, whatever the nature of the instruction may be, but however good the school may be, they will not send the children to it unless there is that exclusiveness.

5379. There is no exclusiveness in your school then?—None.

5380 And you average about 200 pupils?—Yes.

5381. Have you any idea how many boys there are of a similar class in Manchester who might receive the same education?—There are comparatively few.

5382 I mean how many boys do you suppose there are between the ages at which you profess to take pupils, who would be willing to pay about the same rate as is paid at your school?—I could not say.

5383. Should you say four or five times as many?—Thirty or forty times as many, ordinary private schools charge a little higher than we do. I have several times requested the directors to consider the question of raising the fees, in order to enable them to give a more systematic course of instruction.

5384 Are there any schools of a public nature covering the same ground in the town?—There are three or four others, in connection with the mechanics' institute, established on our model.

5385. Does any particular result flow from those schools being connected with mechanics' institutes?—Very many of the parents of the pupils, on removing their children from us, have told us that they did so because they did not like the name of a mechanics' institution, and they would prefer them going to another school with a different title.

5386. Do you think we may reckon on an increased demand for such schools as yours?—No doubt of it.

5387. Do you think it desirable to aim at teaching science in separate institutions, or

merely at introducing a proper amount of information and training in scientific subjects into the ordinary secondary school teaching of the country?—Putting aside the higher science schools, I would say that it would be an advantage to combine the two, and not to separate them, in literary teaching and grammatical composition, why not, instead of taking subjects that have no meaning, cultivate the observation of the child at the beginning, and base the literary teaching, or the teaching of grammar, composition, &c., on the language in which it expresses the results of his observations.

5388 Do you think it is desirable to aim at levelling the ordinary secondary education of the class of pupils whom you teach in Manchester; or do you think there is any case made out for establishing separate science schools?—I think the greatest advantage would be derived from connecting science, as we do, with ordinary education.

5389. I understand you to say, then, you think that the real want of this country is the putting of secondary education on a sound footing?—Yes, but I regard what is called secondary education as involving a mistaken distinction.

5390 What I mean by secondary education is the education of boys who remain at school beyond 12 years of age, and who are past receiving elementary or primary education?—I believe that if boys had a proper course of lessons in object teaching, they would learn even their grammar much better.

5391 Do you think that the main object to be attained is to improve the general secondary education of the country, or that it is necessary to found special institutions for teaching science?—I think both objects are desirable.

5392. Do you think that special institutions should be founded for boys below the age of 14, or do you think that we only want higher science schools, such as Dr Watts has referred to?—For all those below the age of 14 I should unite science teaching with ordinary instruction.

5393. Can you give the Committee any suggestions with regard to the nature of the higher science schools which Dr Watts seems to think are desirable?—I have not thought that subject out nearly so fully as Dr. Watts has, so I would rather abstain from offering any suggestions.

Mr. J. F. ISELIN, M. A., called in, and further Examined.

5394 *Chairman*] You have heard the evidence which has been given before this Committee on the subject of mechanical and geometrical drawing in art schools. I believe you are not an inspector of art schools?—No; I have seen some of the results in some of the art schools.

5395. You have considerable acquaintance with art schools, perhaps?—Hardly, except that there are one or two schools where science drawing has been taught in art schools, and with those I am acquainted.

5396. Do you consider that the mechanical drawing and geometrical drawing taught in art schools is of the same grade as that which is taught in the science schools?—No, I think not, scientifically I do not think that it is equal. The instruction in these subjects in the art schools gives, as it seems to me, merely the power of copying and it is not so thorough by any means as in the science schools, it conveys nothing in the shape of machine construction.

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5397. And, therefore, it would by no means follow that a pupil who would pass in an art examination with respect to that division of the subject, would pass in the same subject in a science examination?—I think not at all.

5398. In fact, there is no parity whatever between the requirements from a teacher of those subjects in an art school, and the requirements from a teacher of those subjects in a science school?—Not at present. I had a fact under my notice in one of the art schools. Not long ago I saw a young man drawing a spur wheel very carefully, and I asked him why he made the teeth curved instead of straight, or of any other form, and he had no idea whatever.

5399. He was simply copying the curved teeth?—He was simply copying what was set before him, the method of finding the pitch of the teeth and the manner of setting off were given in the copy itself, but he had no instructions

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tions by which he could construct a wheel for any given case.

5400. That would apply to art schools generally, would it?—In a great many cases, but I would not undertake to say generally.

5401. Do you think that the teaching of drawing in those schools has a tendency to divert pupils from the more important teaching in the same subject in science schools?—Yes, in a great many instances, where it is proposed to establish classes in scientific drawing, the answer is, "Oh, that is taught in the art school."

5402. And hence you think it would be desirable to withdraw that as a part of the art curriculum, and have it pursued only in science classes?—That is my own idea.

5403. But that would not prevent qualified art teachers from undertaking it as a science subject?—No, certainly not; the more they did so the better.

5404. They would then be also science teachers, and mechanical and geometrical drawing?—Yes.

5405. And that you would suggest as an improvement?—Yes; I would only propose that the two classes of instruction should be kept perfectly distinct in the schools, namely, the science teaching and the art teaching.

5406. In fact, that it should be a mere accident that the art teacher should also be a science teacher in that subject?—Not quite that, as it would be advisable that every art teacher should be able to teach these subjects as closely and accurately as a science teacher; but I would insist that this instruction should be kept distinct from the ordinary art teaching of the school.

5407. You are acquainted with the Minutes which have been issued in connexion with Mr Whitworth's scholarships, no doubt?—Yes.

5408. And you have also considered the Minute of last year, abolishing examinations for teachers' certificates?—Yes.

5409. With regard to those two subjects, is there any course which has been under the consideration of your department for establishing a higher grade of examination in May, so as to avoid the expense which, I believe, has led to the abolition of the examination for teachers' certificates?—Yes; I think there is a scheme under consideration now which perhaps will be brought before the examiners shortly; namely, whether it would not be possible to institute a third honours paper, at the May examination, for the purpose of giving increased facilities for determining exhibitioners and medallists, and also for giving the teachers, if they wish it, the option of attaining a higher grade, something equivalent to what the certificate was before.

5410. Is it your own opinion that it should be optional whether he took that higher grade or not?—Yes; that is my own opinion.

5411. Would you attach any pecuniary advantage to passing in that higher class?—No, I think not.

5412. You would make it solely an honorary distinction?—Solely an honorary distinction; the same as the certificate was before, only the certificate was compulsory.

5413. It gave a title to payment at one time?—Yes.

5414. And you would attach no payment to this new distinction?—I think not.

5415. You heard the evidence of Dr Watts, and you must have also been struck with the absence of science schools in many localities; can you account for this absence at all, and can you

suggest any remedy for it?—I can only account for it from the want of interest which the middle classes and manufacturers generally have taken in the subject of scientific instruction. Until the Paris Exhibition and Dr. Lyon Playfair's letter we heard very little on the subject of technical education; and now, when there is a little more excitement about it, they begin to make inquiries, and are astonished to find that the Government is really in advance of public opinion. How that state of things could have been remedied before I do not see, and I cannot agree that the Government should take on itself the character of a propaganda.

5416. Do you believe that there are large districts in which the operations of the Science and Art Department, with regard to science classes, were, until lately, entirely unknown?—Yes, I believe so, there is one instance at Newcastle, which I can bring before you at once. About three years ago we had in Newcastle a very large and good class in chemistry, but the teacher left, the class died out, and no one took any trouble to resuscitate it.

5417. Inasmuch as the Government are prepared to pay for science teaching, why do you think they should not also take some trouble to make it known that they are willing to pay for it?—I think they have done as much as is possible in that way.

5418. You mean that they have published in every direction, as far as possible, the advantages which the department is prepared to offer?—I think so; for instance, with regard to those new scholarships, there have been no fewer than 40,000 circulars issued to the educational and mechanics' institutes in this country.

5419. Do you mean with regard to Mr. Whitworth's scholarships?—No, the science and art scholarships, the local scholarships under the Minutes of last December, and I hope we shall see some good effect from issuing those circulars.

5420. Mr. Louther.] When were those circulars issued?—About two months ago.

5421. Chairman.] But they were not issued at the time when the Minute was passed?—Not exactly at the time.

5422. But after an interval of four months, and at about the time when this Committee was appointed?—I think that it was about the time when this Committee was appointed, but there was no connection between the two occurrences.

5423. You yourself cannot suggest any other means of making the Government offers more generally known?—I do not see my way very clearly to doing it more effectually, though I see the advantage which might follow from the department scheme of scientific instruction being more generally known.

5424. You do not think it is desirable that the secretary of the department should appear in the lobby and communicate with Members of Parliament as Dr. Watts proposed?—I am afraid that would hardly do.

5425. Mr. Louther.] Why should not the Government take upon itself the character of a propaganda?—I do not recollect that such a course has ever been pursued before by a Government department.

5426. But perhaps there never was so great a necessity for it as in this instance, if the necessity is there?—I should rather be inclined to think that the Government is in every case compelled to wait to a certain extent for local action, just as when the Government makes a grant of money it

is supposed that there is, first of all, a want shown to exist. It is hardly my idea that Government should both create the want and pay for the supplying of it besides

5427. The Newcastle science school, you say, has ceased to exist, because the teacher left the town?—The class in chemistry, held at the Newcastle Mechanics' Institute, has ceased to exist on that account.

5428. Was that matter inquired into?—I never heard that any attempt was made to revive it, or that the inhabitants ever took any interest in the class.

5429. There never was any idea, on the part of the department, of sending another teacher there?—Not that I am aware of.

5430. Mr. Acland.] With reference to the two kinds of drawing of which you have been speaking, did I understand you to say you thought that art drawing ought to be separated from some other kind of drawing?—What I said had reference to the case where an art master gave instruction in science drawing

5431. What are we to understand by science drawing?—Among the subjects taught under the Science Minute, there are three subjects in drawing: geometrical drawing, machine drawing, and building construction, and those we call science drawing

5432. As this evidence will be read by other persons besides the Committee, will you oblige me with a common-sense explanation of the difference between the two kinds of drawing?—I should describe scientific drawing as conveying a knowledge of the principles of construction, requiring, to some slight extent, an acquaintance with mathematics, art drawing, on the other hand, requires the power of the free use of the pencil, and rests mainly on the capability of copying

5433. It has nothing to do with the drawing of scientific subjects, such as the bones in physiology?—No; it is what the French call linear drawing.

5434. Drawing by means of mechanical instruments?—Yes

5435. It has no connection with artistic drawing at all?—It is taught in the art schools, but more in the way of copying than otherwise.

5436. Your object is entirely to separate the acquisition of drawing, as an aid to manufacture, from drawing as a matter of art?—Yes

5437. But do you not think that the general power of expressing form, as every artist must express form, is important for machine drawing, or for what you call science drawing?—With regard to free-hand drawing by the pencil I should say not.

5438. You do not consider the power of what is called free-hand drawing a necessary part of drawing for manufacturing purposes?—For construction I should not call it necessary.

5439. I think you say that the tendency of mixing the two kinds of drawing is to drive the pupil away from that which may be useful to him as a practical art in connection with his trade, or with his pursuit in life, into that which is purely artistic?—Yes; to produce rather a picture than a piece of construction.

5440. *Chairman.*] What you mean is that the pupils fancy they have learned constructive drawing when they really have not learned it?—I think so

5441. Mr. Read.] But surely a knowledge of

free-hand drawing would materially assist in science drawing?—I would not deprive the artisan of free-hand drawing by any means, for it would certainly be an assistance to him

5442. Mr. Acland.] Do you think that any kind of what you call scientific drawing for constructional purposes would be a complete instrument in a man's hands if he had no power of expressing fairly any object whatever which he saw?—No, I should not call it a complete instrument; but it would be a more complete instrument than the mere power of copying.

5443. The scientific drawing which you want to promote implies some knowledge of projection?—Yes

5444. Some fixed principles of a more or less mathematical kind?—Yes.

5445. Can you communicate that knowledge without mathematics?—Yes, in some measure; and I have had occasion to observe that it supplies, to a considerable extent among workmen, the place of what mathematics are to a more educated class

5446. *Chairman.*] It is, in fact, a species of practical geometry?—Yes.

5447. Mr. Acland.] But can you give the power of drawing in a satisfactory way, so that a person can use it when he wants it without communicating some knowledge of practical geometry as a basis?—No; practical geometry is a basis of the whole.

5448. The drawing itself must be an unreal thing unless there have been some sound geometrical teaching, either practical or theoretical?—Yes

5449. *Chairman.*] That is the distinction between the drawing taught in the science schools and the drawing taught in the art schools?—As I understand it

5450. Mr. Acland.] I understand the art masters feel that in their present position they cannot teach science?—I think it is a question which rests entirely with themselves

5451. With regard to propagandism, the position taken up by the Science and Art Department is exactly the same as that which is taken up in other branches by the Committee of Council; namely, that they aid local effort, but they are not responsible for setting it going?—Yes

5452. And, on the whole, you think that system the best?—Whether it is the best or not I can hardly say; but I do not see how the department can take any originating action

5453. Are you disposed to think it is desirable that the Government should take upon the Consolidated Fund the expense of the ordinary science teaching over the whole of the country, in the way of paying fees for the results of teaching?—I think not

5454. You do not think it advisable that the Consolidated Fund should be charged with the expense of paying teachers to instruct working men (foremen and others) the arts by which they will eventually earn money?—My own idea is that it is not; it is not done in foreign countries, and the Report of the French Commission is quite against it, they wait for local action before they supplement it by Government aid

5455. You think the proper province of a Central Government is rather to organise and inspect than to bear the expense?—Yes; I apprehend that the whole of our educational system has hitherto been carried on upon that principle.

Mr.
J. F. Iselt
M.A.

15 June
1868.

Thursday, 18th June 1868.

MEMBERS PRESENT.

Mr. Acland.
Mr. Akroyd
Mr. Bagnall.
Mr. Bazley.
Mr. Dixon
Sir Charles Lanyon.

Mr. Wilham Lowther.
Mr. M'Lagnn
Mr. Edmund Potter.
Mr. Powell
Mr. Samuelson.

BERNHARD SAMUELSON, Esq, IN THE CHAIR.

Professor HENRY E. ROSCOE, F.R.S., called in, and Examined.

Professor
H. E.
Roscoe,
F.R.S.
18 June
1868.

5456. *Chairman.*] I BELIEVE you are Professor of Chemistry at Owens' College, Manchester?—I am

5457. Can you tell the Committee what was your own course of education in science?—I was educated at the University College, London; I graduated in the University of London with an arts degree, the science degree not having been then founded. In order to complete my scientific education I went over to Heidelberg to study under Bunsen, the celebrated chemist, and spent several years with him working at original investigations.

5458. Did you take any other subject besides chemistry?—Yes, I attended many other courses of lectures, and worked in the laboratory, which was my special department, I attended lectures on chemistry, physics, crystallography, and other subjects connected with the science of chemistry.

5459. Have you much knowledge of the scientific instruction which is given on the Continent?—With the German university system I am acquainted, and I know something of the Polytechnic schools.

5460. *Mr. Potter.*] And you keep up a correspondence with the principal professors of chemistry on the Continent, do you not?—I do; most of them are my personal friends.

5461. I believe you visit Heidelberg annually?—I do; almost every year I visit the Continent.

5462. You are also a Fellow of the Royal Society, I believe?—I am

5463. Will you kindly give us a short statement of the nature of the institution with which you are connected?—In the first place, I have been connected with Owens' College, Manchester, since the year 1857-8. Owens' College was founded by the bequest of Mr John Owens, merchant, of Manchester, who, dying in 1846, bequeathed the larger part of his property, amounting to nearly 100,000 *l.*, to "trustees, to found an institution for providing or aiding the means of instructing or improving young persons of the male sex (and being of an age of not less than 14 years) in such branches of learning and science as were then, and might be thereafter, usually taught in the English universities."

5464. What are the numbers of the students who have been educated at that institution since the commencement of the year 1851?—Since 1851 the number of individuals who have passed through that college is 780 in the day classes.

5465. Will you give the Committee a short statement of the comparative numbers at one or two periods?—Taking the day students at the most important branch of the college in the first two years, the average number was about 65. Then, taking the middle period, the year before I was connected with the college, in 1856-7, the numbers amounted to 33, and taking this session, the numbers have risen gradually up to 173, which is the highest number we have had.

5466. There has been a large increase in the numbers during the last and present sessions, has there not?—There has been an increase of over 50 per cent. this last year.

5467. That is compared with the previous session, I suppose?—Yes; the numbers last session were 113, and the numbers this session are 173.

5468. To what do you attribute the very rapid rise within the last 12 months?—I attribute it to the gradual knowledge, among the mass of the people in our district, of the existence of such a place for high instruction. It takes a long time for such an institution to take root, but it has taken root, and the advance will be rapid.

5469. Do you consider that the condition of Owens' College at the present time is satisfactory, and that Owens' College may be taken as a fair sample of what a science school should be?—Yes, I think so, it is certainly working very well now, and, although we at Owens' College are not confined simply to a science school, I think that the department to which we give the name of the science department may be taken as a fair sample of what is needed.

5470. Will you kindly give the Committee the number of individuals who have passed the day classes?—The total number of day-class students has been 780. I cannot give you the number of the evening students who have passed. I have a statement of the numbers of those who attend the evening classes, and I may say, since the foundation of the evening classes

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in 1852, the number has increased from 28 to 324, which is the number attending this year.

5471. *Chairman*] Will you state what you mean by pupils having passed your classes?—I mean simply those who have attended some of the classes or lectures given in the institution.

5472. *Mr Potter*] The day classes are the most important, I presume, because they are the most complete?—The day classes are the most important and much the most complete.

5473. Have you a statement of the average cost of instruction in the day classes?—The total amount of fees received from the 113 students who attended during the last session was 1,734 *l.* 5 *s.* 6 *d.*, a little over 15 *l.* per head.

5474. Is that the cost of a thorough course of instruction?—It is.

5475. Does that include the laboratory course of instruction?—Those fees include the laboratory course, but, of course, the fees of those students attending the laboratory would be somewhat heavier than for the others, therefore they increase the average.

5476. Will you give the Committee the cost to a student for the chemical laboratory course?—The fees for the laboratory course are arranged according to the time the student desires to remain there, if he is there six days a week the fees are 21 *l.*, and if only one day a week five guineas, with intermediate amounts for other times of attendance.

5477. Then as to the cost of materials, how is that borne?—That is paid partly by the professor and partly by the students, a certain number of the re-agents and chemicals are found by the professor, and the students have to furnish the others for themselves.

5478. Then with regard to the evening classes, what is the expense to the students in those classes?—The fees received for the evening classes attended last session, for 280 students, amounted to 364 *l.* 12 *s.* 6 *d.*, or about 26 *s.* per head.

5479. What are the fees, taken separately?—Fifteen shillings for a course of 20 evening lectures, delivered once a week during 20 weeks. The evening session is in the winter.

5480. Do you consider that amount of fee is any bar to the increase of the classes?—To judge from the number we have had I am inclined to think not. I think that, for the class of persons who attend, the fee of 15 *s.* for the evening instruction is not too high, though, of course, a lower would admit, probably, a different class.

5481. What is about the age of the students attending the day classes?—In the present session 32 of the day-class students are above 14 years of age and under 16; 58 are above 16 and under 18, 36 are above 18 and under 21, and 46 of them are above 21; so that the average age would be about 18.

5482. Now, will you give the Committee the ages of the students in the evening classes?—In the evening classes we do not register the age, but the average is very much higher than that of those in the day classes, they are generally adults.

5483. Will you now give us the social status of the students in the day classes?—One-half of them are the sons of manufacturers and merchants, or what we may term the higher classes, one-fourth of the students are sons of professional men; one-eighth are the sons of traders and shop-

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keepers, and the other eighth we do not know the status of.

5484. Will you now give the same information with regard to the position of the evening students, as far as you can do so?—The great majority of the members of the evening classes are young men employed during the day in warehouses and manufactories, not a few of them are teachers in primary and other schools, some are foremen, and a few are artisans.

5485. Can you give the proportion of those whom you call artisans?—I should say the number is very limited.

5486. Are they chiefly adults?—They are.

5487. Your college is, I think, associated with the University of London?—We are associated with the University of London.

5488. Your examinations are conducted by the highest class of examiners; namely, those of the London University?—Yes, the University of London is probably the highest body of examiners, in science especially, in the kingdom.

5489. How many of the students have passed the matriculation examination?—About 140 have passed the matriculation examination at that university.

5490. That is to say from the beginning?—Yes, probably three-quarters of them were day students, and one-quarter evening students.

5491. The evening students were perhaps in the latter period of the college?—Yes, no doubt.

5492. Perhaps you would consider that proportion of one-quarter rather remarkable?—Yes.

5493. They perhaps not having had any previous regular education?—Many of them had not.

5494. Were any of those from the artisan class, or the class above that?—I believe there have been some cases of artisans going in, for matriculation and going in for a degree. One I know, has gone to Oxford, and I believe he has taken, or is about to take, orders.

5495. You would call him an artisan student who had passed the examination at Owens' College?—Yes.

5496. Was his degree taken in science?—No; it was in art, it was before the science degrees were instituted. About 70 of those 140 have proceeded to higher examinations for the degrees in the University of London.

5497. What comparative success have the Owens' College students had in the University science examination?—I think, if we look at the London University calendar, we shall find that the students from Owens' College have taken a very high position. I may say that no students of any other institution in the kingdom have taken a higher position. At the first bachelor of science examination in July last, out of 17 who passed, four belonged to Owens' College, and three of them were in the first division. In the honours examination our students gained first places in mathematics and mechanical philosophy, and first, second, and fourth places in chemistry and natural philosophy, and the first and third places in biology. Again, in the second or final bachelor of science examination in October last, out of 10 who passed, three belonged to Owens' College, one in the first division; and at the succeeding honours examination our students won the first and third places in chemistry,

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Professor
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18 June
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Professor
H. E.
Roscoe,
F.R.S.
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16 June
1868.

chemistry, the first in botany, and the second and fourth in geology.

5498. Referring again to the artisan students, more particularly those in the evening classes, does your class of students differ much from those in the Scotch universities, that of Glasgow more particularly?—I believe our day classes differ considerably from those at the Scotch universities; there is a much larger proportion of poor students in the Scotch Universities: but in the evening classes I should say probably the class of men was somewhat similar; at all events, those that are educated at the Andersonian University in Glasgow.

5499. But a lower rate of fees is charged in Glasgow, I suppose?—Yes; I believe the fees in the Scotch universities for the classes are lower.

5500. And the students to a great degree come from a lower class in life than they do at your institution in Lancashire?—No doubt. That is not wholly, perhaps, to be attributed to the difference in the fees, but also to the fact that Glasgow and Edinburgh Universities have been founded for a great many years, and it is a point of pride for the poor Scotchman to send his son to a university.

5501. Have you any doubt, from your knowledge of the Lancashire people, that if Owens' College be largely extended, and greater facilities afforded, the demand from that class might be expected to be equally large, or perhaps larger than at Glasgow?—I believe that would be so.

5502. The students at Manchester are not all drawn from Manchester, but from the South Lancashire district generally, are they not?—Yes, from the whole district, we may say that at Manchester we are the centre of an immense district, with a population of about 5,000,000.

5503. A considerable average of your students do come from the surrounding districts, do they not?—Yes, from the neighbouring towns; I think very nearly half of them do not reside in Manchester itself.

5504. More particularly those who attend the science classes come from neighbouring districts?—Yes, more particularly those who attend the science classes.

5505. A larger proportion come from the neighbouring districts than from Manchester, I suppose?—It is about half and half.

5506. *Chairman*] I suppose you have students from Cheshire and Yorkshire?—Yes.

5507. *Mr. Potter.*] What are the funds at the disposal of the college; what is the total income?—The amount left by John Owens was about 100,000 *l.*, and that brings in an income of about 3,000 *l.* a year; besides that, since the foundation of the college, about 20,000 *l.* has been left in benefactions of various kinds, for the purpose of founding scholarships, and for the purpose of building the laboratory in which my students work. In addition, the students fees attending are about 2,000 *l.* a year; that gives a total income of something like 6,000 *l.* a year. I should state that the staff of professors consists of the principal, Mr. J. G. Greenwood (Fellow of University College, London), who also holds the professorship of Latin and Greek; Mr. A. W. Ward (Fellow of St. Peter's, Cambridge), who is professor of the English language and literature, and ancient and modern history; Mr. Thomas Barker (Fellow of Trinity College, Cambridge),

professor of mathematics; Mr. William Jack (Fellow of St. Peter's, Cambridge), who is professor of natural philosophy; Mr. Stanley Jevons, M.A., who is professor of logic, mental and moral philosophy, and political economy; Mr. R. C. Christie, M.A., jurisprudence; myself, chemistry; Mr. W. C. Williamson, F.R.S., natural history; and Mr. T. Theodores, who is professor of Oriental languages and literature, and modern languages and literature. Besides those, there are several teacherships attached to the college, and an assistant lecturer.

5508. Those gentlemen forming a very high class staff of professors, you would say there was no difficulty in attaining a very high standard of success in the county for Owens' College?—I believe none whatever.

5509. Will you kindly state your opinion with regard to the special need of the South Lancashire districts for a high class of scientific instruction?—I should say that, apart from the value of scientific instruction for general intellectual culture, which, perhaps, is the most important, the district of which Manchester is the centre, has special need of a high class of science instruction, inasmuch as a great portion of the national industry there carried on is founded on scientific principles and laws. A knowledge of those laws and principles is, in the first instance, necessary, in order that such industry should flourish and grow. Manchester happens to be the great centre of the largest chemical trade in the kingdom, namely, the manufacture especially of alkali and soda ash; the value of the articles manufactured in this trade amounts to 1,000,000 *l.* sterling per annum; the total value of the alkali trade of Great Britain being estimated at about 2,000,000 *l.*; the other half of the trade being situated in the Tyne district.

5510. Taking the large chemical manufactures which would be included under the heads of dyeing, calico printing, and the rest, how would you estimate their value?—I have made some inquiries about that, and I believe it would come to something like 400,000 *l.* or 500,000 *l.* per annum.

5511. That being carried on chiefly in the neighbourhood of Manchester?—Yes; I was about to proceed to say, that in those chemical works there is a great need of well-trained chemists, who are wanted, in the first place, to carry on the improvements which are daily being made, and especially for determining the strength and value of each chemical product which is sent into the market, the quality of each article has to be guaranteed, and for this purpose duly qualified chemists are needed. I may mention, as an instance of the improvements which science is every day making in these trades, the question of the regeneration of the sulphur in the alkali-maker's waste; this has been a question of enormous importance; the sulphur which is required in the manufacture of alkali has been, up to this time, all thrown away, remaining in heaps, not only useless, but detrimental. But now a method has been introduced, by a German chemist, who is employed at several large works in the neighbourhood of Manchester, by which he has succeeded, to a great extent, in obviating the difficulties which were previously felt in dealing with the sulphur, and he can now regenerate it.

5512. *Chairman*] By regenerating, you mean recovering it?—Yes; by bringing it into a con-
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dition in which it can be used over and over again.

5513. Mr. Potter.] Did that gentleman come to England with that knowledge in his possession, or was it discovered after he was in this country? —I believe the process was worked out here, but he had previously received a scientific education in Germany.

5514. Practically, however, he had not carried out that process?—No.

5515. And the district of Manchester afforded every facility for making his experiments, and the prospect of a large reward if he succeeded? —Yes, his previous scientific education enabling him to grapple successfully with the difficulties of the question. In each of those chemical manufactures a chemist is needed. Within the last few years manufacturers have very frequently employed young Germans for this purpose, now, however, many of the students from the laboratory of Owens' College have taken positions which the Germans had been accustomed to take in the district, and several of them occupy positions of trust in various works in South Lancashire, so that now applications are not unfrequently made to me to furnish to manufacturers young men capable of taking such positions. Only last week a gentleman asked me to send him a qualified young man to take the position of chemist in his works, where he would begin with a salary of 100 *l.*, with the chance of rising to the position of a partner in the end.

5516. Do many of the foreigners who have availed themselves of the opportunities of your position and your laboratory come here with the object of obtaining information as to the working of English manufactures in your district?—I have had several cases of foreign gentlemen who have come, not solely to learn chemistry but to live in the district, and to use any opportunities which might fall in their way of visiting our works in England.

5517. Not with the view of ultimately settling in this country perhaps; but with a view of going back to the Continent to carry out the manufacture?—Some stay here and some go back.

5518. Of course a good many English young men of the same class go to the Continental universities for the purpose of obtaining a scientific education as well, perhaps, as to acquire some knowledge of the manufactures of the Continent?—Yes, they go to study science here.

5519. Did I understand you to say that the salary of a young chemist is about 100 *l.* a year to begin with?—I think he would very likely commence with a sum like that.

5520. Is there any scarcity of the supply of that class of young men?—Gradually we are beginning to look for this class of assistance to Englishmen, but, up to this time, such men have been Germans to a great extent.

5521. The Germans come perhaps, from a lower class than the same kind of people in this country, or at least they have been more cheaply educated?—They have been more cheaply educated, and perhaps more thoroughly educated, because the facilities for education are much greater in Germany than they are here.

5522. Should you consider that a salary of 100 *l.* a year was at all equivalent to the cost of the education of such a young man in your district?—It is 100 *l.* a year to begin with, with the

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chances of success afterwards. I look upon it as a kind of mere stepping-stone to the position which a man may afterwards attain than as a remuneration which could be called equivalent for what he had spent on his education.

5523. Chairman.] But is it the case that many of the chemists in the neighbourhood of Manchester, and in the chemical works elsewhere, are receiving much larger salaries than 100 *l.* a year? —Yes, very much larger.

5524. They simply enter at 100 *l.* a year?—They simply enter at 100 *l.* a year, and they are paid more afterwards.

5525. Mr. Potter.] Is not something of the same kind the case with respect to knowledge of all kinds that has a commercial value?—Yes, no doubt, but I should say that, in the case of a young chemist, the position which a young man who is active and wide awake might ultimately attain would be better than any which would usually be open to any mere aspirant in a commercial house.

5526. With regard to classes in technological chemistry; do you visit with your pupils the chief chemical manufactories of the district?—Yes; I constantly take them round to inspect the works.

5527. And you have no difficulty in getting permission to inspect them, have you?—Not the least.

5528. There is no jealousy shown?—No, except perhaps in one or two special cases.

5529. What means have you for encouraging the study of chemistry in the higher branches as connected with Owens' College, Manchester?—We have what we term our Dalton scholarships, which are the result of a subscription of 4,125 *l.* for the foundation of scholarships, two of which are appropriated to chemistry.

5530. By subscriptions you mean local subscriptions?—Local subscriptions; for them we get 50 *l.* a year, which is given every year, to be held for two years, and the condition upon which the scholarship is held is, that the student shall have conducted in the laboratory of Owens' College researches upon some original scientific subject.

5531. And shall have passed a certain examination, of course?—Yes, but the chief examination is the practical work in the laboratory.

5532. How often has that scholarship been taken, and what was the date of its institution?—It was instituted in 1857, and it has since then been taken seven times by various students.

5533. Can you mention the station in life of any of the students who have taken it?—Some have been the sons of chemical manufacturers; one was the son of an optician, another was the son of a Dissenting clergyman; another man was son of a chemist and druggist in the town, another was the son of a gentleman in business.

5534. What are the present positions of those students?—One of them is one of the inspectors under the new Alkali Act, several of the others are carrying on chemical manufacturing businesses on their own account, or in large houses, others are in calico print-works; one has taken the degree of doctor of science in the London University, which is the highest scientific degree in the country, and is now science master at the Manchester Grammar School—that is, Dr. W. M. Watts.

5535. That is the first appointment which the Manchester Grammar School has made for the purpose of teaching science, is it not?—It is the first appointment which the Manchester Gram-

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Professor
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1868.

mar School has made for that purpose, and they are now carrying on the teaching of science on a very extensive scale; this student of mine having been appointed science master there.

5536 What is the value of that appointment to him?—I think they give him 250 l. a year.

5537. Are there scholarships also on subjects connected with economical science?—Yes; in 1865, Mrs. Elizabeth Shuttleworth, of Manchester, founded, and endowed with the sum of 1,250 l., this scholarship, the object for which the scholarship was founded being the promotion of the study of political economy. The first competition took place in October 1866, the competition is open to all persons who have been students at Owens' College, either in the day schools during not less than two consecutive sessions, attending not fewer than three classes in each session, of which in one session the class of political economy shall have been one; or in the evening classes during not less than three consecutive sessions, attending not fewer than three classes in each session, of which in two sessions the class of political economy shall have been one.

5538. Is there not a second Cobden scholarship?—There are two prizes of the value of 10 l. and 5 l. to be competed for by all masters in primary schools receiving aid from Government or the public. These persons can attend the political-economy class free of charge under the Cobden endowment. There are also other scholarships in other subjects, for instance, in classics and mathematics

5539. What are their values?—There was 500 l. given for the foundation of the Wellington scholarship for Greek Testament, and 500 l. for the foundation of a Victoria scholarship for classics, and also two Dalton mathematical scholarships of 25 l. per annum.

5540. Those are all arising, I suppose, from private subscriptions?—From private subscriptions.

5541. I presume you would consider the training of science teachers one of the most important functions of a science college like Owens' College?—I think at the present time that is the great work which we, in the science department of the college, have to do; and I think that that alone would be a return for the endowment of such colleges. I mean that, if that were their whole occupation, the endowment would be well spent.

5542. Is there a great unsupplied demand for such teachers in your district?—There is a very great demand, which, in my opinion, will every year increase

5543. And you think the older universities alone cannot supply that class of teacher?—No, they certainly cannot, the cost of education at the older universities would be far too great; besides which, it appears to me that we must have local colleges to supply the wants of different districts in that respect

5544. You would perhaps except Glasgow?—Yes, I was speaking solely with an eye to Oxford and Cambridge, in order to raise up such teachers, I think you must have them taught in the locality in which they are to be occupied.

5545 Where they would acquire a more practical knowledge of the wants of the district?—Yes

5546. You referred to the success of Dr Marshall Watts at the Manchester Grammar School, have you any instance of men from the artisan class struggling upwards to qualify themselves as

science teachers?—Such examples are, of course, rare at present, but one, especially, I can refer to. Some years ago, a number of us started in Manchester a working man's college, somewhat on the basis of Professor Maurice's Working Men's College in London. We got a great number of men to attend, and among them was a young hand in a cotton mill, who proved himself to be very intelligent, though he could scarcely write. He got a prize which we gave in the class that he attended, and he became, in the course of time, more intimate with me, and since then he has qualified himself for a science teachership, has passed the Government examination, and has continued to give instruction under the Government Science and Art Department, and I believe he was in one winter the most successful teacher in the whole of England. He now holds a position in the works of a gentleman who is to be the next witness; he attended my laboratory for several sessions, of course only when he could get away from his other employment, his employer allowing him a certain number of days in the week to come to me for the purpose of continuing his scientific education.

5547. What education he did obtain was almost afforded to him free, as he could not afford to pay for it?—Just so.

5548. Do you not think that a good many more of such men would be likely to show themselves if education were raised to its proper rate in a district like that of Manchester?—I think it is exceedingly important that some means should be afforded for men of superior intelligence, like him, to rise from the artisan class to a higher level.

5549. By giving them what is almost free education?—Yes.

5550. You have spoken of the establishment of science colleges; how do you think such scientific colleges ought to be supported, do you think the fees paid by the students would at all suffice for keeping up such colleges?—Certainly not. In the present state of education, it is quite impossible that the fees should support such a high-class science school as it is absolutely necessary to found, if any were founded at all, namely, schools similar to the German Universities, or the Polytechnic schools. If such schools were not endowed, and were dependent alone on the fees, it would be quite impossible to get first-class teachers who would devote themselves to the work. To take our own example, for instance, we have an endowment of 3,000 l. per annum from the Owens' trust, and that, upon the scale on which we now exist, enables us to live; and in our teachers we have the pick of the university men, senior wranglers and others of the highest class in the university, when we want to get our professors from the university

5551. Have you any objection to state the emoluments attached to the different professorships in your college?—I can give it approximately, I think

5552. What is the highest sum paid to any professor, speaking now of a fixed salary?—The highest sum which is paid to a professor, qu

5553 What is the next lowest?—It goes down as low as 150 l. Then there are the fees which very often amount to much more than that

5554. The fees attaching to some of the chairs are very small, are they not?—Sometimes the

fees are small, and to other chairs they are considerable.

5555 What is the value of your own chair?—The salary which they give me from Owens' trust is 150*l* a year, but the fees amount to considerably more

5556 *Chairman*] Have you any objection to state the total amount of your income from Owens' College?—The amount of my gross income from Owens' College is between 700*l* and 800*l* a year; but out of this I have to defray certain expenses, which amount to a considerable sum

5557 *Mr Potter*] And that sum includes both the value of your chair and that of the fees?—Yes

5558 Will you kindly give the Committee the extent of your class compared with that of other chemical classes in England, taking, for instance, the classes in Glasgow University, and perhaps the London University?—I will hand in a Paper showing the number of students attending the classes in Owens' College in chemistry from the commencement up to the present time, taking the present year, I have had 44 students in the laboratory. I have had 76 students in my junior lecture class, 16 in my senior lecture class, and four in the extra class; making a total in the chemical department of 140 students

5559 Is there any other larger class in Great Britain than yours?—There are several larger classes of lectures, owing to the fact that we are not connected with a medical school, almost all the professors of chemistry elsewhere, except the one in the Department for Science and Art, at Jermyn-street, have medical students. At Edinburgh, Dr. Lyon Playfair has a class of 200 medical students, but I do not think there is anyone who has a larger number of students in his laboratory than I have, or so large a number, certainly the only one who has a number equal to my own is Dr Frankland, who has a laboratory at the School of Mines.

5560 Is there any other chair of Chemistry so poorly paid as yours?—I am afraid there are some

5561 What is the value of the Chair of Chemistry in Edinburgh?—The Chair of Chemistry in Edinburgh is, I believe, worth about 1,300*l* a year; but there are expenses which have to come out of that

5562 What is the worth of the chair at the School of Mines?—I do not know what the fees amount to. I think that each lecturer at the School of Mines has 200*l* a year endowment, and then fees besides.

5563 *Chairman*] With regard to the Professorship of Natural Philosophy, can you give an approximation to the emoluments of that chair at Owens' College?—I think the emoluments are about 500*l* a year, the fees being perhaps 150*l*, the endowments 350*l*

5564 When you gave the number of 140 in connection with your class, did you mean to convey to the Committee that there were 140 separate individuals attending your courses, or would some of those be entered under different heads?—That did not consist of individuals, there were about 100 separate individuals, some of the 140 being counted twice in that number

5565 *Mr Potter*] Your present funds in Owens' College are quite insufficient to enable you to extend it without further aid, are they not?—Yes. I am not in the secrets of the trust. 0.72.

tees, but I know that we have no money to spare, all that we have, and, I think, more than we have, is used at present.

5566 And you consider your laboratory is quite insufficient for the working out of even what you have now?—Our accommodation is exceedingly limited. For the other departments of the college we have only an old building, a dwelling-house, which formerly belonged to Mr. Cobden, which was bought and presented to us by one of the deceased trustees. It is totally inadequate to even the present wants of the institution

5567. You are acquainted, I suppose, with the laboratories on the Continent, and more particularly that which at Berlin is now in process of erection?—Yes, I know many of the laboratories on the Continent, and they are infinitely superior to any one we have at work at present in England.

5568 *Chairman*] Have you a private laboratory at Owens' College?—Yes

5569 Is that laboratory very luxuriously installed?—It is a very small and disagreeable place

5570 *Mr Potter*] Great efforts are being made by your college now for the establishment of an engineering chair by subscription among engineers themselves, is not that so?—It is so; and I will hand in a Paper which is the draft proof of a prospectus of our department of civil and mechanical engineering, which has just been founded. The subscription was to be 10,000*l*, of which not quite the whole has yet been got among the engineers in Manchester and the district. One firm subscribed no less than 3,000*l* to that fund

5571 Will you state the name of that firm?—It is Messrs Beyer, Peacock, & Company.

5572 *Chairman*] Can you state what is the amount of the donation?—The firm gave 3,000*l*

5573. Does it not amount, in fact, to a donation of about 250*l* a year, in addition to the subscription?—Yes, I think he promises as much as that

5574. For a lengthened period?—Yes

5575 *Mr Potter*] Can you state the details of the proposed course of instruction for engineers?—I will put them in

5576. Has not the college made provisions for carrying out Mr Whitworth's scheme of exhibitions for engineering?—Yes, Mr. Whitworth has given us seven exhibitions of 25*l* each, which have been placed at the disposal of trustees of Owens' College, for the purpose of preparing candidates for the coming examination in Whitworth's scholarships in May next. I will lay before the Committee a Paper giving an account of the mode in which we propose to deal with those seven exhibitions. In the first place, "candidates must not be younger than 16 years on the 5th October 1868, nor have been older than 25 years on the 1st May 1868, in the second place, successful candidates will be required to satisfy the trustees of Owens' College, that they will present themselves as candidates at the competition for the Whitworth scholarships in May 1869. Of the seven exhibitions (A), two will be awarded in June 1868, by selection of the principal and professors, to the two best amongst the sufficiently qualified students of the college of the session 1867-8, either in the day or evening classes, who shall declare themselves willing to hold the exhibitions on the conditions announced.

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(B), two will be awarded, also in June 1868, by selection of the principal and professors, to the two best amongst sufficiently qualified artizans (working for wages), who shall be recommended as fit candidates by the heads of the principal engineering workshops in and around Manchester." I may state here, that this circular has been sent round in great numbers in and near Manchester, to the principals of the workshops, asking them to send in lists of artizans willing to take those scholarships." (C), the three remaining exhibitions, together with any not awarded under (A) and (B), will be offered in competitive examination in October 1868, open to all persons, whether previously students in Owens' College or not." Then we propose, that under the heads (A) and (C), for those that are not artizans, "the exhibitions shall be awarded to those candidates who shall have shown the greatest proficiency in some or all of the following subjects: arithmetic, geometry, algebra, natural philosophy, elementary mechanics, and heat; elementary chemistry (inorganic), drawing, geometrical and mechanical, machinery and tools."

5577. Under the heads (A) and (C) they need not necessarily be artizans, but the scholarships are open to artizans?—Yes; under the head (A) they must have attended the college during the last session.

5578. The evening classes?—Either the day or evening classes. We make it essential that those persons who pass under the heads (A) and (C), that is to say, those who are not artizans shall be required to attend the day classes in the session of 1868-9. We had a good deal of discussion on the question, whether we should make attendance on the day classes a *sine qua non* ; but we felt that it was impossible for the persons to qualify themselves in a proper manner by simply attending the evening instruction, and as our object was to get the largest number to those scholarships for our college next May, we determined to adopt the above plan.

5579. *Chairman.*] You refer now to those to whom you shall have previously awarded the 25 l. exhibitions?—Yes; we necessitate their attendance on the day classes, in order that they shall compete successfully at the May examination for the scholarships.

5580. *Mr. Potter.*] Under that rule it would hardly be probable that any artizan would take an exhibition?—It would not be very likely, I think, though it would be possible. Then we propose that the candidates under the other class, who may be artizans, shall be allowed to attend the corresponding evening classes; but if they choose to attend the day classes, we, for our part, will forego the fees, and give them their instruction for nothing.

5581. You state that your present funds do not permit of the extension of Owens' College to meet the requirements of your district, especially in science teaching?—Certainly not.

5582. Have you taken, in conjunction with the professors and the committee in Manchester, considerable pains to procure funds for the extension of the college with respect to buildings and teaching staff, in order that you may be able to supply the deficiency in regard to the wants of the district which you have referred to?—Yes.

5583. Will you describe the steps which have been taken, and mention what sums have been raised?—I will lay before the Committee a Paper

giving an account of what has been done. After showing what is needed for the district, and putting our position clearly before the public, we say that we are entirely unable to carry on the college with the efficiency which is desirable for giving that high class of teaching which is needed in the district.

5584. And still less able, I suppose, to carry on the teaching of the artizan class?—Just so. We have no room that will hold above 100 people. Having done that, a public meeting was called by the trustees of the college in the town-hall, at which resolutions were read, and an executive committee was appointed for the purpose of carrying out the extension scheme.

5585. The result come to was, that it was considered most desirable that a sum of something like 200,000 l. should be raised for the enlargement of Owens' College?—Yes.

5586. Subscriptions and promises have already been obtained to an extent, including the engineering class, of forty or fifty thousand pounds?—Yes, it is now about 60,000 l.

5587. The desire of your Committee is to increase those subscriptions, and to obtain a corresponding grant from Government—a grant something like equal to what has been granted to the Extension Fund of Glasgow University?—Yes.

5588. It would be the opinion of your Committee, that had it not been for the great pressure on the cotton districts during the last five years, the 100,000 l. would have been readily raised?—Yes.

5589. That has been the only difficulty?—I think so.

5590. As Owens' College, from its situation, would be the head-quarters for the distribution of science instruction among the people of Lancashire, it is highly important that great care should be taken in the selection of professors, and in establishing the College upon a sound, permanent basis, and that is the object of the Owens' College Extension Fund?—Just so.

5591. Have you any scheme to propose by which you think that the mass of the people can be interested in scientific subjects, so that they might be made ready to receive the class of instruction which is now given by the Government-certified teachers?—Yes. First of all, I should like to say that I do not think it is possible that a complete scientific training could be given to working men as a class. All we can really look forward to is, having placed them in possession of the ordinary primary education, which, I believe, must be compulsory, that after that they should be shown some means by which any man of intelligence and force of character can raise himself from his station, and, if he chooses, obtain a really scientific education. The first thing that is needed is primary education, and then an extension of the system of Government examinations in science, by means of certified masters, just as is done now throughout the country, the plan being of course extended to meet enlarged requirements.

5592. What do you consider the best means for bringing this subject under the notice of the working classes?—I will state as well as I can how, in my opinion, it is necessary that the interest of the people in scientific subjects should be stimulated, in order to lead them to take these Government courses. I may, perhaps, quote from my own experience in this matter. The

writes

winter before last I determined to try in Manchester what could be done in interesting working men in scientific subjects. By the help of a few friends who assisted me, I arranged a series of Science Lectures for the People, of which I have here the verbatim report, and which were published at a penny each. A large number of those reports were issued, and I may state that the number of persons attending the 13 lectures was upwards of 4,000; I had over 400 people at my four lectures on elementary chemistry, which I gave to begin with, I charged an admission fee of one penny. This entrance charge did not nearly defray the cost of the room and the advertising, which, in fact, was borne by my friends who kindly helped me and myself. The expense was considerable, but the experiment was very successful, and in this very best way, that not only was an interest in the subject shown by those who attended the lectures, but I said to them, "Now, if you really are interested in the subject of chemistry, these lectures can do no more than stimulate your minds, and if you wish to follow the subject out, you must attend a regular course of lectures in class;" and that very man to whom I have referred some minutes ago, undertook a class of 50 working men, who paid their half-crown a-piece for their 12 lessons from him. I often used to go and see how they were going on, and a more hard-working and enthusiastic class I never saw; they managed to get in that winter a very considerable amount of instruction upon that subject. Now my notion is, that this kind of thing might answer for the purpose indicated by your question, if it were taken upon rather a larger scale; if competent persons were appointed in each large centre of industry, for the purpose of giving such lectures, I think it would be successful. My experiment was on a very small scale, and I believe if the thing were properly done, and if there were good rooms—for the room is a great difficulty—if the matter were taken up by the Government, or by the locality, you would succeed in interesting a very large number of persons in the subject of science instruction. I might also support my notion by referring to the lectures to working men which are given in Jermyn-street, which are exceedingly successful. It would be very difficult to select the lecturers, and to prevent the experiment from degenerating into mere amusement; the great object would be to give lectures which should be really instructive, and care should be taken in the choice of the lecturer, I should object to the appointment of any itinerant lecturer.

5593 Referring now to Manchester itself, if that scheme were carried out, it would require not only a careful selection of the lecturers, but a very large amount of funds?—Yes.

5594. Funds which do not exist now, and which are not likely to be supplied by voluntary subscription?—Funds which it would be exceedingly difficult to get by voluntary subscription—an amount of difficulty which no private individuals ought to be called upon to meet.

5595 In fact, in all educational schemes for the improvement of the working classes, the first step seems to be the possession of a sufficient amount of funds from some source not voluntary?—No doubt; we have found by experience throughout the world that high-class education does not pay its own way.

5596. Have you any further remark to make

to the Committee?—I think I have said almost all that I have to say upon the subject.

5597. Mr. *Ashroyd*.] What is the total number of students attending your institution?—The number this session is 497.

5598. Divided into day students and evening students?—Yes.

5599. Have you a regular curriculum for your students?—We have.

5600. Will you kindly state what it is?—I have here the calendar of the college for last year. We divide our students into two classes; we have courses in general literature and science, which constitute the art course, and a department of theoretical and applied science, which constitute the science course. For the first year the science course, which fits the students for matriculation at the University of London, consists of attendance on the following classes.—Latin, Greek, the English language, mathematics, natural philosophy, modern history, inorganic chemistry, and French or German. The second year, which is supposed to prepare him for his first examination for bachelor of science, he attends mathematics, natural philosophy (mechanics and physics), chemistry (the junior class); then laboratory practice two days a week, anatomy and physiology, and French or German. The fee for the first year is 16 guineas, the second year 23*l.* 2*s.*, owing to the laboratory practice being more expensive. In the third year, which is the preparation for the final degree, he studies logic and mental and moral philosophy, mathematics, natural philosophy, organic chemistry, with laboratory practice two days a week, and geology and botany; the fee for that is also 22*l.* 2*s.*

5601. And that course embraces three years?—Yes.

5602. It is required, is it, that all the students should go through the regular routine?—Not all the 173 day students pass through that routine; many of them go in simply for a few classes; for instance, several of them come simply to study chemistry, or take one or two of the other classes. The scheme I have been reading is the system laid down for those who desire to take up the course of regular scientific instruction, and intend to pass through the London University examination.

5603. It is optional with the student to devote himself to any particular branch of science, or to attend any particular profession?—Quite so.

5604. You spoke of a German who had made some discovery for the recovery of products in the manufacture of alkali, where was that gentleman educated?—I cannot say; but he was at one of the German universities.

5605. Have you any grant from the Department of Science and Art?—None whatever; we have never worked much with that department. We have worked in connection with what we consider the highest system; namely, that of the University of London.

5606. So that you are totally independent of the department?—Totally independent of the department.

5607. You make no returns to them?—No; we have nothing whatever to do with them, though many of our students pass their examinations.

5608. I think you stated that you had recently had a very large increase in the number of your students;

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students; I suppose that is partly to be attributed to the public attention being lately much directed to the subject of technical instruction?—Perhaps so

5609 You are quite satisfied that Owens' College has had a most beneficial effect on the manufactures of the district?—I am satisfied that it has had a most important effect, and will have a still more important effect.

5610 The great majority of the young men you turn out find employment in Manchester and the neighbourhood?—Yes

5611. And a good many of them come from Yorkshire?—Some come even from Newcastle-upon-Tyne

5612 Everywhere you find your young men appreciated, and they have no difficulty in finding employment?—Just so

5613. Mr *Bazley*] What is the minimum age at which you may receive students?—By the will of the founder, we may receive a student if he is above 14 years of age; but, in reality, we very seldom take any who are under 15

5614 Do you find that the young men who come to you are generally sufficiently well prepared?—I ought to say that the amount of preparation among the students has very much improved during the last few years. When I went first to Manchester, which is now nearly ten years ago, the preliminary preparation of the students was certainly defective. I believe that the Cambridge and Oxford middle class examinations have done a great deal to raise the character of the school instruction in the district, and I think we are now feeling the benefit of it

5615. Is it your opinion that Owens' College might become an important northern university, for the purpose of promulgating practical science?—It is so even now, we are practically the university of the north, and we only require putting into an acknowledged position, in order to fulfil all the duties of a northern university. I said practically, because I do not believe that it is either advisable or necessary at present that we should give degrees, and I think that our connection with the London University is quite sufficient for the purpose, practically, however, for all other purposes we might be the university for the north of England.

5616. Mr. *Lowther*.] You said you were intimately acquainted, I think, with the system of scientific instruction in the German universities?—I studied at the Heidelberg for several years, and I know many of the professors in the German universities

5617 You do not know much of the north of Germany?—No; I never resided for any length of time in Berlin.

5618. What do you think the best portions of the system pursued in the German universities?—In the first place, that the scientific instruction in Germany excels that of all other countries. If you look at the men who compose our English science, you will find that they have almost all been over to Germany. The system of high scientific instruction in Germany is on the most elaborate basis in my particular department, in chemistry, all the universities in Germany, which, I need scarcely say, are Government institutions, possess large and very complete laboratories. At present, the sum of money which is being spent in Prussia, especially on laborato-

ries, is no less than 18,000 *l* in Berlin, and 20,000 *l* in Bonn. Of course, this attracts all the very best men in Germany to the university life. Men of science in Germany rank exceedingly high, and hence it is that almost all English students go over there for the purpose of continuing and extending their scientific studies. I might say that the fees in German universities are necessarily very low, any Englishman who goes over to Germany to study, really has benefited by the liberality of the German Government.

5619 Are there any German professors who give lectures gratuitously to the people of the lower class?—Every German professor is obliged to give a free public lecture once a week; there are exceptions, but that is the rule; and, in the case of poor students, they will forego the fee altogether

5620 Have you had any opportunities of judging of the education of the lower class in Germany?—No, I cannot give any opinion on that subject, but I believe that in Prussia the primary education is very good. I may state that the school education in Germany is very much more severe than school education in England, and the examinations are very stiff. When a man comes to the university of Germany, he is supposed to have passed, and, in fact, he must have passed through this rigorous system of teaching up to 17 years of age, but when he has once come to the university, he is a free man, and can do what he likes; he can, as a rule, choose his course of study for himself, the system is totally different from ours, and I must confess I think the result is in many ways very much better than ours; a love of science and knowledge for its own sake is much more seen in those universities than it is in ours.

5621. Do scientific men in Germany generally confine themselves particularly to one branch of science?—Yes, generally, for instance, a chemist devotes himself to chemistry, and very likely makes himself known throughout the world by his investigations; the stimulus which contact with such men gives to the student is something which in England we cannot at present understand. The number of students that came from all parts of the world in the first year when I was studying at Heidelberg, under Bunsen, was very great; we had Americans, Frenchmen, Germans of every kind, and some from Lisbon. The influence of men like Bunsen or Liebig is something which, in this country, we scarcely appreciate. I believe Professor Hofmann has gone back to Germany merely because he finds that it is impossible here to form a real school of science.

5622. But when Englishmen came to Heidelberg, in comparison with the people of other nations, were they generally behind the rest?—I do not think that at all, but they were probably picked men, or men who had picked themselves out for this special object.

5623 Mr *Bagnall*.] In your opinion, would a better economical result be got by giving persons above the manual-labour class such an education as to enable them to hold their own in industrial pursuits, or by endeavouring to teach science to the working class?—I think that the attempt to teach science completely to the working class is a mistake, but I think we should give an opportunity for the best men in the working class to rise.

5624. But still you would rather, for the sake

of the general welfare of the country, think it more important to give scientific education to those who were above the working class than to the working class themselves?—I do not think that we ought to give scientific education to any particular class of people as a class. I think we ought to make scientific education available to all persons who need it, of whatever class.

5625. Do you think the system pursued by the Science and Art Department in confining the payment by results to the wages-receiving class is desirable?—No, I would draw the line higher. I think the remark made by Dr John Watts the other day was very forcible, and that the range ought to be widened.

5626. You think that skilled artizans are often in more easy circumstances than those who are just above them in the social scale?—Very frequently.

5627. Mr. Acland] I understand you to think that the course of instruction in Germany is much more favourable to the spreading of science through the country than the course of instruction in England?—I think that it tends more to the development of the scientific spirit.

5628. The chief reasons you gave were the greater amount of money spent on laboratories, the greater freedom of the student after he enters the university, and his better preparation before he enters?—Yes.

5629. Have you anything to add to these three reasons?—I may mention the love of scientific education, and that the intellectual culture of the people is probably greater throughout the masses in Germany than it is in England. The masses of the people there look forward to going to the university, the poorest peasant's son may go, and sit beside the prince in the lecture-room, and he does it, and that I consider a most important feature. Then the number of universities throughout the country is a very important circumstance.

5630. With regard to the money spent on laboratories, are you aware that in Oxford, for instance, a sum considerably exceeding 60,000 *l.* has been spent on a museum and laboratory for physical science?—Yes.

5631. Are you aware that Professor Clifton has lately obtained the power of spending 10,000 *l.* upon a laboratory for physics?—Yes, and I am very glad to hear it.

5632. Then the expenditure on laboratories alone cannot be the cause?—No, certainly not.

5633. Do you consider the laboratories at King's College and University College very defective?—I would not say that they were defective, but I do say that they are very inferior in size and working power of all kinds to those of Germany; because it is not merely bricks and mortar which makes a good laboratory, but the whole of the means placed at the disposal of the professor, including the funds and the assistance he receives, and so on.

5634. Do I understand you to think that the best cure for the deficiencies in the laboratories in England is public grants from the national exchequer, or from any local sources, or would you trust to the rising feeling of the country supplying the necessary funds in other ways?—I think if it is desirable at once to begin a system of scientific instruction, the only way is that the Government should help.

5635. Confining yourself, at present, to the question of laboratories, do you look to the G.O.72.

vernment grants or local grants for supplying the defects which you think exists, or do you think it should be left to the exertions of the public?—I look to the Government grants.

5636. Meaning by Government grants, grants by the House of Commons out of the national exchequer?—Grants by the House of Commons out of the national exchequer.

5637. Mr. Potter] Do you think, with respect to the Manchester districts, that it would be possible, without going over a whole series of years, to get the necessary funds by way of voluntary process?—I think not.

5638. Mr. Acland] But is it not the fact that within a very short time in Manchester and the neighbourhood, you have proposed to yourselves to raise 100,000 *l.*, and that you have in a short time raised 50,000 *l.* out of that sum, in a time of considerable depression, too?—We propose to raise 100,000 *l.*, and we hope that the Government will do what they have done in Glasgow, give us a pound for pound, making up the 200,000 *l.* which we desire, that is our scheme.

5639. Your plan in Manchester is to raise 100,000 *l.*, in the hope that the Government will give you another 100,000 *l.*?—We do not raise the 100,000 *l.* contingently upon that.

5640. You mean that there is no promise?—There is no promise.

5641. And you have succeeded, even in this time of depression, in raising 50,000 *l.* or 60,000 *l.*?—Our whole available sum is 60,000 *l.*, but we have raised something over 40,000 *l.*

5642. The next point which you mentioned was the better preparation of the young persons intending to go into business before they enter the university in Germany?—Yes.

5643. Will you kindly explain to the Committee, in what respect you think that previous preparation is so much better than any similar preparation in England?—In the first place, the German school system itself is, I was going to say, so much more severe than it is in England, before entering the university, each student has to pass an exit examination as he leaves the school.

5644. With regard to that severe course of examination, will you kindly say in what respect you think that open to imitation to England, or if you prefer it, will you point out the defect of ordinary middle-class school instruction in England, as compared with that given in the German schools?—I doubt if I can give you a very distinct answer, but I think that the schools in Germany are generally superior to our schools.

5645. You attach great importance to that leaving examination, which is almost universal in Germany?—Yes.

5646. Bearing in mind that it is the law in Germany, that no man can be a doctor or a lawyer, or qualify himself for the public service without going into the university, and that he leaves his middle-class school subject to that examination, do you think we could do anything of the same kind in England?—I do not see why a matriculation examination should not be imposed on all the students entering a science college in England, we did, at all events, have an examination during the first few years, but we were forced to drop it.

5647. Why were you forced to drop it?—Because we found it impossible to carry it on if we were to exact any considerable amount of intellectual culture on the part of the entering students;

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students; we feel ourselves now almost in a position to begin that system again, and in fact, it is now practically done, as the principal of the college rejects those who are apparently incompetent.

5648. Your great difficulty in enforcing an entrance examination is, that the standard of public opinion in England is so low on the subject of middle class education that, practically, you think you could not do it?—Yes

5649 Do you suggest that this Committee should propose to Parliament, as one of its recommendations, that the State should, by law, require in the universities and the liberal professions an entrance examination?—I think it would be a very good thing

5650 Looking at the state of England at present, do you think it possible to bring about anything of the kind within any reasonable time?—Yes, it is the case in the medical profession, the medical council have practically adopted that suggestion

5651 You think that public opinion is so far rising on this subject that the public would not resent the interference of Parliament in requiring a test examination, on leaving school, before entering on any preparatory course for a liberal education?—I think it would be very desirable

5652. With regard to the greater freedom of students abroad, are you of opinion that it would be desirable in England to set free our different courses of education, and to leave them more to the choice of the student?—I am

5653 Are you of opinion that any curriculum to which you could point, say that of the medical profession, is much too full of detail, and imposes a great number of needless lectures?—I should not like to give an opinion on the question of medical examinations.

5654 Can you give the Committee any instance of what you think too great detail in any curriculum in England which has a prejudicial effect on the scientific education of the country?—Before I answer that question, I should like to explain that, when I referred to the greater freedom in the German universities, I meant general freedom with regard to the course of the student's life, not only his freedom to choose a subject of study, for even there, where a student goes in for a Government post, and learns his profession at a university, a certain number of classes must be attended, it is imperative

5655 You would not be opposed to the recognition of some definite public curriculum for science?—No, on the contrary.

5656 You would be rather favourable to the aid of Parliament being given to such a requisition?—I should

5657. Do I rightly gather from your last remarks, that you think the great evil in England is the low standard of public opinion in reference to scientific education?—That I most cordially believe.

5658. But the possibility of legislation is, to a great extent, contingent on the state of public opinion, is it not?—It strikes me that, if any improvement is to be made, we must take the lead by legislative measures.

5659 I understood you to say that the great difficulty in England now was to find good teachers of science?—Yes.

5660 I also understood you to say, that you

thought existing institutions did not supply you with the science teachers which you required, and I thought you limited your remark more particularly to Oxford and Cambridge, though you stated generally that there was a good deal of difficulty in obtaining an adequate staff of science teachers from existing institutions?—I wish to say this especially, that gradually as the feeling increases in the country, that science education must be introduced in secondary schools, I think the want of teachers will be felt. I do not say that the want is so very much felt now, because the demand is small, but I say the value of science colleges, if they were established, would be, to a great extent, to train those teachers. And it does not appear to me that Oxford and Cambridge, though they might do a great deal in the matter, could possibly do all.

5661 There are in England various institutions connected with the London University; for instance, the University College and King's College?—Yes.

5662. The School of Mines, and also the universities in Scotland and Ireland?—Yes

5663 Now, excluding Oxford and Cambridge altogether, do you think it is hopeless to get from those institutions a very large supply of the kind of teachers required?—A great deal may be got out of the existing institutions in the way of supply of teachers

5664 You are acquainted generally with the course of instruction at University College and King's College?—Yes

5665 On the whole, do you think they are moving in the right direction?—Yes, I think they are very valuable institutions

5666 Now, with regard to Oxford and Cambridge, will you be good enough to point out any impediments which you think stand in the way of their doing what some people think they ought to do, namely, supply the highest class of science teachers, an opinion which, I presume, you do not altogether dissent from, because you said you were anxious to attract the best university teachers to your own college?—I think you must look to the old universities, especially for mathematics and classics

5667. But will you be good enough to confine your answer to science entirely?—In Cambridge, to begin with, you have not the means of training, for instance, a chemist. I mean that a man who felt that he could distinguish himself in the science of chemistry, would not be satisfied with the education which he could get at Cambridge, but he would go abroad for it.

5668. Do you consider the deficiency at Cambridge is due to want of buildings, or to want of endowments?—Both.

5669 At Oxford there are very considerable buildings for chemistry, and there are endowments, are there not?—Certainly.

5670 Then will you state what impediments you think there are at Oxford to the training of the highest class of science teachers?—I should say none; but I doubt whether a man who is going to be a schoolmaster, can afford to go to Oxford.

5671 Are you speaking then of a schoolmaster of the lowest class, or of the gentlemen who are to be teachers in science schools?—I am not speaking of schoolmasters of the lowest class, I am speaking of men who would teach science in secondary schools.

5672 But my questions have had reference to teachers

teachers who may be required to occupy positions, which at all events, in point of income, and social dignity, shall be equal to those of grammar schoolmasters; and my point is, to know from you how far, looking at the endowments and opportunities of the older universities, you think there is any insuperable impediment to their supplying competent science teachers in that way?—I think the older universities may no doubt train men for the higher science chairs.

5673. Do you think that one of the things we want in England is secondary schools for boys going into business at 18 years of age, or thereabouts, ranking side by side with the first class classical public schools?—I think such a thing would be desirable, and I should think, the conversion of some of those grammar schools into such institutions would be valuable.

5674. Now, with regard to the impediments to the training of those science teachers at the universities, do you think it an impediment that they should be required to have a certain amount of classical, mathematical, and general knowledge, or should you be favourable to retaining that up to a certain point, provided, it was not made to encumber the scientific training?—I should certainly not be for doing away with the ordinary teaching in classics and mathematics.

5675. There has been a strong feeling in the minds of some persons that people ought to be admitted to the universities without any knowledge of Greek, and even without any knowledge of Latin, and simply on the basis of scientific attainments, now do you consider the requirement of either Greek or Latin, or both, to be an impediment to the proper use of the older universities, or would you retain the literary culture?—On the whole I am favourable to retaining it, but cases might occur in which persons had been unable to get much literary culture, and yet ought to be admitted to study some subject in which they had succeeded up to a certain point.

5676. Suppose a son of an artisan or foreman in Manchester to show eminent scientific ability, would you think it desirable that he should be admitted to the older universities on the ground of his scientific attainments alone, though he had not had any opportunity of obtaining a training in literature?—Most decidedly.

5677. Do you think then it would be desirable after he got to the university that he should receive any literary training there, or would you leave him to be trained exclusively in science?—I would leave him to be trained exclusively in science.

5678. I understood you, when you were speaking of the difficulties of using the older universities for the training of science teachers, to speak of the expense of universities, will you now state what you consider to be the limit of expense which prevents the use of the older universities; when you gave that answer, were you thinking of a sum below 100 £, or of a sum a little above 100 £?—I was thinking of a sum of from about 100 £ to 150 £.

5679. Do you think, supposing the expense of living could be reduced to about 50 £ or 60 £ a year, that the expense would be an obstacle?—I think that would be better than double the amount, at all events.

5680. You are aware that there has been a recent regulation by which men can live in lodgings in Oxford?—Yes.

5681. Do you think that is likely to have any

result in relation to the class of men, of whom we are now speaking, or do you now think that the fashionable habits of the people at Oxford will keep working men away?—I am rather inclined to think so; the working men will fancy that it is not in their line.

5682. You mentioned the great importance of science teachers being trained in the midst of the manufactures to which the science is applicable, did I understand you, on saying that, to speak of the highest class of science teachers, or did you mean the ordinary schoolmasters, who would be teaching in the primary or the lower secondary schools?—I was not speaking of the highest class of teachers, but of those who were to teach science at secondary schools, I was not thinking of the professors in colleges.

5683. Will you kindly say what you now mean by secondary schools?—Everything below those science colleges.

5684. Then, with regard to science colleges, could you give any rough estimate of the annual expense of such an institution, you stated very strongly your opinion that in England the fees would never pay for the education to be conferred by such a college, and therefore you thought some endowment would be necessary?—Yes.

5685. Can you form any estimate as to what endowment would be needed?—It depends of course, on circumstances.

5686. First you would require good buildings?—Yes.

5687. Do you consider a good building to be a very good form of endowment?—Yes.

5688. Presuming good buildings, then, do you think that a very large annual income besides fees would be necessary?—No, not very large.

5689. Do you therefore think, that it would be an important point for this Committee to direct the attention of Parliament to the importance of getting thoroughly good buildings for such colleges, leaving the question of annual endowment comparatively open?—No, I would not leave it open, I think the endowment is almost more essential than the building, to be struggling for want of funds after you have got into the building, is a very bad state of things.

5690. But are you prepared to say that when the manufacturers of England are thoroughly awake to the importance of scientific education for themselves, their foremen and managers, and to some extent for their artisans, it will be impossible to get from them an adequate remuneration for those who give the requisite science teaching?—First I would say this, I would not propose that the Government should pay anything, either towards the establishing or the carrying on of science colleges, unless where the districts themselves were willing and able to aid, that is a *sine quâ non*, but I do not think, from all we can now see in educational establishments of a high class everywhere, especially in England, that we can ever hope such establishments will be self-paying, the old universities are a case in point.

5691. Are you aware of what has taken place lately at Doncaster, where, with an endowment of only 8 £ a year, a very complete chain of schools from the lowest up to the highest, has been successfully established by the co-operation of the municipal body and the clergymen of the place?—But that is not a science college, though I have no doubt an immense deal of good could

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be done by co-operation and by the aid of the district, the aid of the district I would make a *sine qua non* of Government help

5692 Then could you give the Committee some kind of estimate of what you think should be the cost per annum to science students of a thoroughly good scientific education, leaving entirely out of account the cost of his own personal maintenance; you are probably aware that the Schools Inquiry Commission estimated the three grades of secondary education from 12 years old up to 18 years old, at the following sums: For the third or lower grade, about 6*l* a year; for the second grade, which would be from 14 to 16, 10*l* to 15*l* a year; and for the highest grade of public school, giving a liberal education (founding the estimate in that case, on the cost at University College and King's College), 20*l*. My question is, taking a boy up to that point of 18 years of age, and setting him as a man on the best possible system of scientific education, what do you think would be the real cost of his education, not necessarily what he is to pay, but the real cost of the article?—I could not give that offhand.

5693 Should you be prepared to put it as high as 30*l* a year?—I can give you the cost of the article that we deal in

5694. *Chairman.*] But I think the question is, what would be the cost per head of the highest scientific education, no matter in what proportions that cost might be covered by fees or by endowments, or in any other way?—Yes, I perfectly understand the question.

5695 *Mr Acland.*] Presuming, then, a reasonable number of students, we will say 150 or 200 pupils, for a science college, the Committee would be glad to know what you think would be the cost of a scientific education at such a college?—Of course, I can add up, the total amount of fees paid by the students in our college, and the amount of the endowments which we have, and divide that by the number of the pupils.

5696. But should you be prepared to say that the article you supplied was properly paid for?—No.

5697. Will you kindly supply to this Committee, after you have left the room, what you think, taking the present circumstances of England into account, would be the cost of a thoroughly good scientific education suited to young men who had had a good secondary education?—I will do so.

5698 In giving your answer, will you separate the cost of the plant from the annual expenses, meaning by plant laboratories, and all that is of a permanent nature?—I will endeavour to do that.

5699 Have you considered the question how many science colleges we want in England, and in what localities you would place them, whether, for example, you would place one in Lancashire, and one or two in the Midland Counties, and whether you would look to having a very large number of such schools, or to having one school of a very high class?—I look to having a very few colleges, but of the first class. The greatest care should be taken not to make too many, for the difficulty of getting high-class teachers is considerable, and the responsibility which rests upon them is also very great.

5700 Then, bearing in mind your opinion

the great industries of the country, you would say that one of them should be, for instance, in the woollen district, one in the potteries district, and one in the hardware district?—Yes, I should take first of all existing institutions which are working fairly

5701. What existing institutions of the kind which are working well have you to point to besides Owens' College?—There is Queen's College, Birmingham, which is, however, I believe, solely a medical school.

5702. Would you point to that as one which is working well?—I am not intimately acquainted with the condition of things there

5703. Then we should have Owens' College, Queen's College, King's College, and University College; do you know of any others?—I think not.

5704 *Chairman*] Is it the case that chemical instruction is given to all the students at Owens' College?—Certainly not to all, but to the majority

5705. Is it the case that an examination in chemistry forms any part of the formal or informal entrance examination?—It does not necessarily do so, but it forms part of the matriculation examination at the University of London.

5706. You have spoken of the German Universities, but you have not spoken of the German Polytechnic Schools; are you aware that in those schools pupils are admitted who have not passed the *abiturienten examen*, or departure examination?—I am aware of that.

5707. Would you not draw a distinction between the preparation which should be given to persons intending to devote themselves to industry and those who were to become teachers?—I think so, decidedly.

5708 With regard to the liberal professional examination which you suggested, would you include mechanical engineering among the liberal professions?—I think so.

5709. Do you think it would be possible, under existing circumstances, to demand of a mechanical engineer that before he entered on actual business he should pass an examination, to be laid down by some competent authority?—I do; an examination showing that he had passed through the ordinary school instruction.

5710. In that ordinary school instruction would you demand anything more than elementary instruction in the case of a mechanical engineer?—I should demand nothing more than elementary instruction.

5711. You would demand that no man should be the proprietor or conductor of a mechanical engineering establishment unless he could show that he had received competent elementary instruction?—Certainly.

5712 Would you demand the same of a manufacturing chemist?—Yes

5713. Would you go as far as to say that no man should practise as a manufacturing chemist unless he had received elementary instruction?—I do not know that I could say that, but I think it would be very advisable that instruction should be made compulsory for the lower classes.

5714. But you would not insist upon any examination in science before a man should be allowed to produce machines, or alkalis, or calicoes?—No, certainly not.

5715. Now, as to the conduct of mining operations, would you consider it desirable that those who had charge of the men underground should

be prepared to prove that they possessed a certain amount of scientific knowledge?—Certainly, I think that would be very important; the amount of ignorance amongst the miners, and especially the coal miners in the Lancashire district, is what I may call awful.

5716. Do you consider that so important a point that the nation has a right to insist on the possession of a certain amount of knowledge by such men?—I think so, I mean the foremen and the overlooker class in mines, persons who from their position hold the lives of their fellows in their hands

5717. Mr. Potter.] Would you submit the proprietors to such an examination as you speak of?—I think it is even more necessary that they should be educated than that the men should be educated.

5718. Chairman.] The persons having the actual conduct of certain operations are the persons whom you would submit to a compulsory examination, is that so, for example, that those who conduct mining operations should be required to pass a previous examination in science, varying in its degree according to the responsibility to be assumed by the person?—I do not know whether I should put it in the form of an examination, but that in some way the instruction should be secured, I think.

5719. Mr. Bazley.] Would you say that in certain cases a certificate of competency might be required from those who were working in mines as overlookers?—Quite so, and I would add, just as it is done in the medical profession

5720. Mr. Acland.] Would you not be inclined to draw a distinction between persons conducting business for their own profit, and persons entrusted with public or official responsibility affecting other persons, and would you not say that in the latter case Parliament might have a clear duty to discharge which might not be so clear in the other cases?—Yes, in the case of Government inspectors, and so on.

5721. Supposing such a regulation were laid down by Parliament, do you not think that would go a long way to raise the whole standard of public opinion on scientific matters in England?—Yes

5722. You would say that in such cases as hospitals and poorhouses, for example, no man should be allowed to perform duties on the discharge of which the happiness of his fellow-creatures depended, without a competent knowledge of certain facts?—I think so, certainly.

5723. Chairman.] You have stated that you have at Owens' College evening classes, attended by a great number of pupils; with regard to chemistry, have those pupils access to the laboratory for laboratory practice?—I have a practical class in the evening for laboratory practice, so that my answer must be yes.

5724. What are the fees?—Five guineas for 40 demonstrations, and that includes the cost of all materials.

5725. Are those materials provided by yourself?—Yes, by myself and by the college jointly.

5726. Are those five guineas remunerative?—Yes, that is to say, the expense is covered by the five guineas; the cost of the materials, and the cost of the instruction also.

5727. Would that include wear and tear?—That includes wear and tear.

5728. Mr. Acland.] But does it not presume the existence of good apparatus?—Yes, of a
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certain portion, though some of the apparatus may also be found as well for that sum

5729. Chairman.] Have you at Owens' College any examination during the courses for those who do not go up for the examination at the University of London?—We have our class examinations, and mine is going on now

5730. Examinations conducted by the professors themselves?—Yes

5731. There is no board of examiners?—No board of examiners.

5732. You have stated you consider that Owens College, and similar institutions, would be entitled to national aid, but why would you say that they should be entitled to national aid rather than to municipal aid?—Only because I do not think that such municipal aid can be got. I do not believe in municipal aid

5733. Your reason for asking for national aid is, that you think it is the only practicable mode of carrying out your operations to the extent to which you think they ought to be carried out?—Certainly

5734. But that answer you would limit probably to the present time?—To the present time

5735. Do you think that there are any indications that local interest in scientific colleges, for instance, in Owens' College, is very much on the increase?—I believe it is.

5736. But probably you would not despair of seeing the time when a rate might be acceptable to a community like that of Manchester, for the purpose of providing scientific instruction?—I think it is possible that such a good time may come

5737. You spoke of certified masters conducting science classes, are you aware that the Government have within the last year or two dispensed with certificates for the masters?—I am aware that there has been some relaxation in the rule.

5738. Do you think it is desirable that the same standard should be adopted for the masters and the pupils in the Government science classes?—I do not feel competent to give an opinion upon that subject, but I think the higher you fix the standard of examination for the masters the better, and I should look forward to the time when the examination for the science masters should be very much increased in amount.

5739. The present tendency being, as you know, in the opposite direction?—Yes.

5740. You are acquainted, I presume, with the results which have been obtained in science classes in Lancashire?—I am.

5741. Do you consider that the operations of the Science and Art Department in Lancashire are really exercising a beneficial influence on the scientific instruction in that neighbourhood?—I am inclined to think that they are, and I would take this opportunity of supplying an omission I made in the previous part of my evidence, namely, to explain that in order to facilitate the passing of a student who gained a high position in the science and art examination into a science college, it would, I think, be advisable to found more Queen's prizes than now exist, and to admit the holders of those prizes not merely to institutions such as they now have access to, but to allow them to go to any science school, naming certain ones in particular, in the district.

5742. Wherever Government aid is given to a college for science, you would make it a condition
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that the college should admit pupils who had passed through certain courses in connexion with the Government, the admission of such pupils being on lower terms than usual, or else altogether free?—On better terms than usual or else altogether free.

5743. With regard to the lectures to evening classes, would you consider it to be a reasonable condition to be imposed by the Government, that wherever a professorship was endowed, or partially endowed by the Government, the professor should give evening lectures to working men?—I think so, I think that might fairly be made a condition.

5744. Do you think that is a condition which men of science would gladly accept?—I can only say that we do it; we each of us do it one night a week during the winter, voluntarily, we having no Government aid at all.

5745. Do you think that the system of payment on results is applicable to the higher science colleges which you would wish to see introduced into various localities, similar to Owens' College?—I do not think it is sufficient, and I think the system of endowment is a much better system for such high class schools.

5746. Do you think it would be possible to obtain professors for such high class schools without some endowment?—I do not think it would.

5747. Returning for a moment to your own laboratory, let me ask you if the practice in that

laboratory is technical?—It is to a certain extent; most of the young men who come to me, come knowing nothing of the subject, and have to go through all the ordinary routine of chemical work, with qualitative and quantitative analysis. Many fathers come to me saying, that they wish their sons to be taught everything in their own particular business; but I have to reply that my duty is to teach the science of chemistry, first in its principles, and that afterwards that they must work out their own particular subject with me, as they like, or that they may continue it at their own works, just as they please.

5748. But do you think it is practicable, and desirable, that after a general course of instruction in chemistry, special instruction should be given in laboratories like your own?—Yes; I think it is both practicable and very desirable.

5749. With regard to the preparation of the youths who come up to Owens' College, I think you stated that an improvement had of late taken place?—Yes.

5750. Do you think that that is an indication of an improvement in the general scientific instruction of the neighbourhood, or that it arises simply from the fact of more being required by you?—I think it is owing to a general rise in the character of the instruction given in the schools.

5751. In fact, what you require is more easily obtained than it formerly was?—Yes.

JOHN PLATT, Esq., a Member of the House; Examined.

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5752. *Chairman*] You are the Member for Oldham?—I am.

5753. I believe you are the largest mechanical engineer in the country?—I believe so.

5754. You employ some 5,000 workpeople, do you not?—From 5,000 to 7,000.

5755. *Mr. Bazley*] I think you might have added that you are the largest machine engineer in the world?—I think that is true.

5756. In conducting your extensive works, may I ask if you avail yourself of every possible improvement in the construction of your machines?—Yes; that is a necessity of our existence.

5757. Whether you originate an improvement, or whether your overlocker suggests an improvement, or you buy an improvement from the inventor, you still think it your duty to avail yourself as rapidly as possible of such improvement?—Undoubtedly.

5758. You have not only supplied very extensive machinery in our own United Kingdom, but you have been a large exporter of machinery to various parts of the world?—There is no known civilized part of the world where people in my employment are not at this moment.

5759. You have to compete with the engineers and machinists of Europe and America?—We have to compete with all the world, and in almost every country. There are duties on the machinery which we make. I know but one exception, and I believe, unfortunately, they are going to put on a duty, that is Russia; but in every other country there are duties. In America the duties are now very heavy; in Belgium they are the lightest of any, being about 10 per cent.

5760. In recent years, probably, the competition with foreign machine makers may have increased?—I can only say that the competition of

foreign machine makers is less now than I have ever known it. When I was very young, I recollect going over to the Continent, that was in the year 1842; and I found in Belgium two of the largest engineering places then in existence, either there or elsewhere, and one was specially devoted to making machines similar in character to those which we make at the present day. Another one was at Zurich, and was specially devoted to making machinery for textile fabrics. At that time those were much larger than any such places as we had in England; but although those establishments were so large at that period, they are now almost closed for that description of machinery, the competition of England having almost shut them up.

5761. Are you subjected to much foreign piracy, foreign machine makers being addicted to copying your machines, designs, or inventions?—There is only one machine that occurs to me, which is used in textile manufactures, that bears the imprint of being invented on the Continent; that is what is called the combing machine, and is used in cotton and woollen manufactures. All the other machines are complete copies, neither more nor less than complete copies of English machines. I wish to make one exception, with regard to America, we are indebted to America for a great many inventions. It is the custom and practice in England among our machine makers to purchase inventions from the Americans, and adapt them to use in this country, and afterwards those very machines are made here and re-exported to America, paying a considerable duty, and still we can undersell the Americans in the American market. I do not know that I can do better than to give you this illustration. In going through the French Exhibition, I was with one of the French tool makers

makers, Monsieur ; he was pointing out the tools and machines that they had manufactured, and which to the eye look extremely well; but the remark I made to him was this, that they were all copies, more or less, of Mr. Whitworth's. I was rather tickled with his reply. He said he was delighted to find that I gave him the name of the Whitworth of France. I said there was a great difference between being the Whitworth of England, who was an originator, and the Whitworth of France, who was a mere copyist; the machines were really nothing more or less than copies.

5762. Are you aware that the combing-machine was not a spontaneous invention, but resulted from a prize of 20,000 francs being offered for the production of such a machine?—I am.

5763. On its introduction into this country it was greatly improved, was it not?—Yes, we may say that the completion of it was in this country: it was a mere rude idea at first.

5764. Judging from your experience, will you kindly say whether you think your foremen and your workmen are as competent in your great engineering establishments as the foremen in any engineering establishments on the Continent with which you are acquainted?—I should be ashamed almost, in one sense, to answer the question, because so many of the large engineering establishments on the Continent are superintended by Englishmen or Scotchmen, so that there is no comparison between them.

5765. You reside in the neighbourhood of Manchester, do you not?—I do.

5766. You are a member of the Manchester Chamber of Commerce, I believe?—I am.

5767. Probably you remember that, in September last, the Manchester Chamber of Commerce had a communication from the Rouen Chamber of Commerce?—I do.

5768. Will you favour the Committee with the precise terms of the communication?—I think the first letter was on the 18th of September 1867:—"To the President of the Manchester Chamber of Commerce.—Would you be so kind as to inform us if trade in your country is suffering equally to the deplorable extent of which we have to report it here.—Signed by the President of the Rouen Chamber." Then the reply was dated Manchester, October the 10th, 1867, that trade was depressed in England, and we added, "At the present time, when it is our boast to cultivate the arts of peaceful industry, we have the spectacle of great nations engaged in a wasteful expenditure, and the peace of Europe jeopardised for no more substantial reason than the satisfaction of national vanity. The time has passed when warlike aggression can add anything to national greatness. True patriotism will seek rather to multiply the means of human happiness, and by increasing the resources of productive industry, bring about that community of nations which would form the strongest barrier against the waste and devastation of war."

5769. Are you aware whether that reply was at all received with satisfaction in France?—I am told that it was not, and that there was a prohibition afterwards that they were not to have any communication with the chamber in consequence, I suppose, of the allusion to war, and that was very natural I think.

5770. And the French Government have interfered to prevent similar communications between the Chambers of Commerce of Rouen and Manchester?—Yes.

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5771. Now, I believe the Manchester Chamber of Commerce has had another communication from a Chamber of Commerce in France in the present year, seeking information connected with the industry of Manchester?—Yes; a letter was sent from the Amiens Chamber of Commerce to the Manchester Chamber of Commerce, to be informed of the best dyers and finishers of cotton velvets, to which a frank reply was returned, and the Amiens Chamber further stated the intention of the manufacturers at Amiens to send goods for dyeing and finishing in this country. It is generally well known that a certain dye was invented in this country which was specially adapted for velvets, I believe we may say that almost the monopoly of that is now with this country. I forget the name of the inventor, but it is an English invention and a most important invention, and it has secured to this country the monopoly of those beautiful velvets that are now worn every day. It is applicable to silk as well as cotton velvets.

5772. From your business knowledge, and from your position in the Manchester Chamber of Commerce, are you aware of anything which tends to prove the inferiority of England as a manufacturing country compared with France?—The only thing that I know about that subject is that I have read a great number of reports in papers, and if I had not read those reports I should have been perfectly astounded at the question being asked me, because I am not aware of anything, except a special manufacturer of silk, where the French at all come near to us.

5773. Have the reports to which you have referred been injurious to the engineering and manufacturing credit of England, having had the effect in some cases of preventing orders being sent to this country?—They would have had a very serious effect if the public had not been better informed by those who wrote on that subject. The letter of Dr. Lyon Playfair was the commencement of it, I believe, and all the papers followed suit; I do not believe there was anything that could be substantiated in that letter; it was a mere figure of speech of a person who knew nothing of what he was writing about.

5774. On the whole, you conceive that France is in advance of other manufacturing countries in Europe, do you not?—No, I think Belgium is far in advance of France.

5775. How do we stand in relation to Belgium?—That country is nearest to England of any country that I know.

5776. Have you been subjected to any system of copying or imitation in Belgium?—As far as any trade goes, Belgium finds it to their advantage to come to this country for their machinery, consequently there is no necessity for that copying; it is better for them to come and buy it in England, and pay the carriage and other expenses, than to purchase the machines in their own country.

5777. You have probably arrived at the conclusion that the scientific instruction given in France and on the Continent is not productive of anything that is injurious to English industry? I am not aware myself of any particular scientific instruction that is given in France that gives them a superiority in any way over this country. In the first place, I do not, as a rule, believe in that scientific instruction in France.

5778. Mr. Acland.] Do you not believe it exists?—No; what I mean is, that it is not so general

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general in France as in Germany, that is what I mean, I am speaking now of France alone, and not Germany.

5779. To what scientific instruction are you now referring as not existing?—The scientific instruction which Mr. Bazley alluded to, I do not think exists in France in connection with engineering.

5780. Mr. M'Lagan.] You made a statement, I think, that there were certain machine manufacturing establishments existing in 1842, which do not exist now?—That is so.

5781. Are you not aware of any establishments of the same class since the extinction of those of which you have spoken?—I am not aware of any since then. I know that the machines that were made at those establishments are now made in this country; in fact they are made by myself.

5782. Mr. Powell.] By what means do those who are employed in your works generally get the scientific knowledge which is necessary for them?—I would rather answer the question by stating what I have found it necessary to do in my own place, where I consider a deficiency to exist. Now I do not, in the first place, believe in the scientific instruction of our people so far; I believe that the science that they have got is what is termed practical science, that is to say, a knowledge of the construction of machines, without understanding the theory of machines. We have attained in this country practical knowledge through a long series of years. Our artisans and masters have attained a proficiency in the manipulation of materials that does not perhaps exist anywhere else. But the time is coming, and has come, when it is necessary that workmen should be acquainted with the science of mechanics, as well as its practical use.

5783. Chairman.] When you say workmen, do you mean mere artisans, or do you speak of superior workmen, foremen, or managers?—I used the word advisedly, because all our foremen, and so on, spring from the workmen; you begin with a workman, and if he is superior in the manipulation of what he is doing, and shows general intelligence, he is then promoted to the position of a foreman; but although he is so, he is very little better instructed than the workman who is placed under him in scientific matters. If we send a complicated piece of machinery to Egypt, or to India, for instance, we have to send a man out with it to erect that machine; but if anything goes wrong with it, or any alteration is necessary in that machine, in consequence of the peculiar position of the country, or the wants of the people, it becomes a question of science to get the machine put right; and then you find that, notwithstanding all the ability which your workmen have in the erection and construction of machinery, they are seriously deficient in these. After a great many years' experience in the conduct of my own business, my observation led me first to the discovery of a deficiency in my workmen induced science and to turn my attention to the question of it solely in our schools in my own town. I did not see an opportunity for these artisans should have themselves if they felt disposed to do it; and I am happy to say that a great many of them who had continually to leave England and go elsewhere, saw their own deficiency upon their returning to England, and showed an anxiety to obtain the

scientific instruction placed at their disposal through this Science and Art School.

5784. Mr. Powell.] Your answer results in this, that although their practical knowledge sufficed for certain purposes, and has sufficed up to this time, the time has now arrived when more science should be mingled with that practical knowledge?—That is it.

5785. Can you give the Committee a description of the school which you have just referred to?—I have before me a syllabus of the studies, in the first place, the master is a civil engineer, and a certified teacher of the Science and Art Department at South Kensington; what he teaches is practical geometry, both plane and solid; secondly, machine drawing; thirdly, building construction; fourthly, theoretical mechanics; and fifthly, applied mechanics; then we have other masters not connected with the Science and Art Schools, but in connection with the Lyceum; the Lyceum has been established many years, it was founded by my late brother, and has been followed up by me for some years.

5786. Could you give the Committee a short outline of what is done in the Lyceum, so that they may see the whole system?—The Lyceum may be looked upon as really a school for the primary education of adults, it is a mechanics institute; the master is an M.A., and he teaches geometry, algebra, and trigonometry; then we have chemistry, languages, and so on, it is what may be called an elementary school for adults.

5787. Can you give the number of the attendants, first, at your school of science and art, and secondly, at your Lyceum?—

5788. Do you find that the working people are, in any numbers, desirous of gaining information of a high class at those institutions?—I do. I have been very gratified indeed by the results of those institutions. The workpeople find it is absolutely necessary to gain this information of a high class, if they are to attain any position in life. Suppose I want to send a person out to India, Egypt, or Russia, I select those who have taken a certain rank in the examination, and who are besides engaged in the particular branch of business in which the person is required to go out.

5789. Your foremen are selected from the workpeople who show promise of excellence rather than from a class specially educated a foremen?—I am most strongly of opinion that the best foremen will always be found to rise from the ranks, and I am certain of it.

5790. Do you find that the condition of primary education among your workpeople is a barrier to their gaining higher scientific information?—I am sorry to say that the state of primary education is a great drawback. When those people go abroad, we find that, in correspondence with them for example, there is great difficulty but within the last few years there has been marked progress, and there is some prospect of that difficulty being got over.

5791. Do you observe a great desire on the part of the parents to educate their children?—I am afraid I cannot say very much in favour of the parents, but I think the next few years we do something towards eradicating ignorance from the workshops; the extension of the Factory Act and of the Labour Regulation Act will accomplish very much of what we want done in the towns.

5792. Mr.

5792. Mr. *Louther*.] You employ a very large number of people?—Yes

5793. When they come to you to be engaged, do you inquire into the education they have received?—No.

5794. You ask for no kind of certificate?—No, but I may inform you what I did myself. I established schools in my own place, and I have certified teachers, and all the boys that come to my works up to 13 years of age, in fact, up to 14 years of age, receive two hours' instruction per day in school, for which I make no reduction from their wages, and I may mention a most curious thing which occurred, as an illustration of the necessity for compulsory education, till I gave the master the power of reporting a boy, and discharging him for non-attendance at school (even though he might receive the instruction gratuitously, without deduction from his wages), we could not get regular attendance at school, and afterwards, when the master reported to the foremen in the different departments that certain boys had neglected to attend school, and the foremen sent these boys away, we found we were able to secure the most regular attendance. The first state of things only lasted a month, and we have had no trouble since. The parents did not care about that before, but when we discharged the boys, they came with the most piteous tales, crying, and so on. All the parents seem to care about is the wages of their children, and when they found they were stopped, they took good care that their children went to school.

5795. Supposing you were to say, "I will engage no man in my works who does not bring a certificate of having been at school, or of having received some education in science"?—I should say that that would be a most arbitrary thing, he might be a very useful and a very skilful workman.

5796. But might he not bring a certificate of his skill from the person in whose works he had been?—The man's skill is ascertained by the result of his work.

5797. If you were to say that you would not take any workmen who could not read and write, and do some arithmetic, do you think that would be a feasible plan?—I think not, and there is no necessity for it, because after the Act of Parliament of last year, some primary education of that kind is compulsory. I look upon the extension of the Factory Act as simply amounting to compulsory education in all workshops, and I do not think the want of education of which we have been complaining can exist in future.

5798. *Chairman*.] With regard to the presence of Englishmen and Scotchmen in machine establishments on the Continent, I suppose that what you intended to state was rather this, that many of the large engineering establishments on the Continent had been founded by Englishmen or Scotchmen?—Yes.

5799. But you are of course aware that there are many extensive establishments, and probably some of the most extensive in the world, which are conducted on the Continent by natives of the countries in which they exist?—Yes, but I think that in a very great many cases you will find that they have English and Scotch foremen.

5800. Take for example the establishment of Messrs Borsig, of Berlin, and the establishment of Messrs Kessler, in Stuttgart, you are aware that they are conducted entirely by natives?—Yes.

Q 72.

5801. In France, you would not name Creuzot as one of those in which English superintendance exists?—I suppose Creuzot is of French origin.

5802. With regard to one of your replies, that you did not believe that scientific instruction existed in France, I suppose you referred more especially to the workmen?—Yes, and I purposely excluded Germany.

5803. But you spoke of the workmen rather than of the managers?—Yes.

5804. Would you say that one distinction among others, between this country and France, is this, that you draw your foremen and managers almost exclusively from your workmen, whereas in France the managers, at all events, and many of the foremen, are educated in schools?—I must say that, as far as regards the managers and some of the foremen in France, I wish to speak with all respect about them, because I am in daily communication with them, but I have not found, as I have already stated, that special scientific knowledge among them which would warrant me in saying that they seem to me more educated than the Englishmen of the same class.

5805. They are, however, specially educated in schools?—Yes, the general education is better no doubt, than in our country.

5806. They have received a theoretical education in schools?—No doubt, to a large extent they have adopted the science classes system, and they are teaching chemistry and engineering more than they have been taught in our schools.

5807. I am endeavouring only to distinguish between the two systems; you would I suppose say that our practical knowledge has, until recently, been much greater than theirs?—Yes.

5808. But you will admit that their practical experience has very much increased of late?—Yes, no doubt the world is advancing, but I do not think their practical knowledge has increased in a greater ratio than our own.

5809. You do not admit that the practical experience of the French and Germans has recently increased in greater proportion than that of the English?—I do not admit that.

5810. But apart from any question of superiority or inferiority, you yourself have found it desirable to establish classes at Oldham for science instruction?—Yes.

5811. And I believe you have also contributed very liberally to the endowment of a professorship of civil engineering at Owens' College, Manchester?—Yes; I must say that as far as my own experience goes, I fully endorse everything that is necessary to be done in the way of teaching our people in the manufacturing towns, both in science and art, but more especially in science. My own idea is this, that in this school which I have established at Oldham, and others which are being established in Sheffield, Leeds, and so on, scientific instruction should be given, and that if Owens' College was made a college for the south of Lancashire, embracing those towns, the more advanced students that attend our evening classes should, after attaining a certain local prize, be draughted off to Owens' College at Manchester, and there receive higher instruction, and that some local or other funds should be devoted for their maintenance, and the expenses incidental to their going to college. I am most decidedly of opinion that it is desirable that these colleges should be situated in the centres of manufacturing districts. Our artizan class is the class that we must rely upon for our manufacture, because

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cance they have got the practice, and it is an every day thing with them to do the work; but if we can follow up that practice by scientific instruction, first, in local schools, and then in a more advanced degree at local colleges like Owens' College, which would embrace a population of three quarters of a million, within a radius of about 12 miles round Manchester, I think we should have gone a long way towards attaining the result we are aiming at.

5812. Do you approve of the foundations which have recently been established by the Science and Art Department of 25 L each, to be supplemented by a similar grant from the localities?—Yes, I am quite prepared myself to vote increased money to South Kensington; taking my own school, the Committee must not suppose it is self-supporting. The salary of the science teacher is supplemented by payments on results. Although we have only been established some four years, the first year was about 80 L, and for the last two years he has received from payment on results something like 150 L per annum.

5813. Would you say, then, speaking as a practical man, that the money spent by the Government upon the Oldham School was money well laid out, in an economical sense, with reference to the progress of industry in the nation at large?—Yes; it is all very well to talk of persons doing it all out of their own pockets, but without the aid of the Government I do not think we could have brought the school to the state of efficiency it is in.

5814. You consider your school to be efficient and extremely useful to the locality?—There is no question about its usefulness.

5815. That was one of the points which you were desirous to impress on the Committee, and state in your evidence?—Yes.

5816. For the education of engineers and machinists, what are the scientific subjects to which you would attach the greatest importance?—As far as regards the engineer, I think it is absolutely necessary that he should learn to draw; that he should understand not only mechanical drawing, but also sketching and designing; and he ought to be a good mathematician.

5817. You think he ought to have a fair knowledge of elementary mathematics?—Yes; then, again, if you take the steam engine, it is all very well to say that an artisan could construct or erect a steam engine, but it is also necessary that he should know something of the science of steam. With regard to mathematics, I should say he ought to know as much as he could well attain to; certainly, he should go as far as algebra; our boys at Oldham are very clever at algebra.

5818. You would expect such men to have a fair knowledge of practical geometry?—Yes.

5819. Mr. Acland] Trigonometry?—Yes.

5820. Mathematical mechanics, of course?—Yes.

5821. *Chairman.*] Subsidiary to your work as a mechanical engineer, you are also a manufacturer of iron, I believe?—Yes.

5822. Is it not the case that in that manufacture very great improvements have recently been made?—You may say that one of the greatest improvements ever since the invention of the hot blast has recently been made, the improvement, namely, which has been inaugurated in a great measure by Mr. Bessemer. Mr. Bessemer was not exactly what you may term a practical iron maker, and the fact tends to show what men of

science may do, even though they have little or no practice. He was a man of science, who had a knowledge of chemistry, and in his own little workshop he produced one of the greatest improvements of modern times, an improvement which is likely to lead to the most important results in the manufacturing of iron.

5823. You would say, then, that a scientific knowledge of metallurgy was of great importance to manufacturers of iron?—There is no question about it. It is necessary to the engineer that he should know something of the nature of the iron he is using, and he could not possess that knowledge without a knowledge of chemistry. So satisfied was I of the necessity of that, that I sent my second son, who is an engineer, to Berlin, where he was at college for three years, and chemistry was one of the important things which he had to study.

5824. You sent him to Berlin because you preferred the scientific education which he would get there to any which he could obtain in this country?—Yes.

5825. How long is that ago?—It is four years since he left Berlin; since then he has been in France.

5826. Do you think it desirable that to the higher science schools workshops should be attached?—No, I do not believe in them at all.

5827. You think the time employed in them would be better employed in study?—Yes, my boy is very clever, and he looks upon them all as baby houses.

5828. Mr. Acland] Do you think it is at all important for a man who is to be a practical engineer or a mechanical engineer in after life, that before he gets his scientific instruction he should have any practical experience of the workshop?—I do think it is important; I followed that plan myself with my son. I do not think a lad appreciates the necessity of scientific instruction till he has first had a little practice.

5829. Then, when a lad left school, you would give him a little time in the workshop, interposed between the school and his special scientific instruction?—Yes, I would give him two years in the workshop.

5830. *Chairman.*] One reason for that would be, perhaps, that he would be unwilling, at a more advanced age, to do what is popularly called pulling off his jacket?—Yes; but I have another reason; he does not see the absolute necessity of scientific instruction till he has had a little practical knowledge; after that the science comes to him as a matter of reality.

5831. Are you aware that in many of the polytechnic schools in Germany the course which you recommend is, in practice, adopted; that is to say, that the pupils go through a preliminary course at the polytechnic schools, then enter a workshop, and subsequently finish their scientific education in the polytechnic schools?—Yes; with regard to these schools on the Continent the fault is the same, I think, as there would be in any new country. Their difficulty is, I think, that they cannot get the practice, but in every town and village in England there is a workshop of some kind, and the practice which would be got there might afterwards be supplemented by scientific instruction.

5832. You think that our facilities for combining science with practice would be greater than those which exist on the Continent, provided we had schools of science?—Yes; schools of science established

established in all our manufacturing towns, supplemented by colleges in the various centres of industry, would be the thing that is wanted. At present we receive very efficient support from South Kensington, but our difficulty is to get masters. I want a master now at my school, and I have written to Professor Rankine, in Glasgow, to ask him to find us one. We have very few good masters in England, and we have to try to get them from Scotland. If some system were adopted in the nature of normal colleges to bring up masters for science, I think that would be one of the best things the Government could possibly do.

5833. Taking the amount to consist either of salary alone, or of salary and fees together, what do you say would be a sufficient amount for the remuneration of a science master for such a school as yours?—I do not think you could get the right man for less than 250 *l.* a year.

5834. What are the fees paid by the pupils in your science school?—We make a distinction between the artizans whom we allow to come in at half fee, and the non-artizans, the fees are stated in the syllabus.

5835. You spoke of having one science master, who was a civil engineer and a fellow of the Geological Society, I believe, has he any assistant?—None.

5836. And it is because your classes are increasing, and he finds it difficult to do all the work, that you are now looking for assistance, I suppose?—No, it is not that, but because he has got something to do which pays him better; he has now got a position in the town as an architect, which is paying him much better than teaching.

5837. But you think 250 *l.* would command a man competent to give elementary instruction in science to artizans?—I think that is the lowest sum you would have to pay, you could not go less than that.

5838. Mr. *Ahoyd.*] Do you not find that your mode of selecting foremen from the most promising young men in your establishment, forming, as it does, a kind of system of promotion from the ranks, has a good effect on the *morale* of your establishment altogether?—I think, no doubt, it has. Nothing conduces more to the efficiency of the works than that it should be known that every boy in them has a chance to rise.

5839. The fact that the road to promotion is open to all the youths stimulates them to improve themselves in the practical part of their business?—Yes, but I have carried that further in my own works within the last six months. I have put the business on the limited system, retaining about three-fourths in my own hands, so that a man may feel not only that he could get a better salary, but that he should feel that he might have a share in the works, and was a part of the place to which he gave his services, so satisfied am I of the soundness of the principle to which you refer that I carried it to the extent before stated.

5840. It is understood among the young men that it is a condition of promotion that they must qualify themselves for it by taking science lessons?—Yes.

5841. And the very fact of your calling attention in that manner to the importance of scientific teaching has this effect, that the young men will find it will pay them to devote a certain amount

of labour to the attaining of that knowledge?—Yes, and every day they find the advantage of it by observing that others are promoted.

5842. When they find it will pay, they are anxious to acquire this knowledge?—Yes, that is the great rule of life, no doubt.

5843. Mr. *Dixon.*] Would you advise that the Government should give assistance to the establishment and maintenance of science schools to a greater extent than it has hitherto done?—I maintain that the scientific schools could not be continued without assistance from the State. As a master manufacturer, employing a great many people, it is my interest to pay this money on purpose to have my people educated in science, but, on the other hand, you will very likely find that that will not be the opinion of all the masters in England generally. So satisfied am I, myself, of the desirableness and necessity of this instruction in science, that if South Kensington did not give anything towards it, I should still keep up the school at my own expense.

5844. But under present circumstances, seeing that, generally speaking, manufacturers have shown considerable apathy and indifference to the subject of science teaching, you are an advocate for the Government coming forward and doing more in this respect than they have hitherto done?—Yes, under certain conditions. One would like to see the conditions before one wholly committed one's self, but if there was to be an increased vote for South Kensington for paying by results, I should support that vote.

5845. In what way would you advocate increased action on the part of the Government?—I do not know, at the present moment, that I am prepared to say. One thing that suggested itself to my mind was this, we have a college in Manchester which goes by the name of Owens' College. Within the last two or three months a number of gentlemen, myself amongst them, have subscribed a fund of 10,000 *l.* for endowing an engineering professorship; you would naturally suppose that that was a thing that ought to come within the cognisance of the Government, and that the Government ought to do it. That is one case in which I think Government aid would be desirable. I should, for my own part, certainly do all I could to persuade the Government to vote money for these purposes, and I think they might do great service by offering prizes to young men. It is not every day you find a Mr. Whitworth to endow scholarships such as his. The feeling with regard to those scholarships is one of universal satisfaction all over England, among the engineering class especially. Everybody is delighted with them, and I believe we shall see good results from them.

5846. Would you advise Government action in those districts where the manufacturers have not come forward to establish scientific schools, or would you limit the action of the Government to those localities where a disposition had been shown to establish and maintain those schools?—I should advise a plan something like this: that where a district has shown a desire by subscribing a certain amount, Government should support it by granting at least an equal sum; but I think every district ought to do something for itself.

5847. But the want of this scientific instruction might be quite as great in a neglected district as in the district where there happened to be benevolent and patriotic individuals inclined to make a movement in favour of it?—Yes.

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Then you come to another question, whether Government should found these institutions where there was no desire for them. I think, myself, that the first question is whether the people show a desire for it or not; but if you go to a place where they would not thank you to establish a school of that kind, the probability is that the school would fall into disuse.

5848. But might not the desire exist on the part of the working men, for whose benefit you were contending, although it did not exist on the part of the richer classes, who usually found these schools?—Yes; but I am not prepared to go the length of establishing these schools, unless I saw a desire for them.

5849. But where the desire existed, you would advise a larger action on the part of the Government than has hitherto been the case?—Yes, wherever there was a desire for them, I think the Government should not leave the matter to individual effort, as it does now. You find that a school may be established, and be successful for a time; the patron of that school dies, and then the school gets into disuse, because there is not another patron ready to take it up, but the Government would be a permanent patron, and the institution would not go into disuse, although its founder or first friend might die.

5850. Mr. Acland.] Will you be so good as to give the Committee an estimate of the scale of salaries and other current expenses requisite for conducting such a school of science as you would wish to see established in large manufacturing towns, the buildings and plant to be estimated separately from the current expenses?—I will do so.

SCIENCE AND ART SCHOOLS.

We estimate the cost of schools suitable for a town containing 70,000 or 80,000 inhabitants to be 2,000 l., exclusive of fittings, to embrace—

Science room	-	-	-	50	pupils
Art room	-	-	-	40	"
Laboratory or Chemistry room	-	-	-	20	"

Also master's private room, and one additional classroom, lavatories, &c.

Woodhouse & Potts.

5851. Mr. Potter.] I presume the very large majority of master manufacturers are small capitalists?—Yes.

5852. It is not possible for them to subscribe largely for the establishing of educational institutions, is it?—No, that is quite true, and very important.

5853. Therefore in country districts immense difficulties exist with regard to the education of the working classes?—Yes.

5854. Mr. Acland.] But if this teaching of science is important as an investment to capitalists, do you think it is the duty of the Govern-

ment to come forward with a subvention of capital, be it large or small?—That is really the point. The fact is, that the promotion of science among those people is necessary for the small manufacturers, as well as for the large manufacturers; so that the small manufacturer would, to some extent, get the benefit of what was done without contributing towards the result, his machinery would be improved, and his profits would be increased, and he would be enabled better to resist competition. The question arises, how far the burden should be thrown on the Government, or on the manufacturer who receives the benefit. My answer would be much the same as I gave to the honourable Member for Birmingham just now, that the division should be about equal between the locality and the State.

5855. Mr. Potter.] Then, taking that mode of distribution of the cost, the smaller manufacturers would be obliged to concentrate in the towns, in order to get the benefit of this scientific teaching?—Yes, my schools are open to everybody, they come from the neighbouring villages.

5856. Mr. Ahroyd.] But where there is not a large manufacturer, there might be a number of smaller manufacturers, and they might subscribe collectively, and raise a sufficient fund?—Yes, or you might make it a town's matter.

5857. Mr. Acland.] You stated, just now, that there was a science school at Manchester which would meet the wants of pupils within a radius of 12 miles round. Did you, in giving that answer, consider this point, that if boys have to leave their homes and go to a boarding establishment, it is of very little consequence whether they have to go 12 miles or 50 miles; or did you contemplate those boys being day pupils?—Yes, I did.

5858. Then do you think it is desirable to establish science colleges in England on that principle?—Yes, you would not only have day pupils, you would have evening pupils.

5859. But do you contemplate the establishing of so many science colleges as to bring them within the reach of a daily journey by every person who frequents them for the purpose of receiving instruction?—Yes, that is my deliberate intention.

5860. Then would it not also be, in your opinion, an important point that, for the sake of those manufacturers who may want the highest scientific knowledge, some arrangement should be made to meet the expenses of going to these establishments at a distance where the best education might be given, because the science school, which was close at the door, might be a very bad one?—I think the nearer you bring it to people's doors the better.

Friday, 19th June 1868.

MEMBERS PRESENT:

Mr. Acland
Mr. Bagnall
Lord Frederick Cavendish
Mr. Dixon.
Mr. William Lowther.

Mr. Edmund Potter.
Mr. Powell.
Mr. Samuelson.
Mr. Read.

BERNHARD SAMUELSON, Esq., IN THE CHAIR.

MR. ROBERT RUMNEY, called in; and Examined.

5861. *Chairman.*] I BELIEVE you are an extensive Chemical Manufacturer at Manchester?—Yes, I am a chemical manufacturer

5862. You have been engaged in that occupation for many years, have you not?—For upwards of 30 years.

5863 During the greater portion of that time, I believe you have taken an interest in questions relating to education?—I have taken a very active interest in all educational questions for the whole of that period.

5864 Mr *Potter.*] You have resided in Manchester for 35 years, have you not?—I have.

5865 I believe you are an Alderman of the City of Manchester?—I am.

5866. And I believe you have been in the Council for many years?—I have.

5867 You have taken during the whole of that period a very deep interest in all educational questions?—Yes, during the whole of that period I have been connected with more mechanics' institutions than perhaps anyone else

5868. You have watched the progress of education in Manchester, have you not, during that time?—I have.

5869. You are a Dissenter, I think?—I am.

5870 And have been very much attached to the voluntary system?—Yes.

5871 During the whole of that time, have you made great sacrifices in the cause of education, both pecuniary and otherwise?—Both in time and money I have made sacrifices.

5872. There is no man in Manchester in your position that has given more time to the subject of education than yourself?—Certainly not more than I have.

5873. During the whole of that time you have had very great intercourse with the working classes, have you not?—Yes.

5874. Not only of Manchester, but in the surrounding districts also?—Yes.

5875. And you have attended a great many meetings, have you not?—Yes, I have attended a great many meetings, and given lectures, and had a large amount of intercourse with the working classes.

5876. All the recreation you have had has been in the time you have devoted to education, is not that so?—I believe that is the case to a large extent.

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5877. Is there any change in your opinion with regard to the voluntary system?—My opinion has changed very much with regard to primary secular education. I do not believe that anything short of compulsion can reach a very large class in this country.

5878 There is a great want of education among the working classes in Manchester more particularly, is there not?—Yes, there is a dense population among them, which scarcely anything has reached.

5879. In the country districts it is not so bad, is it?—It is not so bad as in Manchester, where public opinion is brought to bear on the country districts, the ignorance is not so great.

5880. It is the large aggregation of the lower class in Manchester which makes the want of education so much felt, is it not?—I think so.

5881. Do you consider the primary want to be good teaching?—Yes, the primary want is good teaching. The more I consider the subject the more convinced I am that the first great want is good teachers. Teachers as a class, I think, are miserably paid and quite inadequate to their work

5882. They have no great position as educators?—No.

5883. The better part of them quit the profession as soon as they can, do they not?—They do

5884. There are great temptations in large mercantile communities like Manchester?—Yes. I have often applications to get commercial situations for them.

5885. Have not some who have left the profession succeeded well in mercantile pursuits?—Yes, a great many

5886. Now, I believe, the half-time system is largely worked in Manchester and the neighbourhood; what is your opinion of that system?—Using a very expressive, though not a classical word, my own opinion is that it is a great sham. I could give you an illustration from my own experience. Some years ago two very excellent Christian ladies, who wanted something to do, came to me; we established, what we called a domestic mission and a night school for girls, to teach them reading, writing, and arithmetic; that was in a dense factory district with which I am very well acquainted. We have carried it

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on for eight years, there are 400 girls receiving this kind of instruction, including sewing, knitting, and so on, two or three nights a week, a considerable number of those girls are girls from 15 to 25 years of age, and one-fourth of them are half-timers. The teaching is wholly voluntary, we take the teachers out of the Sunday schools; they are not very competent, but they are the best we can get. About 100 of the girls are at present or have been half-timers, and very few of them can read or write. They do not appear to learn anything. The attendance at school is alternate, the morning being devoted to elementary knowledge, and the afternoon to sewing, the time is very short, and the results are such as I describe. They come to us quite willing to learn at the age of 15 to 20, feeling the inconvenience of their own ignorance. They come almost without any knowledge at all.

5887. Perhaps the employers in Manchester, from the density of the population of the lower class, know very little of their own workpeople?—Very little indeed, they cannot know much of them in a place so large, and where the population is so changing.

5888. They take, naturally, very little interest in the working of the half-time system?—They do not take much interest in it, I think; the small employers of labour do not, at all events.

5889. In the country districts, perhaps, a different state of things exists?—The large employers of labour in the country districts take more interest in their position, the hands do not change their employment so much. There is a public opinion brought to bear which is now in favour of education, and the employers feel the responsibility more than they do in large towns.

5890. It would be your opinion, perhaps, that if the compulsory system of day education were carried on to a later period, say to 10 or 12 years of age, and the half-time system afterwards, it would be a very beneficial change?—Yes, I think so; those girls who have been full timers until they were eight or ten years of age, are by far the most intelligent girls we have. They can read very well, they can write, and they know a little of arithmetic.

5891. Passing by the primary schools, what would be your opinion with regard to the best means of supplying artisans with an education of a scientific nature, so as to secure our industrial success and to maintain our competition with foreign countries?—That is a very broad question. My idea is that it is infinitely more important to give elementary knowledge to the whole mass of the people, to give them the implements by which they can educate themselves. I think science education might be left to take care of itself. It is of great importance, but there are facilities now in operation which, to a great extent, meet the requirements of the case; some extension of those facilities might be indicated, but my own conviction is strong upon that point, that the great thing is to give elementary instruction to the mass of the people.

5892. In the secondary class of education is there not a great mass of ignorance on social and economic questions more than scientific ones?—Yes, far more; the evil we suffer from is ignorance on economic subjects far more than scien-

tific subjects, the worst outlook appears to me to be the ignorance of economic laws.

5893. And the consequent power of trades' unions?—I do not know that there is any evil that is unmitigated, otherwise I should say that it was an unmitigated evil. I do not know anything that is doing more to damage the industry of the country than trades' unions.

5894. Especially in your district?—Yes. I always tell the working people (I stand so well with them that I can speak my mind) that that is the case.

5895. In the Lancashire districts there is the means, to a certain extent, of encouraging scientific education?—Yes. The Manchester mechanics' institute of which I have been a director for 30 years, has always been giving scientific education, the directors called it special knowledge, not technical knowledge; but it has had classes for teaching science all that time.

5896. But there has been a great want of teaching on social economy, has there not?—Yes.

5897. There is nothing of the kind among the working classes?—Nothing; the profound ignorance prevails.

5898. Secondary schools of that class, of course, could not be self-supporting to any degree?—Not at present; perhaps ultimately they might be.

5899. Do you think the cost of a sound scientific education would ever be met by the fees of the pupils in those districts?—Not at present, at all events; perhaps hereafter. The great want in these districts is a want of appreciation of the value of education. I can quite conceive it possible that if we could only educate the first generation compulsorily, it might not be necessary afterwards.

5900. You are aware that there is a proposition for education, in Manchester, by means of rates, will you kindly tell me what is the amount of the rates in Manchester?—Perhaps I shall answer your question best by stating that the penny rate which we have under the Free Libraries and Museums Act, brings us in 5,400*l.* a-year.

5901. What is the cost of your free library?—We spend the whole of that money.

5902. Supposing the Manchester ratepayers to be about 60,000 or 70,000, and four-fifths of them under a 10*l.* rental, do you think they could ever be brought to assent to a rate, which might be 6*d.* in the pound, for educational purposes?—I should very much doubt it. I think they would consent to a rate for free schools for the poor.

5903. But not for the education of any class above the poor?—I think not.

5904. Mr. Acland.] Do you think it would make any difference to their opposition to the granting of a rate, if they felt that their own families would be really benefited by it?—Yes, I think it would. I think they would consent to a rate for schools for the poor; but I think it would be very difficult to induce them to pay for schools for shopkeepers, and the class above them.

5905. But suppose the proposal of the School Inquiry Commission were brought before them, namely, that they should grant rates for school buildings, and then fix a reasonable scale of school fees, do you think there would be much objection to that?—No, I think not.

5906. Mr. Potter.] Provided there were free schools, where attendance was compulsory?—Just so.

5907. You

5907. Your trade is that of a manufacturing chemist?—Yes

5908 That is a very extensive trade in the district of South Lancashire?—Yes

5909 To the extent, perhaps, of half a million or a million of money?—Yes

5910 And requiring a large amount of scientific preparation?—Yes.

5911. You are yourself an importer of all the finest scientific preparations for dyeing and manufacturing purposes from France and elsewhere, are you not?—I know pretty well the products of England in that direction, and have some little knowledge of the products of the Continent.

5912 You have been brought in contact both with the foremen and the masters in the manufacturing districts of South Lancashire, particularly those in the calico printing and dyeing trade?—Yes, especially those

5913 Will you kindly give the Committee some idea of the extent of that trade?—The calico printing and dyeing trade as very large indeed

5914 Taking the calico printing and dyeing trade as a section of the large cotton trade of this country, should you say it was equal to a return of twenty to twenty-five millions of money?—I should think so; the export trade might be taken at from fifteen to twenty millions, and the home trade at four or five millions.

5915 You are aware that the cotton trade is the largest export trade we have in this country?—Yes.

5916. And the artisans in the calico printing trade are the best educated class of artisans, and the best paid?—I should say they were the most intelligent class in the cotton trade.

5917. The trade, as far as the workman as concerned, is one of the most remunerative ones, I believe?—It requires the greatest amount of skill of any branch in the trade

5918 The establishments of these classes of business are chiefly in country districts?—Yes

5919 That is more advantageous for the moral and physical condition of the workmen than if they were in towns?—Yes

5920 But not so favourable to their education perhaps?—It would be more difficult to get high class scientific education in villages than in towns.

5921 From the impossibility of their paying the fees of good masters?—Yes.

5922 And yet, it is among that class that scientific education is more needed than in any other department of the cotton trade?—Yes, no question about it

5923 Something has been said, perhaps, of the laxness of the masters themselves in seeking to supply education to those whom they employ?—I do not very well see how they can do it in the country districts, they are not large employers.

5924. They are often very small capitalists?—Yes.

5925. They cannot afford to establish schools of their own?—Just so; they must avail themselves of the schools around them, and they do not employ a large number of young people

5926. There, however, have been many signal instances of devotion among the masters to the education of the workpeople?—Very many

5927 Has not there been a very marked progress within the last 20 years in the education of the class to which we are more particularly referring?—A very marked progress.

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5928. You find men of great natural ability among them?—The class of men who have now the charge of that trade are a very superior class of men, very superior to the men of 20 years ago

5929. A good deal has been said before this Committee of the ignorance of the foremen class, and the want of a proper supply of foremen; have you anything to remark upon that subject?—My experience is contrary to that, they are not ignorant men, they are very intelligent men

5930 And you are practically acquainted with almost all the works of that class in your district, I suppose?—I think I am acquainted with all of them, more or less, in South Lancashire; and in Glasgow I am acquainted with many of them

5931 And you find no want of practical knowledge among that class?—No, I find them very clever

5932 And many of them do strive to procure a certain amount of education?—Yes.

5933 Particularly in chemical knowledge?—Yes

5934 And large numbers of them, I believe, are sound practical chemists?—Many of them are very good chemists

5935 The master class is, I believe, drawn almost entirely from that class of men?—Almost entirely.

5936 Are there very frequent instances of scientifically educated men having been successful at the head of these trades?—No, but some of the younger masters are well-educated men.

5937 In many establishments now are there not among the master class in the cotton trade young men who have taken degrees at the London University, or at the Glasgow University, or in connection with Owens' College?—I should say a great many

5938 Twenty-five years ago there was perhaps not one, or scarcely one?—Just so

5939 The larger capitalists who are able to appreciate it do value an educated staff?—I should think so

5940. Do not those educated foremen command very ample salaries?—Yes, they are well-paid men in the print trade

5941 But is it not the fact that commercial knowledge and economical knowledge are better paid than scientific knowledge?—Better paid than purely scientific knowledge.

5942. But better paid than scientific knowledge?—If you merely take a good chemist, yes, but if you take the managers, then they are as well paid as many merely commercial men, there is a far wider field for men, salesmen, and others in the warehouses than in the works, perhaps.

5943 Now with regard to the French print trade; have you a practical knowledge of that?—I know it by visiting Mulhouse and Paris

5944. The French are the producers of the finest and most elaborate productions in the print trade, are they not?—Yes

5945. But that production is a small one?—Very small.

5946. Probably you can say, from your own knowledge, that those finer portions of the print trade which require higher taste and chemical knowledge are not more than a twentieth of the whole trade?—I should say not a twentieth; I do not know that it could not be carried on here, I fancy that Messrs. Crum, of Glasgow, and Messrs. James Black, could do it.

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5947. May I take it that it is your opinion that the printers who supply 19-20ths of this trade are possessed of superior machinery and superior organization to anything abroad?—Certainly, the English common prints are very much superior to any I have seen in France, speaking generally.

5948. The English printers produce nineteenth-twentieths of the whole of the trade?—Yes.

5949. Do you think the English printer has advanced very rapidly on his French competitor within the last 20 years, in staple goods?—He has decidedly advanced, the machinery and general organisation, as far as I have seen them, are very superior in England, the French are, perhaps, better colourists, but in every thing else they are very much inferior to us.

5950. *Chairman*] To what do you attribute the fact that they are better colourists?—I think it is the climate, perhaps, and their general education; perhaps they pay more attention to fine colours than the English printers; in England, quantity and common use have been regarded as of prime importance

5951. Do you mean, as a matter of taste, their style of colours in France is superior, or that the colours themselves are superior?—The colours themselves; take, for instance, the finest colours which are put on woollen fabrics, the French seem to have finer fabrics to work upon, they select their woollens with greater care, of which the De Laine trade is an instance, and they have cultivated apparently the finest class of prints; that is to say, they have attempted to print very fine for small consumers, while the English printers have printed for the million.

5952. Then assuming that our printers find it worth their while to follow a similar trade, do you think that they have the capacity to do it?—I think they have the capacity, but I am not quite sure whether the climate has not something to do with the French colours, but there is no question that the English could do it in most cases if it would pay them to do it.

5953. You do not think that the production of those very exquisite colours depends in any measure upon superior knowledge, skill, and attention to minute details, with regard to the chemistry of colour in France?—I think not.

5954. *Mr. Potter.*] Would it not be much more costly for the English printer to supply that class of goods?—Much more costly, a great deal depends upon the fact that hand labour is cheaper in France.

5955. The labour would be obtainable at 40 per cent. less cost?—Yes.

5956. And there is much less machinery employed there than is employed in England?—Yes.

5957. It is your opinion, in fact, that machinery could not be supplied for the production of such things?—It could not be done by machinery.

5958. But in every trade in these branches in which the conditions are at all the same, is not the English printer quite the equal of the French printer?—Quite.

5959. May I ask you whether in the commoner colours, the English printer is not superior to the French?—I should say he is decidedly superior.

5960. Whenever the Englishman can bring machinery to bear, he is superior to the Frenchman?—Yes; a very large portion of the prints are produced by machinery.

5961. The French master-printers of the

highest class are a very well-educated class of men?—Yes, as far as I know them, they are.

5962. Do you think that the English school has within the last 20 years furnished men of equal eminence with the French, even as chemists; take, for instance, one very remarkable name, that of Mr. Mercer?—Yes, he was an extraordinary man, quite equal to anyone that France produced.

5963. He having risen from the working class, having been himself a weaver?—Yes.

5964. And there are other names of the same kind, for instance, that of Thomson?—Yes.

5965. But in England the master class are not usually men who have received University education?—The French are men of higher culture, but in general intelligence they are not superior to the English.

5966. And they are certainly inferior in economic knowledge, I suppose?—Very, decidedly so.

5967. Have you ever heard an expression on the part of the English printers of any fear of French competition?—Not the least.

5968. You are aware there are no duties on the import of French goods into this country, nor have been for 20 years past?—Yes.

5969. And yet the import is confined to a very limited supply of fine goods?—Yes.

5970. Now, with regard to art teaching and designs for the English print trade, these are chiefly supplied to the English printers from Paris?—Sketches are supplied; a great many of them, and they are adapted in Manchester.

5971. Some of the leading houses in England have establishments in Paris, and costly establishments for that purpose?—Yes.

5972. The supply is both better and cheaper in that way, I suppose?—It is cheaper, perhaps better.

5973. We may presume that it must be better because the purchases are so very large?—Yes.

5974. The designers in those *ateliers* are not altogether French, are they?—I believe there are both English and German.

5975. There has been an art school in Manchester for the last 40 years, has there not?—Yes; it was established by the calico printers, with some idea of training designers.

5976. You have been a director of that school for many years, I believe?—Yes; I have been on the council several times.

5977. The annual expenditure of that school has been about 1,200*l.* per annum, has it not?—*£*. 1,200 or 1,300*l.*

5978. Are you aware also that out of the classes taught there, there is not above one-fourth of the artisan class?—I should say from one-fourth to a half.

5979. The subscriptions and the allowance from South Kensington come to about 400*l.* a year, do they not?—The entire cost is about 1,100*l.* or 1,200*l.*; last year the cost was 1,200*l.* independently of the amount received from South Kensington.

5980. That school was established mainly for the purpose of supplying designs?—Yes; it was called a School of Design.

5981. But it never succeeded to any great extent, I think?—I think not.

5982. But it is a very good Art School for teaching the upper classes, I believe?—It has trained several painters, men like Watson and others.

5983. *Chairman*

5983. *Chairman*] What chemicals do you produce?—They are chiefly the mordants used by calico printers and dyes.

5984. You are not a manufacturer of soda, are you?—We have works standing for the manufacture of soda ash, but we could not compete with our neighbours, and we closed them; I do not know whether we shall ever re-open them.

5985. You are aware that the present mode of manufacturing soda ash is of French invention?—I am not aware of that, I think it owes as much to English chemists as French chemists, and in fact, there have not been many improvements.

5986. But was not the production of soda ash from salt an invention of Le Blanc, a French chemist?—I believe he claims it, and I do not dispute the claim, but I think it is not accorded to him by everybody.

5987. Is it attributed to some working man?—I cannot say.

5988. With reference to the exquisite colours produced in Mulhouse, and elsewhere, the invention of the aniline dyes, for example, was an invention of a scientific chemist, was it not?—There are several claimants for that.

5989. But was not Mr. Perkins a scientific chemist?—He was a practical chemist, as well as a scientific man, but he was not the inventor of these dyes, he simply took the inventions of other people, and used them, but Mr Perkins has made discoveries.

5990. And he is a scientific man?—He is a scientific man.

5991. With regard to the distillation of oil from coal, was not that also the discovery of a man who possessed scientific knowledge, Mr. James Young?—He got his scientific knowledge after he got his practical knowledge, and he was a working man.

5992. But at the time he made the discovery, he was a scientific chemist, was he not?—Yes, being also a practical manager of chemical works.

5993. But he was a man of science?—Yes.

5994. It was not by any mere course of trial and error that that discovery was made; it was based on scientific considerations, was it not?—I should almost doubt it.

5995. But if he stated it, you would accept it?—Yes, but I know very well what he was doing at the time.

5996. *Mr. Potter*] He had never had the benefit of scientific training, had he?—I know that he was a working man.

5997. *Chairman*] Are you not aware that he received scientific instruction in the Andersonian University at Glasgow?—He attended there.

5998. Do you not think the acquisition of scientific knowledge of very great value to practical men?—I have no doubt about it.

5999. *Mr. Powell*] You would wish to combine the two things, I suppose?—I think so. It is possible to have scientific men who are utterly incompetent to manage your works. I think the training up of what may be called captains of industry is an idea that may mislead, it requires much more than a mere scientific training to make a man a captain of industry; by which I mean, the manager of a large establishment. A very pertinent illustration is afforded by the young man named by Professor Roscoe, Mr. Hartley, who is with me at this moment. He had attended some courses of lectures, and I took him.

6000. *Mr. Potter*] You took him from a feeling of kindness?—Partly so, and he soon got know-

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ledge enough to enable him to conduct analyses in inorganic chemistry, which as all I require, and then he became a science teacher, in which he was very successful. But afterwards he left me to manage some works. I never asked him much about it, but I was very much surprised; and, in fact, he soon came back again, as I expected he would, for he was quite incompetent for such a post; he has a good knowledge of chemistry, is an excellent teacher, but quite uncultured, and not capable of managing an establishment.

6001. *Mr. Powell*] He has not the faculty of governing men?—No.

6002. *Mr. Potter*] May I take it, that if Mr. Hartley had had the advantage of a good primary education first, he might have acquired that faculty?—Yes, perhaps so, but it requires a moral power which scarcely any education could be expected to give; a good primary education would have been of great advantage to him, but it would not have made him a captain of industry.

6003. *Mr. Powell*] You said that labour was 40 per cent. less in France than it is in England, I suppose you referred only to the weekly wages of given individuals?—Just so.

6004. *Mr. Acland*] I think you stated that, in the present state of public opinion, the fees alone would not pay for scientific education, but do you not think that if the State were to take measures to establish a thoroughly good public standard of education, by which efficient teachers could clearly be distinguished from inefficient ones, that would very much affect the market value of education, and the power of raising the fees?—I think it would; but that would depend very much on what remuneration the teacher saw before him. I think it is of primary importance to have a better class of teachers, the teaching in our primary schools is bad, and it has lately been growing worse under the influence of the late Minutes.

6005. In what respects do you think those Minutes have done harm?—They have reduced the standard of qualification.

6006. You do not mean that you think a well-trained master from a good training college, as a general rule, is an incompetent teacher?—I think that a well-trained master from a good training college would not be an incompetent teacher.

6007. Then do you mean that there are not enough of that class of men?—Just so.

6008. Do you think that the remedy for the present deficiencies is rather to be found in improving the primary and secondary education of the country generally, or in establishing institutions for the special teaching of science?—In the former, decidedly. I think science might be left to take care of itself, if we once got good primary education, though of course that must be based on scientific principles and be combined with some knowledge of common things.

6009. Will you kindly point out in what way you think primary education might be improved in England; bearing in mind the particular object of this Committee, which is to improve education with a view to the improvement of our national industry, do you think that confining payment for results to any examination in the three R's is not at present working well?—I think it is not giving the scholars much information, it is not inspiring them with a love of knowledge. What I should like to see in primary schools would be a

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thorough knowledge, so far as it is possible, of the implements by which they could afterwards educate themselves. My opinion is that it is of infinitely more importance to give good general primary instruction to the mass of the people, than to give any kind of special instruction.

6010. Assuming that to be done, my question is this, taking primary education as you usually find it in your district, do you think the deficiency as due, not in quantity but in quality, to the requirements of the Government confining to the three R's the test by which the money is to be paid?—In part I should say so.

6011. Do you think that that is most injurious in shutting the door to information, or in producing a stagnating effect on the minds of the pupils, or do you think it operates in both ways?—Perhaps in both ways. I do not think they seem to be impressed, after leaving school, with a desire to pursue any studies whatever.

6012. I understand you to say generally, that we cannot do much for the industry of the country in the direction of what is called technical education, unless we thoroughly grapple with the question of primary education?—I do indeed think so.

6013. Then I gather from you that, in the matter of primary education, you think it positively deficient in quantity?—I think that it is positively deficient in quantity, and still more deficient in quality.

6014. You are aware that there are many differences of opinion on the statistics of education?—Yes, I am.

6015. Confining your answer to your own district in your opinion which of the statistical views are most correct: those which take a favourable or an unfavourable view of the quantity of education?—I am rather inclined to those that take a favourable view of it, I think the statistics have been exaggerated.

6016. In what sense?—The amount of the ignorance of men who are stated not to have received any education is exaggerated, and sufficient allowance is not made for those who are sick and detained at home and those who are poor; education is a costly thing to a poor working man.

6017. Still, after making allowance for that, you think there is a considerable deficiency in education, if it is not to such an extent as we are inclined to say?—Yes, there is.

6018. Are you, on the whole, disposed to think that the deficiencies in primary education, in point of quality, are to be met by a combination of various efforts or by State action?—I think they cannot be met without State action. I am sorry to come to that conclusion, but I think the State action should be of such a character as to call into exercise voluntary effort.

6019. Should you be, on the whole, favourably disposed to develop and amend the existing system, or to substitute a system of local rates?—I am rather inclined to the development of the present system with the modifications suggested.

6020. Some persons of some weight and authority have expressed an opinion that it is quite impossible to keep up any voluntary action if any kind of rate is adopted; do you agree with that?—No.

6021. In what way do you think a local rate might be combined with voluntary action?—I see greater difficulty in combining voluntary action with a local rate than I do in combining voluntary action with a Government subsidy.

6022. Keeping in mind the particular object of this Committee, which is to find out what kind of improvement in our educational system, will conduce to the advancement of our industrial prosperity, are you of opinion that it would be desirable in this country to take any measure with the view to supplementary practical work on apprenticeship?—Certainly not, it would be most objectionable to meddle with the workshops.

6023. Do you think that there is any department at all of industry in which a model establishment of an industrial kind could be conducted with practical success so as to give experience of real business to the pupils?—I do not think so.

6024. Is your reason for coming to that conclusion that the business so shown is, in point of fact, a show article or a model, and not a reality?—I think so, it would be a sham and not a reality.

6025. You think still that the practical experience which we have been in the habit of teaching in England requires to be supplemented by a greater amount of scientific knowledge?—Yes, I do.

6026. Would that be best done by giving scientific knowledge in the form of improving our general secular education, or by forming special institutions for scientific teaching?—Perhaps both, but the former is the more important of the two.

6027. Do you think that we want a new system of secondary schools for tradesmen, foremen, and upper artisans, or that we may improve both the existing endowed schools and the private schools?—I do not think that we want a new system of schools at all. I think the present endowed schools might be altered to great advantage, by introducing scientific teaching, in my opinion, that is one of the great points.

6028. Do you think that if a good system of examinations coupled with exhibitions, derivable either from endowments or other sources, were open to private schoolmasters, they would respond to the whip and improve their system?—Yes; the difficulty we have in Lancashire now is in the science classes finding good teachers. We have no difficulty in finding night pupils; we can find teachers.

6029. My questions have only to do with schools, I speak of the education of young lad above the age of 12 up to 14 or 16 or 18, according to their position?—What we want for sharp intelligent boys who leave the primary schools is some cheap technical institution by which they could carry on their education.

6030. Are you able to give us any suggestion on that subject, which I am aware is one of the most difficult to deal with?—Altering the foundations of the present classical grammar school would do much towards remedying the evil.

6031. It has been proposed that endowment which are now spent very much in supply cheap evening education, by giving fixed salaries to masters, and education to pupils either at low rates or gratuitously, should not be spent in that way, but that the system should be done away with, or very much modified, and that the endowment should be used to stimulate and improve education in the form of exhibitions open to public competition, and that those exhibitions should be open to public schools as well as private schools. Do you think that such a proposal would answer?—I should think it would.

6032. It has been suggested that it would be desirable to have science colleges at four or five or more centres of industry, or rather large schools for pupils who have gone through a good general secondary education, and who desire to have the best scientific education the country could afford. Should you be favourable to that plan?—I should be favourable to a few such schools, but I do not think many would be needed. Owens' College, in Manchester, would supply the whole of Manchester and district. It is a very easy matter in our mechanics' institutions to establish a science class if we can find a teacher. I may give an illustration. In more than one case where I have attended meetings I have offered small money prizes to induce the members to form a science class. At one of the smallest institutions the matter was taken up, with some heartiness by the directors, and a chemistry class was formed, that class has been most successful. Mr Hartley is the teacher of that class; other cases of the kind have occurred, several of such pupils, who had received a stimulus during their first elementary instruction, have gone for further instruction to Dr Roscoe, or have pursued it under some chemist privately. There is no difficulty in forming science classes, except that of obtaining science teachers. The remuneration is in some cases inadequate. All that is required after the elementary instruction in these classes, is some means by which a young man who is poor could go to such a college as Owens' College to pursue his studies. The scholarships are valuable, I myself, in our associated organisation of institutes of Lancashire and Cheshire, am about to give 50*l.* a year as an encouragement to the pupil who has taken the largest number of certificates from the examination of the Society of Arts, the Government science classes, and our own examinations. He will have 50*l.* a year for three years to pursue his studies there if he likes. The spread of these scholarships, the Whitworth scholarships and others, in such a college as Owens' College, would nearly meet all the requirements of the case. I also think it is of very great importance in order to generalise and extend technical education to have lectures. A suggestion has been made here more than once in connection with Owens' College, that if the Government gives any money for the endowment of any of its chairs, free lectures should be given every winter. Whether there should be half a dozen of such colleges, whether there should be one in Bradford, one in Leeds, and one in Birmingham, I cannot say.

6033. Before you go to any other subject I wish to ask a few questions about free lectures?—I think that free lectures are of very great advantage, anyone who has anything to do with young men knows that some suggestion starts him upon a career of self-improvement, and, after all, self-improvement is infinitely more important than anything the boy gets at school, as to his future life and character. Of course free lectures would stimulate him.

6034. You recommended lectures as the means of stimulating and giving a starting point to improvement?—Yes.

6035. Are you prepared to say, and if so, will you give your reasons for saying, that it is the duty of the State to give gratuitous, or nearly gratuitous education to any particular class for technical purposes?—I am not prepared to say that it is. I think it is the duty of the State to

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look after primary education, and it may be the duty of the State to encourage technical education by supporting such an institution as Owens' College, and the return for that would be giving lectures to the working class generally.

6036. The reason for giving a lecture would be a temporary one, to improve the present state of public opinion?—The object would be to elevate public opinion, and give a stimulus to the youths who might attend the lectures.

6037. Are you prepared to say that if the industry of a great town finds the need of increased scientific instruction beyond what it now has, it is the duty of the State to subsidise it?—No, I believe it is not. If a town has such need, it will get that instruction; but the difficulty is impressing it with a conviction of that need.

6038. Supposing it to be a question of a profitable investment of capital in brains, is it the duty of the manufacturer to make the investment, or of the State to make it for him?—I think it is rather the duty of the manufacturer than of the State.

6039. With regard to the exhibitions, do you think that sums of 10*l.* or 15*l.* would be sufficient to induce the sons of working men, or the sons of small shop-keepers at the age of 13 or 14, to continue their education?—I should think that sums of 15*l.* to 20*l.* would induce them to do so.

6040. Mr Powell.] You spoke of the remuneration of the science teachers as being inadequate; what should you consider to be a fair remuneration?—At present it is very precarious. I believe some of our Lancashire science teachers are very well paid. It depends upon the number of the classes they can arrange to have, and upon the contiguity of the different institutions to each other. I think one or two of them make from 120*l.* to 150*l.* a year, but that is derived only from night work.

6041. How is the rest of the day spent by them?—The rest of the day they spend as they please. I am now speaking of the teachers of the Government science classes. I have a man in my own employment who is a Government science teacher. If he can be occupied every night in the week in teaching a numerous class, he would make 150*l.* a year by it.

6042. Is there any reason why he should not be engaged during the day in teaching the higher classes of primary schools?—There is no reason why he should not be so engaged.

6043. What should you consider to be a sufficient remuneration for a man fully occupied in teaching?—I should think from 300*l.* to 400*l.* a year would be adequate, if he was a competent teacher.

6044. Do you mean to teach youths?—To teach young men who have received a primary education.

6045. Do you think there is much probability of such a remuneration being produced either from public or private sources?—No, not until we have a much higher appreciation of the value of education for its own sake, apart from any material interest connected therewith.

6046. Should you be willing to trust the maintenance of chairs in such a college as Owens' College to the House of Commons, an assembly which in financial matters is liable to very cold fits?—I should think it might be so entrusted. The House of Commons is in advance of the general country.

6047. You would rather rely upon the House

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of Commons than upon the independent action of such a community as Manchester?—I think the House of Commons should only supplement independent action. I think in any case it is not desirable for the State to supply funds without calling into exercise the interest and efforts of others.

6048. You would make use of the action of the central Government as a stimulant and a guide?—I would do so as a stimulant and a guide.

6049. When you speak of its being desirable that youths having attained the age of 12 or 14 should have technical education, do you use the term technical in the sense which has been used in this Committee, namely, science closely allied to the pursuits of life, or did you apply it as being synonymous with science generally?—Synonymous with science simply, not science applied. He would find out afterwards how to apply it.

6050. With reference to England, you spoke with great reason against artificial workshops as modes of instruction; supposing you had a country in possession of some national resources entirely undeveloped, should you think it wise to promote artificial workshops in that country, so as to bring home to the minds of the people the nature of the resources which they had?—I should doubt whether you could stimulate the industry of the country by making artificial workshops.

6051. But you show the people on the spot what you suppose the resources could produce?—You would show them something, and they would attempt to carry it out, and would be utterly disappointed with the result.

6052. Is not that the state of affairs in Zurich, and some of the continental countries?—I understand, from reading, that on the whole they have failed. I think that is so in France.

6053. Are you acquainted with the schools in Zurich?—No, I am not.

6054. Mr. Dickson.] Have you had considerable practical acquaintance with the working of mechanics' institutes and science classes in Lancashire?—I have had very considerable acquaintance with them. I introduced Dr. Booth, who first established the Society of Arts' examinations. I introduced him to the mechanics' institutes there, and we have had the Society of Arts' examinations ever since, and they have been extended. I introduced Mr. Buckmaster to the mechanics' institution for the establishment of the Government science classes there. They were the first introduced.

6055. Have you found that the demand for science teaching has been steadily on the increase?—It has been steadily on the increase, as it has been stimulated by us in the council. We scarcely ever found a demand without first stimulating it by soliciting, and recommending the objects, but the demand is increasing year by year.

6056. Do you consider that that scientific teaching to the working classes would be of great benefit to the industry of the district?—I do not, indeed, think so.

6057. Then why do you promote it?—I think an educated people much better than an uneducated people, but I think it is not from the want of scientific teaching we are not making the progress we ought to do. It is rather the want of economical teaching. We are deficient in scientific knowledge, but we are not suffering

from that deficiency so much as from the neglect of economical laws.

6058. Assuming that good primary education is given to the people, would you advocate the addition of scientific instruction to the working classes?—Yes, I would.

6059. Do you think that the additional scientific instruction would be of advantage in the development of the industrial resources of the district?—I think it would be of advantage in that respect to some extent.

6060. Would it be of a greater advantage than giving to the working classes a knowledge of Latin or Greek, or some other branch of study which has no bearing upon the industry of the district?—Yes, entirely so.

6061. So that you would advocate giving scientific instruction if you had only first obtained good primary education?—Yes; I have advocated it all my life.

6062. In what way do you think scientific instruction, given under such circumstances, would develop the industrial resources of the district?—You have had progress hitherto made by scientific men, and in that event you would have a larger number. I have no doubt that it would have been an advantage to Mr. Mercer if he had had an early scientific training; and the probabilities are that if a considerable section of the working class was instructed in science you would have inventions and improvements in industrial pursuits amongst the community.

6063. Do you think that in the management of the manufactories of the district a greater amount of scientific education amongst the foremen would be of advantage apart from any inventions that such scientific instruction might lead up to?—They would be better able to direct intelligently the men under them. I do not think it would necessarily make them managers at all, because there are other higher and more important qualifications than technical knowledge required in managers of works of any kind.

6064. You mean that mere sciences would not constitute a foreman?—That is what I mean.

6065. The question is, whether a knowledge of science would not enable them better to understand the processes which they were superintending, and therefore make them better foremen on that account?—I think there is no doubt it would. My meaning is this for instance, take the trade to which reference has been made, which requires more skill than any other trade in Lancashire, that is the trade of calico printing. It is very easy to purchase the chemical knowledge. It is possible to have a very excellent manager without much chemical knowledge, because there is an abundant supply of chemists now. A few years ago a chemist was not to be had. I, for instance, have had a Russian, and I have had Germans, but now I have no difficulty in obtaining an English chemist. It is the same with regard to works where chemistry is required; you can purchase chemical knowledge. It has not a very high value attached to it at present.

6066. So far as you are acquainted with the manufactories of your district, do you think that the masters are supplied with a sufficient number of scientifically trained foremen and managers?—To a great extent I think they are, but there are many trades that do not require them. For instance, the spinning and weaving of cotton does not require a foreman scientifically educated. It requires a good mechanic.

6067 In those cases where scientific training is of advantage, is there a sufficient supply of it?—I think there is. I know in my own trade I have constant applications from young chemists. We used to have very large impositions from Germany; but they found the competition too strong for them. I have been obliged frequently to send back Germans and others, who have come to me seeking employment. I remember three recently who came over to learn processes, and who have gone back to carry them out in their own country. One young man, a Russian, whom I became acquainted with, obtained as much information as he could in our employ, and has gone back to Russia to manage works, and two in Germany are doing the same thing now.

6068. Do you refer exclusively to your own trade?—Yes.

6069. You cannot speak to other branches of trade?—I am engaged largely in the iron trade, where we employ from 2,000 to 3,000 men. If we wanted a chemist, we should have no difficulty in obtaining one.

6070. Speaking generally, as far as your information goes, are you not aware of any want of scientific knowledge in the foremen and managers of the manufactories?—I should not say that there is not any want, but there is no pressing want, and I would say further, that I do not think trades are suffering to any great extent from the want of it.

6071. I did not put my question in that way, I asked whether they could be beneficially increased by a larger amount of scientific knowledge?—To some extent, I should think they might.

6072. You say that you are very anxious indeed that elementary instruction should be given to the people, but as regards scientific education, you think it might be left to take care of itself?—Very much so.

6073. In what way do you think it would take care of itself?—In the very way that it is doing now, that if we had a better instructed artisan class, they would be members of our institutions, and they would be starting off in life from a rather higher platform, and joining in larger numbers the science classes, where pure science is taught to them. I think we should have double or treble the number we have, if it was not for the lack of elementary training. We have that difficulty strikingly illustrated in our examinations. The Society of Arts very properly insists upon an elementary examination. We have students constantly pretty well prepared to go in for special sciences who have not an elementary knowledge, and cannot therefore compete.

6074. What is the object with which youths pursue a scientific study?—The object of many of them is, to better their position; but many pursue it for the love of it; and I think it is desirable to cultivate education for its own sake, and not for any pecuniary prospective advantages.

6075. The larger number seek a pecuniary advantage from their scientific knowledge, do they not?—I do not think they have any definite object in view in these classes, but their ambition is excited, and they would look forward to bettering their position in life.

6076. Do you think they are correct in that view?—To a certain extent they are correct; of course, if we had a very large number, no doubt there would be great disappointments, because

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there would not be situations for all of them. Education is a costly matter, and that is a difficulty. I think the present feeling of the working class, especially the unskilled artisan, is thus, if he sends his boy to a good school and pays for his schooling, and the boy is rather sharp, his idea is, to put him to some other occupation, he is not to follow his father's occupation. Instruction is looked upon as a means to an end, and he would try to get him in a warehouse or some commercial occupation. If the father is a stonecutter, the son is not to be instructed in stonecutting, because he thinks the son's education fits him for a higher position.

6077. That would apply to general education, but not to scientific education which would only fit the boy for a manufacturer?—I speak of the feeling which the working classes generally entertain respecting the education of their children, they do not appreciate it for its own sake, but that it may bring something to them in the way of a better position for their boys.

6078. As regards the scientific part of that instruction, you think they are somewhat mistaken?—I think they are mistaken, if there were a large number scientifically trained, there would not be occupations for them.

6079. You do not think that a man would make a better workman because he had a knowledge of the science which underlies the art he is practising?—I think he would not, if he had simply the knowledge, apart altogether from any moral considerations, his daily work is so much a matter of routine and mechanism. The subdivision of labour by which we obtain our economical results, is carried out so far where it can be, that I do not think, being scientifically trained, would make a man a better workman apart from the higher moral training which might, or might not, accompany it. One might hope that it would follow, but supposing a man daily working in a machine shop, at a lathe, all the technical knowledge of iron which he could possess would not help him to work the lathe or tool better.

6080. Mr. Potter.] His master does not ask it?—He does not require him to have that knowledge.

6081. Mr. Dixon.] You say that in your opinion there is a sufficient supply of scientific instruction amongst the foremen, and yet, at the same time, that there is such a demand for science teaching, that you are unable to find teachers enough; does not that seem rather contradictory?—The science teaching in these institutions is of very recent growth; these science teachers, I apprehend, are the first fruits of the establishment of these science classes, originated by the Society of Arts, and carried on by the Government. I should suppose that all the teachers we have (I am speaking now without being quite certain) are pupils of those earlier science classes. Speaking of my own trade, there is no difficulty in obtaining chemists, which I attribute as a result of these science classes. Still a man may be well instructed in science and be utterly unable to communicate it. It does not follow that he should become a teacher or be able to teach if he has been scientifically trained.

6082. Do you think the examinations of the Science and Art Department have been useful?—I think so.

6083. And of the Society of Arts as well?—Yes, the standard has been raised.

6084. And the Oxford and Cambridge examinations?—

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aminations?—Yes, I think it is a great pity we should need them, I hope we shall arrive at a higher appreciation of education, and dispense with them some day; but to a great extent they have been valuable.

6085. You have had great experience in the management of science and art classes in the mechanics' institutes. I suppose you have acquired considerable funds, have you not, to carry them on?—No, the institutions have not had to pay at all. Payment on results by the Government has been the only payment generally received by the teachers. In mechanics' institutions there have been very good mechanical drawing classes for years, and we had to pay the teachers 700 £ or 120 £ a year; but the establishment of the Government science classes took the payment out of our hands, we now find that the payment which the teachers receive is quite sufficient without the institution being burdened with their payment, and it therefore relieves the institution to that extent.

6086. Then those science classes have not been a burden upon the institutions?—No, they have helped the institutions.

6087. Have you been able to supply the demand for science teaching?—We have been able to supply the demand, but I think if we had more good teachers we could soon create a greater demand. At some of our annual meetings we have suggested the establishment of these classes, and we have told them that the teachers will come and take them, depending upon the result, possibly we offer a small prize to a student who shall pass the first examination, and the class is started.

6088. In addition to what the Government has already done for science, through the Science and Art Department, all you would advocate in addition would be that the Government should assist in providing a sufficient number of good teachers?—I should think it very important. The Government is going in the right direction.

6089. That is about all you would advocate the Government doing?—Yes, except in connection with Owens' College and the institutions which might be established at Birmingham and elsewhere, where I think the Government might aid in paying teachers who would give lectures. I attach very much more importance to lectures than some of the witnesses who have been examined, I consider them to be of great advantage, not as teaching instruments, but as stimulants. The system of free lecturing would be of great advantage with us.

6090. With reference to science teachers at present, how do you think the Government could act so as to increase the number?—Only by paying more liberally, but keeping to the system of paying for results, possibly that might do it, but I am not clear upon that point.

6091. You mean that the Government should raise the emoluments?—Yes, and so raise the teacher in the estimation of the public, lift him up, in fact. Unfortunately, a teacher is not appreciated at present as he ought to be by the general public.

6092. Would you advocate Government making grants for the erection of such buildings as Owens' College, not only in Manchester, but in a few other centres?—I think that they should spend a little money upon buildings in a few centres where such an effort was met in a corresponding manner by the inhabitants.

6093. And in addition to a grant of money for the erection of buildings, would you further advocate the Government paying a portion of the salaries of the professors in the colleges?—They might pay a portion of the salaries, because it would stimulate the benevolence of the neighbourhood. I would not, in any case, help a locality unless it would do a great deal for itself. I should not be disposed to ask the Government to do very much, but I think that if gentlemen connected with Owens' College would raise 100,000 £ the Government, over a few years, might very properly expend 100,000 £ also.

6094. I think I understood you to say that there is amongst the working classes a readiness to be taught if there were teachers?—Yes, I believe there is.

6095. Hitherto the teachers have been mainly brought to these working men by means of such gentlemen as yourself, who, seeing the advantage to be derived from education, have spent their money and their time in providing it for them?—That has been the case.

6096. Then the only difference between your district and one of these neglected districts, remote from the great centre, would probably be the absence, in the latter case, of gentlemen like yourself. The demand would probably still exist with the working men, but there would be no leader to provide the teachers?—I believe that is very likely to be the case.

6097. Do not you think that an enlightened government might do for the working men in those remote districts, what you and other enlightened people have done in great centres?—Yes, I think it might do something to stimulate instruction. I am not prepared to say how far it ought to go in any such districts.

6098. Mr. Powell.] Have you considered whether it would be advisable that young men who are desirous to take a prominent part in the great industrial institutions of the north should instead of going to Owens' College, and passing a season of tuition in the same atmosphere as that in which they have been brought up, pass 12 months at Oxford or Cambridge, supposing the same opportunities were afforded at Oxford and Cambridge as are afforded at Owens' College, and that the cheapness and efficiency of the education were equal?—I do not know. Assuming the cost to be the same at Oxford as at Owens' College, the difference would be this, that their every-day life would be different at home amongst their own associates, they would be gaining an amount of knowledge of another kind which they would be deprived of at Oxford and Cambridge, they would have a constant opportunity of applying their knowledge by residing in this centre of industry, where they are being taught; they would have a greater stimulus applied to them by coming in contact with the thought of the neighbourhood than being confined to Oxford or Cambridge where they only meet with students, all moving much in the same groove as themselves.

6099. You think that the advantage derived from living in an atmosphere permeated with industry, would be greater than the advantages derived from living for a time in a larger sphere, such as Oxford or Cambridge?—I think that the advantages of living in the centre of industry are greater; thought is stimulated there; the opportunity is afforded of testing their knowledge at any time, and possibly the prospect of advance afterwards is constantly present with them, and the

the general knowledge outside would be greater than even the advantages of Oxford and Cambridge.

6100. Mr *Acland*.] Considering that the advancement of industry depends upon two principles, one the knowledge of science, and the other the knowledge of practice, should you be prepared to say that it is not an advantage to a young man to be removed for a time from the bustle of business, and to concentrate his thoughts on scientific principles as such?—For the highest training, I think it is desirable.

6101. You may have heard it said with reference to the profession of medicine, that the bustle of the London hospitals is not altogether favourable to the study of pure science, and that the highest practical results are hardly attainable without the most profound science, and on that ground it has been suggested that the proper function of an university was to teach science, while the proper function of hospitals is to teach practice, may there not be something similar to that in manufactures, having in view not only ordinary foremen, but such men as Mr. —, who is a wrangler of Cambridge?—I think that may be quite true with regard to men seeking after the highest practical attainments; but speaking of ordinary life and industry, I do not think it is desirable.

6102. I understand your answer to Mr. Powell to refer mainly to those who would occupy a subordinate position in the immediate conduct of the details of business?—Yes.

6103. And you would be afraid that if they were taken into the purely intellectual atmosphere of an university they might acquire a distaste to the details of business?—Just so.

6104. That answer is not inconsistent with the view that, for the highest national interests, it is important to have centres of purely scientific study which might be attended by the highest classes, or the most advanced teachers?—Not at all, I think that is most important.

6105. Are you aware that, at Oxford especially, there is a very large altitude in the new

museum, and in the laboratory of Professor Clifton?—Yes.

6106. Looking at the great want of teachers in England should you view, favourably, endeavours to make the old English universities supply the want of the highest class of teachers?—I look very favourably, indeed, on the efforts made in Oxford; I think they will supply the higher teaching power; I am quite aware that the faculties now at Oxford are very ample for scientific culture.

6107. That which is true of Oxford would, to a certain extent, be true of our grammar schools, that by a wiser application of the endowments of grammar schools we might hope to benefit greatly the education of what we may call the second grade of the middle class?—Yes.

6108. You have pointed out, in several of your answers, that science alone will not make a manager, or a successful man of business, because certain other moral qualifications of character were necessary, are you of opinion that it is desirable to make science alone the main instrument of mental training, or should you be inclined to say that a certain amount of moral and literary cultivation would assist the scientific growth?—I think it would be a very partial culture without.

6109. Are you also of opinion that in the improvement of primary education, the introduction of subjects having for their purpose the training to habits of observation, is very important?—Very important.

6110. Therefore, you would be favourable to introducing, as an instrument of education in primary schools, a moderate amount of science?—Yes, certainly.

6111. And in the secondary schools, while you introduce a considerable amount of science as a matter of training, as well as information, you could not make it exclusive of moral and literary education?—Certainly not, and I would include elementary political economy as well.

6112. Is there anything else which you wish to add to your evidence?—No.

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Monday, 22nd June 1868.

MEMBERS PRESENT.

Mr. Acland.
Mr Akroyd.
Mr Bagnall.
Lord Frederick Cavendish.
Mr. Dixon.

Mr. William Lowther.
Mr. Edmund Potter.
Mr. Powell
Mr. Samuelson.

BERNHARD SAMUELSON, Esq, IN THE CHAIR.

Mr. JOHN HENRY CHAMBERLAIN, called in; and Examined.

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6113. *Chairman.*] WHAT are you by profession?—I am an Architect.

6114. I believe you are resident in Birmingham?—Yes.

6115. How long have you been resident in Birmingham?—Thirteen years.

6116 Mr *Dixon*] You are the honorary secretary of the Birmingham and Midland Institute, I believe?—I am.

6117. How long have you held that office?—Nearly four years.

6118 Will you state for what objects that institute was founded?—For the advancement of science.

6119 That is one of the objects, but not the sole object, is it?—I believe that was the main object; the advancement of science especially among the industrial classes

6120. To what extent has the institute carried out that object?—That is rather a difficult question to answer. All that I can say is that we have carried out for a great many years a system of instruction in different classes, that those classes have been generally well attended, and we have reason to believe that they have been followed by very good results

6121. What are the science classes which exist at the present time in your institute?—There are several; there are science classes in chemistry, experimental physics, geology, geometry, practical mechanics, botany, algebra, physical geography, and in the Latin, French, English, and German languages, and also in English literature, English history, English grammar, writing, arithmetic, and singing

6122 Have you a large number of students attending the science classes?—Yes, the number under instruction in classes taught by certificated teachers is 160, those subjects being physical geography, experimental physics, and chemistry.

6123 I suppose the number of students has gone on gradually increasing since the commencement of the classes?—Yes, the total number of students has gone on increasing since the commencement.

6124 Can you tell the Committee from what class of people those students come?—Yes; if you take the 160 under certificated teachers for the present year, they may be analysed as follows 48 artisans, 29 schoolmasters and teachers, 19 chemists, grocers, and tailors' assistants, 24 clerks, and 46 tradesmen and manufacturers, and their sons; but if the Committee wish to know the classification of

those that are not under certificated teachers I can give that also to a certain extent

6125. Are those in the science classes?—Yes I think they are; but they are not recognised by the Department of Science and Art.

6126. What is the charge to the students in those classes?—Three shillings a term; and there are three terms in the year, so that the charge is nine shillings a year

6127. Are you aware what the cost of those students is to the institute?—I can give you the total cost of the teaching throughout the whole of the institute, but that will include some classes that are not scientific classes The total cost of the classes, as nearly as we can ascertain it, is 700 L a year.

6128 Of that 700 L a year how much is subscribed by the students themselves?—Three hundred and eighteen pounds we get back in the shape of fees, which leaves a deficiency for the year of 382 L

6129 How is that deficiency of 380 L supplied?—It is supplied by payment from the general department. We have two departments one of which is called the industrial department, and the other is called the general department. The members of the general department are subscribers; they pay one guinea a year towards the institution, and receive certain advantages such as public lectures, which they may or may not attend, as they please, and there is a news room. Of those subscribers we have about 850 at this time, and what we can save upon those subscribers goes to pay the expenses of the industrial department

6130. Then the guinea subscriber does not gain any advantage from the science teaching excepting so far as the lectures are concerned some of which, I presume, are scientific lectures —Yes, in a certain proportion they are so, by a great many of those persons subscribe on purpose that they may assist those industrial classes knowing that without their assistance they could not be carried on I think you may say if subscribers do not look to any return themselves in the way of scientific instruction; that is say, the majority of them.

6131. In fact, they have no educational privileges?—No

6132. What is the total number of students the institute?—The total number of students the institute at the commencement of our present session, was 1,142.

6133.

6133. I presume the cost of the teaching of those students was mainly in the science department?—Mainly in the science department I can give you the details: the classes in chemistry, physics, botany, geology, mechanics, and physical geography cost us 339*l.*, and we received in fees 118*l.*, so that the loss upon those classes amounted to 221*l.* In mathematics and arithmetic the cost of the classes was 112*l.*, and the fees received amounted to 27*l.*, so that we lost there 85*l.* In French, German, and Latin the classes cost 99*l.*, and we received in fees 87*l.*, so that the loss there was 12*l.* In English history, literature, grammar, and writing we spent 119*l.*, and we received 60*l.*, so that we lost there 59*l.* In singing we spent 31*l.*, and we received 26*l.*, so that the loss there was 5*l.*, making altogether a total deficiency of 382*l.*

6134. So that it may be said that Birmingham spends over 300*l.* a year on the Birmingham and Midland Institute alone, in contributions towards the teaching of the industrial classes in science?—It does.

6135. Can you inform the Committee from what class of persons the subscriptions are obtained for the support of the Birmingham and Midland Institute?—Assuming that we have at the present time about 850 subscribers, they may be divided in this way: manufactures, 348, merchants and factors, 104; tradesmen, 98, professional men, 195; miscellaneous, bankers, and so on, 30, gentlemen, 68; and ladies, 10, making up a total of 853.

6136. Therefore, considerably less than half the subscriptions are derived from the manufacturers, who are most directly interested in the science teaching?—Exactly so. Perhaps I might add, that during the last year the support of the manufacturers has been given in a larger proportion to the institute. The number of manufacturers the year before last was only 227, and now the number is 348, so that in proportion to the other classes we made a great advance last year in getting support from the manufacturers.

6137. You, perhaps, think that fact shows a growing desire on the part of the manufacturers for science teaching?—Yes, I think so. Some gentlemen connected with manufactures have interested themselves heartily in connection with the institute, and did us some good in obtaining new subscribers.

6138. Was the institute originally projected by the manufacturers, has it been carried on by that class, and do they chiefly form the council of the institute?—I could not say that the manufacturers originally projected it, but, at the same time, they have always borne a fair share in the general management, as far as regards the council of the institute they have taken a very active part. We have now in our council 11 members, elected by the subscribers annually, and among that 11 we have four manufacturers, and we had during the last few years a great many manufacturers, some of whom are very influential men, on our committee; but it is difficult to give the exact proportion to the other men, because one gentleman serves, perhaps, three or four years, while another finds his professional engagements interfere, and he only serves a few months; but the manufacturers have been very well represented on our council.

6139. From what classes are the other managers drawn?—They are very various; but they are mostly professional men.

6140. And that is, in fact, the class from which the majority of the managers, and the most active among them, have been taken from the commencement of the institution?—I think I may say so.

6141. *Chairman*] That is to say, professional men?—Yes, professional men.

6142. *Mr. Dixon*] What assistance have you received from the Science and Art Department?—We have received assistance in the way of payment on results, but I am not aware that we have received any other actual assistance from that department.

6143. Do you know the amount that you have received in payment on results?—I do not, but it has been exceedingly small.

6144. Do you think it has reached 50*l.* per annum?—No, I think not. I question if the amount has been much over 30*l.* per annum.

6145. And, besides that, I suppose you have received Queen's prizes?—Yes, we have received Queen's prizes.

6146. Are they much valued by the students?—I think I may say they are not valued at all. The Queen's prizes are books of such a remarkably poor character, and so thoroughly insignificant, that I believe the students prefer the Society of Arts certificate to a Queen's prize. The Society of Arts certificate carries an acknowledged value with it. The Queen's prizes, I believe, carry very little.

6147. *Chairman*] They are sometimes only manuals, costing 1*s.* 6*d.* or 2*s.*, are they?—That is really the nature of them.

6148. *Mr. Dixon*] Would you advocate the Government giving greater assistance to the institute than has hitherto been given?—Yes.

6149. In what way do you think the Government might wisely assist the Birmingham and Midland Institute?—I think the Government might assist the Birmingham and Midland Institute very greatly if, in addition to the present payment on results, they would make an additional payment on results to the committee as well as the teachers. One great difficulty is this, that no one at the institute has sufficient inducement to press students to go up for examination, and, consequently, out of the number that we educate, very few take the trouble to present themselves for that examination. There are special reasons why other schools in the town send up more for examination than we do. The masters of other schools look to the payment on results as their remuneration, but, with regard to the institute, the committee getting no benefit from payment on results, they are naturally a little careless about it, because they have no inducement to go to the students and insist on their presenting themselves for examination.

6150. *Chairman*] How is your teacher paid?—He is paid partly by a salary from the institute, and he partly gets this money paid by the Science and Art Department, but his principal remuneration is in the shape of a defined salary.

6151. If the payment on results received by him were larger, you would scarcely like to diminish his salary?—Certainly not.

6152. Otherwise you might gain as an institute by his receiving a larger sum on results?—Yes. Suppose our present science teacher, Mr. Woodward, were to get a much larger sum from the Government, we should not decrease his salary, because he has done excellent work for us.

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as at a very small remuneration; in fact, we are only able to offer him a small remuneration.

6153. Mr. Dixon.] Do you think that the grants which are made by the Science and Art Department for apparatus are satisfactory?—Practically to the institute we find the grants for apparatus are of no use. The Science and Art Department grant 50 per cent. on an arbitrary scale; but this 50 per cent. does not in any way represent the value of the best instruments. The Science and Art Department will not give any money at all upon cheap instruments, where they are likely to be damaged; and when you come to the higher class, we find that the amount of the grant is so trifling, that at present we have availed ourselves of it to a very small extent. A short time ago some gentlemen in Birmingham took some trouble to raise a sum of money in order to meet some of our wants, and they collected 140*L*. As nearly as I can ascertain, all that we shall get from the department in advance of this sum is about 25*L*, or 30*L*. at the outside, so that although we are prepared to spend 140*L*. on apparatus, we can only expect to receive a comparatively small amount from the department. I have two lists here which are issued by the department, and the first that I take is the third article in the list, and that is a battery, their scale of allowance on that would be 50 per cent. on 2*L* 12*s* 6*d*; but I find our battery cost us 20*L*. Our science teachers say that a battery on the South Kensington scale really would be of comparatively little use. In going through the list you find that whenever you want instruments, if you are to give the price that is required for good instruments, the advantage to be got out of South Kensington is very small indeed, and it is the opinion of many persons that the advantages are not sufficient to compensate for the restrictions which are placed upon the receiver of the money.

6154. Are we to understand that in reality the Science and Art Department do not pay 50 per cent. of the cost of the apparatus, but simply 50 per cent. on an arbitrary scale laid down by themselves?—Exactly, they do not pay 50 per cent. of the cost of the apparatus absolutely, but they refer you to their scale, and they say, "We will give you 50 per cent. of the amount named in this column on a given instrument."

6155. Do you remember whether, in that particular instance, the 1*L* 6*s* 6*d*. was actually received by your institute?—No, we received nothing at all, no application was made from us. If you receive the money, the Science and Art Department have some claim upon the instrument. I believe, for instance, that in the case of the institution being suspended, or anything of that sort, the instruments revert to the Science and Art Department.

6156. And on that ground it was not considered worth while to accept the assistance of the department in respect to the instrument in question?—Exactly so.

6157. Do you know what is the total amount spent on apparatus by the institute?—No, I cannot tell you; but the sum has been so small for many years, that the little fund of 140*L*. was got together by a special effort, in order to buy things that we stood greatly in need of. The institute has been so hard pressed ever since its commencement to carry on the classes at all, that it was for some years in a deficiency, and had

no money to spend in keeping up the apparatus to the state of efficiency in which it existed at the commencement.

6158. But if you had had a larger fund at your disposal, would you have increased your apparatus?—Certainly, and the teaching could then have been much better conducted.

6159. Do you think that would have led to an accession of students?—Possibly it might; but at all events it would have increased the value of the teaching given in the institute.

6160. Is there any other way in which, according to your opinion, the Government might help such an institution as your institute?—I think the Government might help us very considerably, if the rule with regard to payment on results could be enlarged, that is to say, if persons other than artizans, could obtain payment on results. We are placed in an exceedingly difficult position, for we really teach the teachers, a great many of the people who come to us for instruction are themselves in the receipt, perhaps, of more than 100*L*. a year, and at all events they cannot be accepted for examination by the Science and Art Department. We are really teaching the very gentlemen who, in their turn, take pupils, and get payment on results from the Science and Art Department, while we get no profit whatever ourselves from the Government for that very teaching. We have 29 schoolmasters and teachers and of these 29 schoolmasters we cannot claim on more than about 12, so that, although we are teaching them, we get no aid from the Government in so doing. There is a rule, which says that any person is excluded whose father is assessed to the income tax. There is a young man named Caswell, who has just passed a first-class examination in geology, and will probably be entitled to a medal; but he cannot receive that medal, because his father keeps a shop in Birmingham; that boy is 17 years of age; if he were 21 he would, I have no doubt, be a working man like his father, who as a printer as well as a shopkeeper, and would receive the reward which is now withheld, because his father pays income tax. I find from inquiry, that with regard to a very large proportion of our scholars, the teachers are debarred from getting payment on results by this rule.

6161. So that in the case of the Birmingham and Midland Institute, the rule laid down by the Science and Art Department has been rigidly and conscientiously adhered to?—Quite so.

6162. [Chairman.] Do you state that the age of the pupil is 17?—It is about 17; I do not know whether he is over or under the age.

6163. The restriction by the department is a 40 middle-class students above the age of 17, is it not?—I was told that he was 17 years of age.

6164. The fact being that if he had been under 17 he could certainly have taken the medal?—Yes.

6165. And you consider that that restriction unjustifiable?—He is excluded simply because his father pays income tax, whereas if he were four years older he would himself be an artisan in the receipt of weekly wages, and could claim the medal; he is, in fact, an artisan at the present time, but because his father keeps a shop he cannot claim a medal; he will be an artisan when he becomes of age.

6166. Was a claim put in on his behalf and rejected?—No, I think not.

6167. You are quite sure that the young man

is an artisan, are you?—I believe he is a working printer, his father is a printer and keeps a shop, and pays income tax.

6168. Do you know whether he is an apprentice or whether he is earning wages?—I believe he is an apprentice, but I cannot say that I know that of my own knowledge.

6169. (To Captain *Donnelly*, who is present.) You have heard the statement of Mr Chamberlain to the effect that the Midland Institute refrained from claiming a medal on behalf of a student who would otherwise have earned it under these circumstances, that the young man was a working printer living with his father, who is a printer keeping a shop, and paying income tax, the young man being about 17 years of age. The question I would ask you is this, whether, assuming that the young man was 17 years of age, and was either an apprentice or a working printer, the fact of his living with his father who pays income tax and keeps a shop would have precluded him from earning the medal?—The committee of the school send up the names of those who are qualified according to the rules to receive medals; and if they could certify that he was an artisan he is qualified to receive the medal whether he is above or below 17 years of age, but if he was a middle-class student he would not be qualified to receive the medal if he was more than 17 years of age. The restriction in question was inserted in order that middle-class students from colleges and upper class schools should not compete with artisan students in the ordinary science classes. Of course there could be no fair competition at all if you took students, say from King's College, to compete with artisans. But, besides, if this young man stood first on the list he would receive a certificate even supposing he could not receive the medal; a certificate, namely, stating that he stood first on the list, and would, if he had not been certified as a middle-class student, have received the medal. It is certain that if he is certified as an artisan he is qualified to receive the medal.

6170. But is it your opinion that under those circumstances, the committee would have been justified in returning him as an artisan?—If he is a working printer, certainly they would.

6171. He being a working printer, would he have been excluded on the ground of his being over 17 years of age, and his father paying income tax?—No, certainly not, if he is a working printer.

6172. Mr. *Acland*.] May I ask what is your definition of a middle class student?—That includes anybody who comes above the weekly wages class, anybody earning more than 100 l. a year.

6173. But has that definition reference to the circumstances of the father, or to those of the student himself?—If it is a student at school entirely dependent on the father, then the position of the father settles that of the student, but if the student is at work, then the student's position is taken as the guide, whatever the father's position may be.

6174. It comes to this, then, that if a boy is still under education, and exclusively dependent on the parent, then the position of the parent settles it, but if the boy has completed his school education and has gone to work, then the position of the boy settles it?—Yes.

6175. *Chairman*.] We may take it that if the

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circumstances of this particular student are correctly apprehended by Mr Chamberlain, the department would have considered him entitled to take the medal?—Certainly, if he is a working printer.

6176. Is it the case that in applying this rule to the occupations of pupils and parents, the department has been very stringent, or otherwise?—There have been special cases, and whenever a good special case has been made out showing that the student could be fairly brought into the competition with artisans, I think the rule of the department has been relaxed as far as possible, the whole object of the rules being to keep the competition a fair one.

6177. That is to say, your rule has been rather to keep the competition a fair one than to save the national exchequer?—Entirely so.

6178. (To Mr *Chamberlain*.) Is there anything you would like to add upon this point?—There is another aspect of the subject, namely, that which refers to ourselves as well as that which refers to the pupil, we cannot, I believe, get any direct payments on results on those young men, according to the rule that direct payments are made to teachers only on behalf of adult artisans, or the children of artisans, or persons not assessed to the income tax. I merely mention this to show that here is a young man who otherwise could not get a scientific education at all, and who obtains that scientific education through us, and reaches a high order of merit, and yet our teachers can get no payment upon him, because his father happens to pay income tax, and that is one out of a great many cases that press hard upon us every year.

6179. Is there any rule of the department which states that no person shall be considered an adult till he is 21 years of age?—That I do not know.

6180. Mr. *Dixon*.] Does your experience of the advantages conferred by the Midland Institute upon the industrial classes in Birmingham lead you to approve of the rule of the Science and Art Department, which deprives of its aid all pupils who are not of the artisan class?—I consider it a hardship, more, perhaps with regard to ourselves, because there is a good deal of our teaching for which we get nothing from the Government, so many persons attending our classes who have larger incomes than artisans, but the argument in favour of what I am saying is this, that those persons could not get the scientific instruction which they get from us in any other way, because they could not afford to pay any more for it than they pay to us, and it seems a little hard that we are carrying on all this teaching for so many years, and yet we cannot get any assistance from the Government, or at least the Government regulations prevent our obtaining a much larger amount than we might otherwise obtain.

6181. What you would say I suppose is this—“If we, the managers and subscribers to this institute, who are not directly interested in the result of this teaching, think it worth our while to pay something for the education of a class a little above the artisan class, we think it is equally the interest, if not the duty of the Government, to supplement our efforts by these payments?”—Personally, that is my opinion.

6182. The experience you have of the institute confirms you in that conviction?—Yes, certainly.

6183. Mainly on the ground that this scientific education

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education would probably never be received by those persons who do now actually receive it if it were not received from the institute which I believe is self-supporting?—I think the instruction would not be received at all by those persons if our institute were to die.

6184 Do you think the instruction so given to those pupils results not only in benefit to themselves, but also in a benefit to the town and the trade of the country?—I believe it does result in a very large benefit generally as well as individually.

6185. So that you think it would be wise on the part of the State to devote its money to the purpose of aiding you?—I think so.

6186. Would you advise the Government giving any aid in the shape of building grants to science colleges or classes?—I should; we ourselves are in the very sorest need of additional room, we have so many students that we do not know where to put them; we are obliged to carry on a great part of our instruction under serious disadvantages of this kind I believe that if we could get a building grant from the Government we should find that would act as a spur to private liberality, and without any great difficulty we should get as much money as we needed for our purposes. In fact, I believe that an addition to its present premises is essential to the institute being carried on as it ought to be, the institute is just at that critical period of its existence that if once the classes are allowed to flag, the interest in the institute will cease to a great extent, and we shall lose what we have been working for for so many years. We could open fresh classes if we had more room, and we could now adopt a system which has been found very useful in some of the classes, namely, the penny system. We have a penny arithmetic class which has been crowded, and if we had double the room we could get double the students, and we could open other classes on the penny system, which would be attended by very great numbers of people, so that the instruction would be brought within the reach of hundreds of persons who otherwise, even under our present system, are unable to get it. The charge of 1 d a lesson is made at the doors when the people come in.

6187 Has any estimate been formed of the amount of money that the managers of the institute would think it desirable to spend in additional accommodation?—No estimate of that has yet been made, which is particularly to be regretted upon. We endeavoured this spring, in conjunction with the School of Art, to form some notion of what we want in that way, for they themselves require, like us, vastly increased accommodation. We want more room for an industrial museum, and the conclusion we came to was, that we require, perhaps, 12,000 l to 15,000 l; but that is more a guess than anything else.

6188. How much has the town already spent in the erection of this institute?—I believe the town has spent about 17,500 l on the institute.

6189. That is exclusive of the value of the land?—Yes, the land was a gift.

6190 A gift by the corporation, I think?—Yes, I think so; but that was before my time.

6191. And the land was valued at 10,000 l, was it not?—Yes.

6192 Therefore the town of Birmingham has expended on this institute about 25,000 l?—On the institute alone it has spent about 28,000 l.

6193. Exclusive of the cost of maintaining it?—Exclusive of the cost of maintaining it.

6194. Therefore you think it would not be asking too much to ask the Government to pay a portion of the additional 12,000 l or 15,000 l, which you are now wanting?—I think not.

6195. *Chairman.*] You mean of the 12,000 l or 15,000 l which you now think it necessary to raise in order to carry out the objects of the institute?—Exactly so.

6196 *Mr. Dixon*] Do you know the population of the borough of Birmingham?—It is in round numbers about 300,000.

6197. Do you know the rateable value of the property in Birmingham?—About a million.

6198 *Chairman*] Has the Libraries Act been applied in Birmingham?—The corporation have erected a very large central library, and some branch libraries, and have spent every available farthing of the fund in doing it.

6199 The rate is entirely exhausted by the objects to which it is now applied?—Yes.

6200. *Mr. Dixon.*] Judging from your knowledge of all that has been done in Birmingham, and the disposition of the Birmingham people, you would say that they come forward liberally with respect to the education of the people in Birmingham, and especially with reference to their science and art instruction?—I think so, looking to the general scale of effort throughout England.

6201. The total amount received from Government to support what has been done in Birmingham in these particulars has not exceeded from 100 l to 150 l a year?—If you take in the other science schools in the town, that is probably about the amount.

6202 *Lord Frederick Cavendish.*] You were speaking of the hardship to the institute in having to educate persons just above the artisan class without receiving any assistance from the Government, but you gave no reason, I think, why that class should not pay a little more than the artisan class themselves; is there any such reason?—Practically there would be great difficulty in having a different scale of fees, because the instruction would have to be carried on in the same class with the artisans. We have very often had the question before us with regard to increasing the fees, especially in the chemical class, where the expenses are enormously heavy in proportion to the charge made for instruction but we always found, on inquiry, that to raise the fees would be to destroy the classes; for many of the persons who attend the classes do not pay merely 9 s a year, because they attend several of the classes; and especially is that the case with regard to those 29 gentlemen, who are many of them national schoolmasters. Many of them pay 2 l or 3 l a year for the instruction they receive; and I think if we were to raise our fees, even to them, we should hinder their coming to the institute.

6203. With regard to the practical difficulty of having two classes of fees, would it not be possible to say that you would have one rate for those on whom you would obtain assistance from the Government, and another rate for those on whom you would receive no payment?—We might possibly do that; but I am afraid that that increased rate would act prejudicially against us, because the very great majority of the persons who come to us for instruction are persons to whom 2 l or 3 l a year is undoubtedly an object.

6204. *Mr.*

6204 Mr *Acland*] Do you think that your institute is the chief agency for scientific instruction in Birmingham?—For certain classes of people it undoubtedly is. That is to say, for those who are not boys, but men, or boys fast growing into men, and who are occupied during the whole of the day.

6205. We have heard something of Queen's College, Birmingham, is that doing anything on the same ground as that which your institute occupies?—Not anything. There is no ground of comparison between Queen's College and ourselves.

6206. What class of persons do they teach?—They have a theological department and a medical department, it is a complete medical college.

6207. It is chiefly confined to those two faculties, is it?—Entirely.

6208. It presumes that all the pupils who come to it have had a good general education first?—I suppose so.

6209. Whereas your function relates chiefly to those who are in receipt of wages, or who are otherwise occupied, some of them being occupied as teachers?—I do not think that would be a perfectly correct statement of the case, because we educate a good many small manufacturers, and there are in Birmingham a very large number of small manufacturers, men, perhaps, who have very few workmen under them, but who are not themselves in receipt of wages.

6210. That circumstance makes a great difference in comparing Birmingham with the large cotton towns of the north, and with some other manufacturing towns?—A very great difference indeed; and it operates prejudicially to us, because we cannot claim results on those students.

6211. Now, is it your opinion that, with a view to the object of this Committee, namely, the application of scientific instruction to the advancement of the national industry, scientific instruction should be given chiefly to adults, or do you think there is a deficiency in our schools?—I think that, if it is a question of choice, the earlier you begin the better.

6212. You are aware that there was recently an inquiry into the grammar school at Birmingham?—Yes.

6213. You are aware of the report of the Schools Inquiry Commission?—I am.

6214. Is it not the fact, that in Birmingham it is found very difficult for private adventurers' schools, or other schools of an independent kind, to prosper, on account of the very large endowments of King Edward's School?—I have heard it so stated.

6215. Have you any reason to doubt it?—No.

6216. Then if that be so, is it not probable that the want of scientific instruction in Birmingham ought to be supplied by improving the whole of the secondary instruction of the town?—I think it would be of immense advantage if you could improve the whole of the secondary instruction of the town.

6217. Are you of opinion that the large endowments of that King Edward's School, which amount, I believe, to 13,000 *l.* a year, are applied in the manner which conduces most to the general advancement of middle class education in Birmingham?—My general opinion about the matter is, that the grammar school might be made of more advantage to the middle classes of Birmingham than it is.

6218. You are aware that the endowments of

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that school are not limited simply to classical and mathematical schools, but that they include, besides several other schools, which are called elementary schools?—I believe so.

6219. Are you of opinion that in those so-called elementary schools connected with the great foundation, as much scientific instruction is given as might be given?—I am afraid I do not know sufficient with regard to their teaching to answer your question.

6220. Speaking generally, have you any hope that the scientific instruction which the country requires, and which the town of Birmingham in particular requires, can be given without a very great improvement in general secondary instruction?—Not upon the scale on which it ought to be given.

6221. Do you find that the persons who come into your own classes enter them with any adequate preparation in the shape of elementary knowledge, in elementary mathematical knowledge, for example?—We teach elementary mathematics, and it is of constant occurrence for persons to begin with those classes, and then to go on with the higher classes in our institute.

6222. But do you find any great difference between the lower middle classes and the upper artisan class, in the elements of general secondary education?—That question does not practically present itself to me at the institute for the reason which I have just given.

6223. But do you find any great number of those who come to you desirous to advance their knowledge of science, are well prepared in arithmetic and the elements of mathematics?—The best possible answer I can give to that question is, to say that we have large classes in arithmetic and elementary mathematics, and the presence of those pupils at the classes shows that those persons feel the necessity of that kind of education, we recruit our higher classes from those lower ones.

6224. I think you stated it was necessary, in your opinion, that the fees of all your classes should be alike, but will you kindly point out why, in a town which includes a large number of labourers, and a larger number of skilled artisans, and a very large proportionate number of small manufacturers, there should not be a graduated scale of fees adapted to the wants of the different classes requiring instruction?—I can only speak from practical knowledge of the great difficulty there always is in that kind of classification, and of the way in which even now many of our students dislike that degree of classification to which they have to submit. The preliminary questions put to students even now are not liked, and they do in some cases act so as to deter persons from attending the classes.

6225. Do you give instruction by day?—Not any.

6226. Will you state the reason?—In the first place we have not the requisite staff.

6227. And I suppose the instruction is not wanted?—I cannot say that it is not wanted, but we should have to revolutionise our institute in order to give that instruction.

6228. *Chairman*] There is one exception to that rule of yours, I think you have a chemical class on Saturday afternoons?—That was done simply as a matter of convenience, it was found that many of the processes which required to be gone through took longer hours than could be given to them in the evening of the day, and

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Mr. Woodward represented to the council that Saturday being a half holiday it would be better if they could have a double lesson in the afternoon of Saturday, so as to give the class time to follow out the researches which took longer to complete than the time given to the ordinary evening lesson permitted.

6229. *Chairman.*] You stated that the apparatus required for your institute was generally of a character very much superior to what would be sanctioned by South Kensington, and you gave as an instance a battery, can you give us any other instance?—On the 9th page here I find under the head of Organic Chemistry a balance, and the Department offer to give 50 per cent. on 6*l.*, but an instrument of the kind we require would cost 15*l.* to 20*l.*, then, again, on an air-pump we cannot claim more than 32*s.* or 33*s.*, whereas our air-pump cost us 15*l.*

6230. You would say, then, that the instrument supposed to be bought at South Kensington would be only suitable for extremely elementary instruction?—I think so.

6231. *Mr. Acland.*] You have selected in your objection a certain number of instruments, say 8 or 10, in which the expense might range from a very small sum to a very large sum, and you think the figure fixed by South Kensington is too low, but in that list are there not contained considerably more than 100 articles, many of them ordinary instruments, glass tubes, and various other things of that kind in relation to which the range of expense would not be great?—The apparatus grants are rigorously confined to articles of an indestructible nature

6232. Are there not a number of instruments of that kind in the list?—What I believe is the case, is this: that the apparatus may be divided into two or three classes, there are first of all those on which no grant at all is given, because of their destructibility, and then there is the class which you now mention, and all that I can say is, upon that inquiry I am told by our science teachers that the sum received on them from the department is so small, that it is not worth the trouble, or worth submitting to the restrictions for.

6233. But does your objection apply to a selected few out of that list, or to the whole list, or anything like the whole list?—Our objection applies to this, that in small matters where we may reasonably be supposed to help ourselves, we could get upon things that cost a few shillings, something like a reasonable amount, but the moment we come to the higher class of instruments, we find that the money received from South Kensington is hardly of any use

6234. Are you prepared to say that an air pump and battery on the scale allowed at South Kensington are useless instruments for teaching pupils in an ordinary science school?—I am told they are useless for our purposes

6235. But though they may be useless for the school of the Birmingham Midland Institute, which is a very high-class scientific institute, they may be very good instruments for ordinary science schools?—I have no doubt they are

6236. Then, does not your objection fall to the ground?—Not with regard to our institute; our science teachers say, and I can readily understand it, that what they teach cannot be illustrated without instruments of a high class. I hear science teachers in the country speaking in terms of almost affection of some institutions in London,

which are marvellously gifted with good scientific apparatus, and I can readily understand that nothing annoys a science teacher more than having inferior instruments put into his hand, especially under the guise of liberality.

6237. No doubt instruments such as are necessary for illustrating lectures like Professor Tyndall's, are enormously expensive, but do I understand you to say you think that the Science and Art Department should make grants of 50 per cent. on the cost of instruments such as those all over the country?—Such instruments will never be asked for all over the country.

6238. *Chairman.*] I understand you to say, that for the purposes of tuition, the instruments on which the Science and Art Department make grants would not be good enough for you?—Yes, that they would not be good enough for our purpose.

6239. *Mr. Acland.*] But for other purposes would they not be good enough?—You can give science teaching in various ways, of course, but the best way is that which we aim at. I can give another instance, and that is the lime light apparatus, the South Kensington Department give 50 per cent. on 4*l.* for that, but I believe that our instrument, which is not the very best, cost 15*l.*

6240. *Chairman.*] Mr. Woodward is a teacher of very remarkable ability, is he not?—I believe so

6241. And you think that his qualifications as a teacher would not be able to develop themselves satisfactorily unless he were provided with a good laboratory?—Yes, his time is very much wasted in trying to make his instruments serve his purpose.

6242. With Mr. Woodward as a teacher, you would rank your institute somewhat higher than an ordinary science school?—I think I should not be wrong in doing so.

6243. Has it occurred to you that it might be desirable, in connection with your institution, to establish day classes for teaching science?—I think probably it would, but it would lead to such a total alteration of everything in our institution that it is rather difficult to give a definite answer to the question

6244. Your laboratory, I believe, is large?—Yes

6245. There is accommodation in it for a considerable number of students, is there not?—Yes.

6246. At this moment, it is not devoted at all to teaching during the day, is it, except with regard to that instruction on Saturday afternoon?—And with the exception of its being used for Mr. Woodward's own researches.

6247. Mr. Woodward would, no doubt, require considerable assistance if he were to open science classes in the daytime?—Yes.

6248. And payment would have to be provided for that assistance?—Yes.

6249. Which the funds of your institute would not meet?—Just so

6250. But is it not very probable that the fees paid by the students of the day classes, those students being derived from a somewhat different class of persons, might cover the cost of such instruction?—I cannot say; the matter has not been entirely overlooked, it has been thought about to some extent, but at present we have only the vaguest idea how far it would pay Birmingham is a very busy town, and it is quite possible

possible that if we taught boys science we might do a very good thing, but all the young men and boys are very busily engaged.

6251. I am speaking of boys only (not of young men) of a higher class than those from whom you now derive your pupils; say, the sons of manufacturers, and also of those whose income may vary from 300/ to 1,500 L a year?—Yes, I think it would take a long time before the matter was really a success.

6252. In fact you believe that there is not yet a great demand for scientific education among the middle class in Birmingham?—I do not think there is, it is so difficult to get the people to understand the value of a scientific education.

6253 I suppose we may say that they do not yet realise the value of that instruction for their children?—I really cannot say.

6254. Mr. *Acland*.] Suppose science to be recognised as an indispensable element in a good secondary education, and supposing also that what you have stated, namely, that good scientific instruction cannot be given without very expensive apparatus, would it not, in your opinion, be desirable that your institute should receive classes from the commercial schools of the town, and give them the advantages of a good scientific apparatus, if you had it?—Exceedingly desirable.

6255. Would not that be a kind of operation for which you might charge a fair fee, which would go a long way to cover the cost?—I think so.

6256. Do you think it possible to spread scientific instruction in a high degree throughout the

schools of a town like Birmingham, without some such arrangement as that?—It would be much more difficult to do it, of course, without some such arrangement.

6257. *Chairman*.] In addition to the penny classes, have you any penny lectures?—Yes; we have about 18 in the year.

6258 I suppose that some of those penny lectures are on scientific subjects?—Yes.

6259 Is it the case that you find persons who have attended those lectures, have afterwards become students in the science classes?—Yes, we find those penny lectures a most valuable recruiting ground. Perhaps only a few persons attend upon the first night, but their numbers are rapidly augmented, and these lectures always lead to an accession to the classes.

6260 You have traced the attendance of many of your pupils at the science classes to the fact of their having been subscribers to the penny lectures?—Yes, certainly.

6261 With regard to the population of Birmingham, is it not the case that it is difficult to draw a line strictly between the artisan and the manufacturer in Birmingham?—Yes.

6262 In fact, many persons who would be piece masters in places where labour is organized on the factory system are master manufacturers in Birmingham?—Yes.

6263. Therefore it is a hardship to you that the line of the Science and Art Department should be drawn stringently, while in other places it might not be any impediment?—Yes; that is our great hindrance.

Mr WILLIAM C. ATKEN, called in, and Examined

6264. *Chairman*.] You are a manufacturer at Birmingham, I believe?—I cannot say that I am a manufacturer, but I am extensively connected with manufactures.

6265 What is your occupation?—My occupation is that of practical director of the metal works department of Messrs. Hardman & Co.

6266. I believe they are brass founders?—They are mediæval metal workers and glass painters, and are engaged in working in all kinds of work and materials after the mediæval style.

6267 I believe you have been engaged in business in Birmingham for a considerable length of time?—I have been engaged in business in Birmingham for 25 years.

6268 And you have been on the council of the Midland Institute, I believe, almost from its commencement?—Yes, I was on the first council, and have been so, with the exception of a year or two, ever since.

6269 Mr. *Dixon*.] Can you inform the Committee the number of workmen exclusively engaged in what might be considered or is considered to be the special manufactures of the town of Birmingham?—I have made out a table, the idea occurred to me that such a question might be asked, and I went very seriously and cautiously through it, because I think it is most important that scientific instruction should be given of such a character as would operate on what may be called the manufactures of the town. I find that there is a total of 48,242 male artisans employed in the special manufactures of Birmingham, namely, under 20 years of age 14,480, and over 20 years of age 33,672.

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6270. Have you a considerable amount of acquaintance with the state of education among those classes?—I have.

6271 Is it your opinion that there is a deficiency of scientific education in the trade that you are more particularly connected with?—It is, for instance, I may say that out of some 7,000 persons engaged in the Birmingham brass or brassfoundry trade, I am not aware of a single one who is capable of making an analysis. Dipping is a manipulatory process, which consists in immersing brass in nitric acid, for cleansing or finishing purposes, there is not a single Birmingham dipper who could tell, if he is not successful, the cause of the failure, from any scientific knowledge of his own.

6272. Do you think the same deficiency in scientific education exists in other branches of the trades of Birmingham?—I think so, from my inquiries I made an inquiry in the electro-metallurgical trade, it is very possible that there are from 70 to 100 persons engaged in that trade as depositors, and it has been told me, by persons practically conversant with it, that there are not, perhaps, three of that number who have studied the art or process scientifically. What I am now saying refers to the *modus operandi* of the art of the deposition of metals from their solutions on articles made by other workmen, altogether, in the trade, since 1,500 males are employed.

6273 Do you think this deficiency in scientific knowledge extends to the foremen and managers of the manufactories?—Yes, I do.

6274. It is not confined to the artisans, then?—No, it is very general.

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6275. Would

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6275. Would you go so far as to say that it was an exceptional thing to find a manufacturer who was thoroughly acquainted with the science connected with his trade?—I should say so. Within my own knowledge there are only some three or four acquainted with the practice of the sciences connected with their trade.

6276. Can you give any further illustration of this want of scientific knowledge?—I would mention the glass trade, my own conviction (and, in fact, I am confirmed in it) is that there is, practically, no science in the glass trade, so far as respects the artizans employed in it.

6277. *Chairman*] Would you not except one very eminent name?—That is one of the exceptions that I was talking about.

6278. You speak of Mr. Chance?—Yes; the only thing I was going to say about Mr. Chance is, that he had a Frenchman to superintend his works for a very long period (Monsieur Bontemps), and he has many French workmen employed; I think that is rather in favour of the value of scientific education, it proves that you can get science useful in connection with manufactures better in another country.

6279. *Mr. Dixon*] You went over to the Paris Exhibition, did you not?—I did, at the request of the Birmingham Chamber of Commerce, and wrote a report on the manufactured articles exhibited there, similar to those manufactured in Birmingham.

6280. Did you have an opportunity of noticing the state of education among the industrial classes abroad?—I cannot say that, but I can judge from results, as I have a good deal of information on that subject, which I dare say is common to other gentlemen. I am conversant with what Dr. Lyon Playfair has written, and with the Report by De Coquevil upon Industrial Instruction in England. I find it is very much confirmed by a Report published by the chairman of this Committee and I also find that there are others who are well qualified to give opinions upon the subject, who tell us that scientific instruction abroad is a great deal more common and advanced than it is with us, and I believe that is the case from what I saw in the Paris Exhibition; this was also the general opinion of the 28 Birmingham artizans who accompanied me to the Paris Exhibition (see Reports of Artizans published by the Society of Arts, London).

6281. What was it in Paris that confirmed you in that belief?—I was present at the French Exhibition of 1849, prior, of course, to the great Exhibition of 1851; I was present at the second Exhibition of 1855, and I was also present in 1867, and I believe that it must be perfectly evident that there a large advance has been made by Continental countries, by France among others, within that period of years. It is apparent that what they made in 1849 was chiefly ornamental, in 1855 they went in for substantial work, and in 1867 they have advanced upon that again. I think that is decided evidence that a considerable impetus has been given to technical instruction in those quarters, and that the artizans of these countries have profited thereby.

6282. Would that observation apply to continental nations generally, or do you limit it to France alone?—To continental nations generally.

6283. *Chairman*] Are you speaking with regard to the trades with which you are specially acquainted, or generally?—I speak generally,

because I have had a good deal of experience in other trades.

6284. But speaking more especially with regard to those trades in which you are concerned, or those trades which are carried on in Birmingham, would you say that the progress made by the Continent from 1851 to 1867 has been much greater than that which has been made by England?—My conviction is that they have made advances, and very considerable advances.

6285. But do you think they have advanced more than England has advanced?—No, I would not say that; they have advanced more in proportion, but not more than England.

6286. *Mr. Acland*] Relatively, they have advanced more?—Relatively, they have advanced more, I mean as regards not the art element, but that which bears upon the present branch of inquiry, i. e., the science-united-to-practice view of the subject.

6287. *Chairman*.] But would you say that in any of those trades with which you are specially acquainted, they have passed us?—No, I do not consider that they have passed us in manipulation.

6288. *Mr. Dixon*.] In your opinion, has the trade of Birmingham suffered, or is it likely to suffer, in consequence of our deficiency in scientific instruction?—I think eventually it must suffer. I do not think it has suffered so much yet as regards the home trade. I will put it on a very broad principle, which is simply this: that if other people are educating their artizans, and we do not educate ours, then, notwithstanding our natural ability, others must pass us in the end.

6289. *Chairman*.] In using the word artizans, do you speak of artizans popularly so called, or do you speak of foremen and managers of works?—I would include them as well; I would take them altogether. Our superintendents and foremen are simply artizans who are not generally in advance of the men they superintend. It is possible that they have certain mental or moral qualities which the others have not, or they may have gone ahead of the men in possessing more manipulative skill; that seems to be the position in which the Birmingham foremen stand with regard to the artizans, but I am not aware of any scientifically educated foremen in the manufactories in Birmingham.

6290. And, therefore, by increasing the scientific knowledge of the artizans you increase the area from which the scientifically educated foremen may be drawn?—Yes.

6291. And the area from which those men are now drawn, such as they are?—Yes.

6292. *Mr. Dixon*.] Do you think that that is the sole reason for giving scientific instruction to artizans, or do you think that the artizan, as an artizan, is a more useful man for having received scientific instruction?—I think the difference between the more educated man and the man who is not educated is this: that if you educate the man you give him better mental instruments to work with; you unite science to practice, and therefore he must be a better man and artizan for receiving scientific education.

6293. But supposing those men were educated in something else than science that would equally develop their faculties and make them think would you be of opinion that that would be equally advantageous, or do you confine your remarks to scientific education?—Thought would be a mere abstraction, which would do you

good. You must come to such educational facilities as relate to execution, thinking makes a man better, but the object of this Committee is not an abstraction

6294. Suppose you had educated your artizans in science to such an extent as that you had supplied all the managers and foremen that might be required, you would still go on in instructing them scientifically for their own sake, I presume?—Unquestionably, for their own sake, for posterity, and in a national sense as well

6295 Do you think this deficiency in scientific knowledge is also felt in Birmingham, do you think it is acknowledged and regretted?—I must answer that guardedly, because there is a stage at which men become thoughtful and intelligent, and see what they want, and I am of opinion that the Birmingham artizans, manufacturers, and foremen are becoming alive to the knowledge of their wants in this respect, and that is a decided step in advance

6296. Mr *Potter*.] You include the masters in that remark?—Yes, decidedly.

6297. Mr *Dixon*.] Have there been any efforts made to supply the deficiency in Birmingham beyond those that we have heard described by the last witness, with respect to the Birmingham and Midland Institute?—I am not aware that there have been any other efforts, but that includes a great effort, and it includes an acknowledgment on the part of those gentlemen who projected the institute, that the artizans were deficient in scientific education.

6298 But have not science classes been introduced into some of the primary schools?—I am not aware that they have

6299. Is there not a Mr. Bullpit, who has a science class in the lower part of the town?—Yes, but that was not prior to the institute.

6300. My question did not refer to time, I merely meant outside of the institute?—Then my answer must be in the affirmative. I find there are five science classes, Saint Barnabas, the Metropolitan Railway works at Salfley, the Wesleyan schools, and the St. Matthew's school at Edgbaston.

6301 Some of those are science classes in primary day schools, and some of them are evening classes, I believe?—I think the majority of them are evening classes, but I am not sure of that.

6302. What additional science instruction would you like to be given in Birmingham beyond what is given now, or what improvements would you advocate in that which is given?—I am not aware that I could suggest any such improvements. I should like to see the means of the Midland Institute extended, because I recognise in it a very important centre from which to work, a most important centre

6303. *Chairman*] How would you propose that the extension should be brought about?—We could not do it without additional funds.

6304. Mr. *Dixon*.] Would you advocate Government grants?—Unquestionably

6305. For the purpose of extending these schools?—Yes, I have always advocated Government grants.

6306. Do you concur in what the last witness said on the subject of Government aid?—I do.

6307. Would you add anything to what he said in that respect?—I think there is nothing to add

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to what he said, because he has studied the subject thoroughly, and indeed, I have studied it in common with him from time to time, we are now at the end of our class-room in that institute, and are compelled to teach classics in the cellars of the institute building

6308. Would you advocate the Birmingham and Midland Institute being made a central school or college for that class of person, and that there should be a number of other science classes established in various districts affiliated to the Birmingham and Midland Institute?—I should do so for more reasons than one I should do it for the sake of the scheme itself, and I should do so still further, because it carries out the original intention of the institute, which was meant to be a centre for the education of the industrial classes of the town, and also for the people connected with the iron manufacture, coal mining, &c., of the district, of which Birmingham is the centre

6309 Do you think those off-shoots of the institute would require Government assistance also?—I think so, they get it now to a very small extent.

6310 In the shape of payment on results?—Yes

6311 But would you advocate anything further than that, for example, a contribution towards the erection of the necessary buildings, in the same way as for the institute?—I think they should, but I have not maturely considered that question.

6312. *Chairman*] You regard the Midland Institute as a superior school of science, and those branches you would consider as elementary schools?—Exactly

6313. And you think Birmingham is a suitable locality for the establishment of a great central school?—Yes

6314 Having regard not only to its manufacturing, but also to its geographical situation?—Yes

6315. Mr *Potter*.] You are connected with the firm of Hardman & Company, Birmingham?—Yes.

6316 They rank very high in their own class of business, do they not?—They are the very highest in their class, they were the originators of the revived mediæval arts in metal working.

6317 And they find no difficulty in producing that work in Birmingham, I suppose?—None, because they have trained a staff of men for it.

6318 They are themselves men of taste?—Undoubtedly Mr Hardman, who is recently dead, was a man of considerable taste, and was allied with Mr Pugin, when the pure Gothic revival, as regards glass painting and metal working, was carried out.

6319 A capitalist of that class can supply himself with any kind of workman he requires, I suppose?—The workman requires to be trained, and the Messrs. Hardman trained them for themselves It is upon record that for the first altar-lamp that was ever made by Mr Pugin, he had to employ a German workman who was acquainted with the beating up of thin metal, they could not find an English workman to do it

6320 What was the date of that?—I think that was at about 1840.

6321 This firm have supplied themselves with that class of artizans since then?—Yes, they have trained them

6322 How many workpeople have Messrs. Hardman?—I should say about 200.

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6323. What

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6323. What is about the range of wages paid by them to skilled workmen?—The wages of the skilled workmen range from 50 s. to 80 s. a week.

6324. What are the wages for the workmen for ordinary work?—The wages of the workmen for ordinary work are from 14 s. to 30 s.

6325. I think you spoke of 7,000 workmen engaged in brassfoundry trade in Birmingham, among whom there were none who could carry on an analysis in their own business?—The Committee will understand that when I stated that, I intended to convey that out of 7,000 workmen there is not one who is capable of making an analysis in mixing metal; but then the whole of that 7,000 are not concerned in the mixing or casting of metals.

6326. You referred also to the dippers as requiring a certain amount of science, what are the wages of those dippers?—They work usually at low wages, from 16 s. up to 25 s. or 30 s. a week.

6327. Would you think it possible that a man who had only 16 s. a week and upwards to 30 s. could get for himself a scientific education?—Yes, I think that if the education was properly conducted there would be little difficulty in his doing that.

6328. Would it be worth his while to do that, unless his wages were enhanced?—Yes, I think it would.

6329. Do you think master manufacturers would employ beyond a certain number of men if the wages were doubled?—I do not think that is the question now.

6330. But if those men are to acquire scientific knowledge it must be attainable at a low rate, must it not?—Yes, or else it must be given them at a very early age.

6331. And at a low rate, even in that case; the education must be brought home to every child?—Yes, and I think it ought to be.

6332. You have spoken of the foremen as being a very ignorant class, I think?—No, I have not spoken of them as being an ignorant class; they are ignorant in scientific matters.

6333. Is there not, however, a great want of primary education in Birmingham?—Unquestionably there is.

6334. And the foremen are drawn from the class in which there is that deficiency?—Yes.

6335. At the Paris Exhibition, did your Birmingham people exhibit very largely?—They did not exhibit very extensively.

6336. Very few exhibited, I believe?—Very few.

6337. I suppose only large capitalists could afford it?—There was at least double the number exhibited in 1855 to what exhibited in 1867.

6338. *Chairman*] The number was twice as large in 1855 as it was in 1867?—Yes.

6339. *Mr Potter*] What do you think is the fair inference to be drawn from that comparison?—I always look upon exhibitions with some degree of suspicion, because I am aware that there are a great many things exhibited which are not made for sale, but for exhibition.

6340. You consider exhibitions, on the whole, unfair as tests of competition, do you?—No, I will not say that, I do not think an exhibition is an unfair criterion, I receive it as evidence, but I receive it cautiously.

6341. But you admit that the Birmingham people did not exhibit in 1867 as they did in 1855?—Yes.

6342. Did you spend any long time in the Exhibition?—About a fortnight.

6343. Were you aware that other large trades of this country exhibited still more extensively than the Birmingham trades?—Yes, I have my impression upon that subject.

6344. Are you aware that the large branches of the cotton trade did not exhibit at all?—Yes.

6345. That the Leeds people scarcely exhibited at all?—Yes.

6346. Do you think that any fair deduction can be drawn, under those circumstances, from the French exhibition as a test of the standing of English manufactures?—It could be tested in its connection with my own trade very easily.

6347. Did Messrs Hardman exhibit in both exhibitions?—Yes, slightly. They exhibited a stained glass window and a silver cup in the last Exhibition.

6348. They hold the first rank in their own class in Birmingham, you say?—Yes, they hold the first rank up to this time in their particular trade.

6349. They did not consider it worth their while to go to any great expense to exhibit in Paris?—All I can say is that they did not exhibit extensively.

6350. *Mr Acland*] You know something of Scotland?—A little.

6351. Have you noticed any great difference in the demand for education among the lower, middle, and upper classes in Birmingham, as compared with Scotland?—It is now 25 years since I left Scotland.

6352. But I daresay you have not forgotten the old country?—No.

6353. Is the desire for general or scientific education as strong in Birmingham as it is in your own country?—I can safely say that the desire of the English to receive education is quite equal to what I see in my own country.

6354. Will you kindly tell the Committee what opportunities there are in Birmingham for a man who is earning about 2 l. a week, little more or less, to get a good education which is something more than elementary, for his family, at an expense not exceeding 1 l. a quarter?—I could not tell you from my own knowledge.

6355. Do you know of the existence of any great number of schools in Birmingham where a good education, suited to the wants of a well-to-do working man's family, can be obtained for any sum between 10 s. and a pound a quarter?—I do not know any.

6356. Do you not think that in every great town there should be such opportunities?—I do.

6357. You have one very large endowment in Birmingham?—Yes.

6358. How is that spent, is it spent in giving gratuitous education or in giving education for fees?—My own conviction is that no fees are paid.

6359. It is your opinion generally, that there is great need for bringing home to the working men of Birmingham a good education, better than that afforded in the ordinary national school or British school, and at low rates?—That is my conviction.

6360. Do you think that any solid advance in scientific knowledge among the working classes is attainable in England if that better early education is not provided?—I think not; I think the elementary instruction must be improved.

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6361 But supposing that it is admitted on all hands that that education in reading, writing, and arithmetic should be open to the whole population, do you not think it is necessary to give to the higher workman's family opportunities of going beyond what is given in ordinary national schools?—Unquestionably.

6362. And that opportunity does not exist in Birmingham?—Just so.

6363. Have you formed any opinion upon the expediency of having a scientific branch in King Edward's Grammar School, as is recommended by the Schools Inquiry Commission?—I think that ought to be done.

6364. Are you favourable to the payment of fees in that institution?—No.

6365. You would think it better that gratuitous education should be given to a small number of persons, whether they valued it or not, rather than that education should be extended to a large number of persons, its value being tested by the payment of fees?—My idea is that a large sum of money was left for the purpose of education, and that with the advance of the times, as the necessity for education of a special class becomes apparent, the endowment ought to be extended to other uses. If classical knowledge was at one time the great feature of the day, special and scientific knowledge is now the want of the present day, and I think that the sum of money which was once entirely expended on classical education, a portion of it should now be devoted to the purpose of giving scientific education.

6366 *Chairman*] You stated with regard to artisans generally, that if they were to receive scientific education, you thought they should receive it at an early age, have you formed any opinion as to how far it is possible to introduce scientific teaching into elementary schools?—Yes, I think you might impart the elements of science in ordinary elementary schools.

6367 Would that apply to children leaving school at as an early an age of twelve?—I think so.

6368. What subjects do you consider to be best adapted to the faculties of young children, say from 10 to 12 years of age?—I think the elementary parts of every science, you could teach them the simple A B C of science.

6369. Wou'd you consider it of great importance that arithmetic should be more scientifically taught in elementary schools?—I do not see how you could teach it more scientifically, there are

the first rules of arithmetic, which must be taught in elementary schools, and that is an illustration of what, I mean by the simple elements of science.

6370. But do you not think that the children should be taught the reasons of those elementary rules?—I think they might.

6371. With regard to geography, do you think it would be very advantageous that physical geography should be substituted for the political or topographical geography which is now taught in elementary schools?—I think so.

6372. With regard to the establishment of a science branch in your Free Grammar School, would you recommend that such a branch should be established, or would you rather desire that science should be taught in conjunction with literature in the school as it now exists?—I have not maturely considered that question.

6373. *Mr. Potter*] Would you be in favour of compulsory attendance at primary schools?—
Yes

6374. *Chairman*] Is that an opinion which you have deliberately formed from having given a considerable attention to the subject?—
Yes.

6375. *Mr. Acland*] Then in giving that answer, do you contemplate gratuitous education, or do you mean that the parents should be compelled to pay?—I think the parents should be compelled to pay.

6376 *Chairman*] Is there anything you wish to add to your evidence?—With respect to those five schools in which science is taught (outside the Institute), I find the students at St Barnabas National School are 61, and that the other four are grouped together, and the number of students is 55, the masters who teach those schools received their certificates through the Midland Institute I mean that the certificate gained therein is acknowledged by the Government, it is tantamount to a Government certificate.

6377 *Mr. Dixon*] You mean they receive there the education which enables them to take their certificate from the Government department?—Yes, I may add that at the commencement of the Midland Institute (in 1853) a number of working men sent in a memorial backing up the efforts of the institute with regard to the teaching of science. I put in a copy of that memorial, and copy of Report of the Birmingham Chamber of Commerce on the International Exhibition at Paris in 1867 (*handed these to the Chairman*)

Mr. JOHN BRAGG, called in, and Examined

6378 *Chairman*] You are a Manufacturer in Birmingham, I believe?—I am.

6379. What is the description of manufacture which you carry on there?—I carry on the manufacture of the best gold jewellery.

6380 Have you been engaged in that manufacture for a considerable length of time?—I have been engaged in that manufacture for 30 years.

6381 *Mr. Dixon*] Is that branch of trade a very large one in Birmingham?—Yes, it includes all classes of jewellery, including silver jewellery and gilt toys, and employs about 8,000 persons, young and old.

6382 The average wages that they get would at least be equal if not superior to the average 0.72.

wages of the town?—Superior to the average of the town.

6383. Do you consider that the knowledge of science is very important in your trade?—I do.

6384 Is that knowledge possessed generally by the artisans or the foremen and masters?—No, on the contrary, there is a decided absence of it.

6385 What are the sciences the knowledge of which wou'd be most useful in your branch of trade?—Certain departments of the science of chemistry would be the most useful in our trade; the science of the laws of heat would be the next most useful, and metallurgy would be the next in the order of importance.

6386 Can you give the Committee any illustration

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tration of the injury to your trade which arises from this want of scientific instruction?—I can give the Committee many illustrations, the difficulty would be to select them, taking them in the order in which I have mentioned, chemistry coming first, we will speak of the colouring of gold, the whitening of silver, and the oxidation of both those metals, which are chemical processes requiring considerable delicacy and accuracy. I do not think there is a person scarcely who practises them who understands the principles on which he acts; and the failures and the losses and confusion, and so on, that arise are something very serious.

6387. Could you explain the manner in which those losses arise?—I could not without explaining the processes.

6388. But does the loss arise from the want of scientific knowledge, because losses may arise from a want of proper manipulation?—I will give you an instance that will show you distinctly how a loss will arise from the want of scientific knowledge. In colouring gold, you can only do it at present when it is about 15 carats pure, but with a higher application of scientific knowledge in alloying the metal, and also in the process of colouring, it is coloured in Germany, and it has recently been successfully coloured in Birmingham down to about 13 carats, and we can sell the article at 7s or 7s 6d, an ounce less on account of the difference between the 13 and the 15 carats.

6389 *Chairman*] And it is the case, is it not, that the application of these methods took place earlier in Germany than in England?—Decidedly, it is years since we have been buying German coloured chains two carats lower than we could make them. I am told that the chain-makers are now beginning to perceive the value of that application of science in the matter, and are applying it.

6390 *Mr. Dixon*] But still you do not consider that the position of science generally in Birmingham exists to the extent that it does in Germany?—Certainly not.

6391 Can you give the Committee any other similar illustration?—Yes, I can give another chemical one. For years, in fact, till within the last six months, we have thrown away water of that quality (*producing a vial containing water with a yellowish tinge*), but we now throw it away as pure as that (*producing a bottle of much clearer water*). We get a quantity of gold from it by a simple application of science. We have bought the secret from a Frenchman for an annual share of the profits.

6392. *Mr. Acland*] Can you give us any idea of the value of that discovery to you?—That would make at least 50l a year difference in my manufacture, and we had always been exceedingly careful to see to the filtration. In fact there is a large fortune thrown into the gutter every month, or, at all events, every year in Birmingham for the want of scientific accuracy. Take alloying again, they want a knowledge of the operation of the laws of heat; nearly all our meltings done by the small masters always on an open hearth in an open crucible, they are not aware that the subjecting of certain alloys to undue heat causes the alloy to be burnt away. If they alloy precisely for 9 carat gold, when it is turned out of the melting pot, if they were to test it, they would find it was 9½, and they

innocently sell it at a loss for want of a knowledge of the laws of combustion.

6393 *Chairman*.] The baser metal is dissipated?—Yes, I could give a number of cases, which would prove that a practical elementary knowledge of science, from the boy up to the finished workman, would be of great value.

6394 *Mr. Dixon*.] Have you any other striking illustration to offer to the Committee?—I should think that the case of refining and gathering refuse would be one, that is chemistry again, refining from all kinds of scraps and mixtures of filings, scraps of iron and tin, and lead, and so on. This art is known but to a very few, and yet many people endeavour to work up their dust and scraps, and suffer a loss, for if but an infinitesimally small quantity of lead or zinc, or sulphur, even a 500th part, remains in it under certain conditions, the metal is brittle, and they are forced, after all their trouble, to send it to the refiners and pay 6d or 1s. an ounce for the exchange of it. The theory of chemical science would enable them to guard against that. I speak on behalf of a large number of manufacturers, but I could say much with regard to the men in that respect. If the men understood the laws of heat, a great deal of our spoiled work would be avoided. They do not know, for example, that heat requires a certain time to be conducted round a coil of wire, and they set to work with a blow pipe and burst the coil. The smallest elementary knowledge of the laws of heat would teach them that they must allow it time to travel round the coil, or it will spring open and burst. I have been a workman myself, and take a great interest in scientific matters, and I have had constantly to teach the "why and because" of their various processes.

6395 You would consider that scientific knowledge was almost as necessary in your trade to the artisan as to the master?—Decidedly, the artisan must have it, it is more important to him.

6396 And yet among your artisans you scarcely have any who are scientifically educated?—I am happy to say that in my own manufactory we have a superior class, but taking the trade as a whole, the testimony which I receive from the masters on this subject of scientific knowledge is, that it is almost universally deficient.

6397 Then how comes it that you have got some of the very superior class?—We have chosen our apprentices and trained them. They are generally youths who have received a better education, and whose parents encourage habits of study in them.

6398 Have you given them that scientific instruction in your own manufactory?—No, not in a systematic way, but they have imparted it from one to another mutually.

6399 Do any of the workmen, or any of the children of the foremen and managers in your trade, make use of the science instruction given at the Midland Institute?—Yes; many of them feel the need of it, they are just beginning to feel the need of it, and accordingly avail themselves more or less of its advantages.

6400 Do you think that means exist in Birmingham for the scientific instruction of all those students who are now desiring to avail themselves of it?—No. Allow me to say that I can only speak with regard to those branches of trade with which I am quite familiar, but with regard to those branches of trade, we need, as it were, a special professor who should teach what is wanted.

to the workmen, and again give higher teaching to those who are more advanced, it is useless to teach a boy anything on the subject of melting, which he has nothing to do with, but that boy will come to be an artizan, and there should be the means to teach him progressively, all he will need, including what are called by some, the "masters' secrets."

6401 You would not only teach them the principles of science, but the principles of the work which they had in hand?—Yes, technical instruction, *i.e.*, the science involved in their trade processes.

6402 And you think the means of giving that do not exist to a sufficient extent in Birmingham?—Certainly not to a sufficient extent, if at all.

6403 In what way would you propose to supplement the instruction that is now given?—I think the extent, number, and importance of the group of trades which I represent is sufficient to warrant the appointment of one man who should devote himself entirely to the science of these trades, and that he should give class instruction by day and by night to the young, the adults, and the masters, and that he should be paid to devote himself to the difficult problems of our trade, so that we should be on a level with France and Germany, which we are not now.

6404 *Chairman*] That he should teach you the practice of the trade?—No, not that he should teach us the trades, but find out and overcome its scientific difficulties for us, for example (*producing some specimens of enamelling*), we want to be able to have those colours to melt at the same heat, and we cannot do it yet. I believe it is done at Geneva. Again, we want to be able to guard against that roughness from little bits of iridium from steel pens that we get in our scraps, and we cannot do it; a man had need to devote himself specifically to those points for months, and there are many other equally important points of difficulty.

6405 *Mr. Dixon*] Then he would not be engaged in teaching children or adults of the labouring class?—Yes, these researches need not occupy the whole of his time. I do not speak specially to that; the concentration of one man's whole attention and abilities to this circle of subjects is the point, and I have it in my mind to agitate that our body of trades should appoint such a man if the Government does not do it.

6406 *Chairman*.] Do you not think that that is the proper course rather than that Government should be asked to do so?—If they help other trades it is proper that they should help ours, but if other trades are thrown on their own resources, we are content that ours should be thrown on its own resources.

6407 Are you acquainted with any instances in which Government assists trade in that way?—I am not, *i.e.*, in a way precisely parallel to what I wish, though the assistance given by Government investigations through Mr. Whitworth and others, and by offering prizes for the perfecting of arms, and of ammunition, and also the Government maintenance of the School of Science relating to specific subjects in Jermyn-street, London, are sufficiently close in principle to what I mean by such Government assistance in our case.

6408 *Mr. Dixon*.] Where do you think this scientific instruction should be given; would you have it given in elementary schools to children

varying from 8 to 13 or 14 years of age?—It cannot be given there, my experience as secretary for many years in an elementary day school is that it is as much as children up to 12 years of age can do to get the elementary education that the Committee of Council demand of them; I know what our inspectors will say to-morrow, how is it that you cannot keep the children a little longer time than this? Our maximum age is 12, and they cannot get science teaching in that time.

6409 But supposing that children were to be kept in the schools from the earliest age at which it is advisable to send them there until the age of 12, and their attendance were to be regular, do you still think it would be impossible?—A great deal could be done between the ages of six or seven and twelve. I should like to see them compelled to attend.

6410. You are in favour of compulsory attendance, are you?—We shall never get on until it is made compulsory.

6411. In that case, you think a little elementary scientific knowledge could be given at primary schools?—Quite sufficient could be given to carry a boy over many of those difficulties in my trade.

6412 When they left the primary school, would you advise the scientific instruction being continued in night schools, similar to those at the institute?—Yes, certainly, they would have a taste and desire for it.

6413 Do you think those schools self-supporting, or would you look for support outside your trade?—In the first instance they must be established by the aid of Government, and afterwards, when the taste and desire existed, they would be self-supporting.

6414 You say that the desire does exist to a certain extent, and is increasing?—That is so.

6415 So that the object of seeking Government aid would be more for the purpose of anticipating and hastening the increase of this desire for scientific instruction?—Yes, clearly so, and only so in my opinion.

6416 Supposing the Government to stand on one side and do nothing, do you think what you are seeking to get would be attained a little later?—Not a little later, but a great deal later; it is certain to be got, because we shall be beaten by our Continental competitors, until we find out certain causes, which I think it is the province of Government to take steps to help us to do.

6417 In fact, you think that Government would scarcely be a loser by giving such assistance, because the property of the nation would be so much increased by this aid that the return would probably be equal to the expenditure?—Exactly.

6418. *Chairman*] Is there anything peculiar in the trades of Birmingham that makes it more desirable that Government should teach those trades rather than any other trades of the country?—Textile and fictile trades, I do not think, have the same demand on the Government as the metal trades of Birmingham have.

6419. Why do you think that?—I do not think that the artisans in the carpet manufactories or calico mills have the need of science that artisans in any of the manufactories in Birmingham have.

6420. The question was this: whether there was any reason why the Birmingham artisans and Birmingham manufacturers should demand of the

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Government that they should be taught their trades rather than manufacturers and artisans in other trades?—I propose that they should only be taught the science or philosophy of their trades

6421. I mean the actual manipulation, because you wish experiments to be made in order to discover the best methods of enamelling, for instance?—Yes, and colouring and other processes.

6422. Those things are strictly matters of trade, are they not?—I understand your question to refer to improving the processes. It is a different matter from the application of a process by the workmen themselves.

6423. In what way would it be different?—The improving of a process is altogether a new step, while for a clever workman an existing process is an old matter.

6424. I am not speaking, of course, of the mere manipulation, though manipulation was included in my question?—I am against Government teaching trades, although I am in favour of Government helping us to understand the science belonging to our trades.

6425. Would you consider the instances which you have given as instances of the teaching of science, or would you not rather consider them as being instances of the application of science in a profitable direction?—Decidedly it is the latter, though the former is involved. It is the application of science in a profitable direction, and so is all scientific instruction, when brought into actual practical use.

6426. Then, you think that Birmingham has more claim to be assisted in the discovery of improvements in enamelling, than Manchester has to ask for assistance in the invention of improvements in their machines?—No, I should say not, but a Birmingham mechanic would be more highly benefited in his trade by scientific instruction than a Manchester mill, hand would in his, at least, so I think.

6427. Mr. Acland } I understood you to say that your trades in Birmingham require a professor, or scientific man, to assist them in explaining what you call the philosophy of their business?—Yes, I do think so

6428. You are probably aware that the agricultural community have been for a long time in the habit of employing an agricultural chemist, or a consulting chemist, either to test their manures or their soils, or to give them advice in the processes?—Yes

6429. Do you wish for something of that kind, do you feel that your business requires the same kind of assistance?—Yes.

6430. But I want to know on what ground, that which the landowners and farmers have done for themselves, should, in the case of your trades, be done by Government?—On no other ground than that the national prosperity would be advanced by it.

6431. Then, should the Government, in your opinion, offer to assist landlords in the analysis of their manures?—Yes, decidedly.

6432. But they can do it for themselves?—They do not do it for themselves, individuals may do it, but it is not generally or universally done

6433. If you were told that an eminent manufacturer had spent 25,000 £ in perfecting one particular class of agricultural implements, should you be very much surprised?—No.

6434. And that he had done that entirely

without assistance from the State?—I should not be surprised; I could give you instances from manufacturers around Birmingham, in which the heads of the firms have spent as much money in perfecting processes; the name of Mr Chance occurs to me in a moment. I think that if we were large capitalists, my partner and myself would ourselves engage a first-class chemist, but the expense is so much that we cannot do it.

6435. Now is not this, in your opinion, a rational view of the case, that the Government, should, as a matter of national prosperity, promote the advancement of general science as part of the intellectual stock of the nation, and should also undertake to inspect, and to a certain extent where they desired it, to guide institutions for special teaching, but that those who were to make actual money from the science should provide it for themselves?—That is fair enough.

6436. Then if this Committee should recommend that Government should superintend and stimulate science instruction, that would meet your views?—Yes, and that they should extend the opportunities, and where needful make such instruction specifically suitable to the wants of the local industries.

6437. You think that is a necessity which arises from our backwardness to appreciate science in England, and which will pass away when public opinion is more advanced in that direction?—We cannot prophesy, but that is my opinion.

6438. Are you of opinion that in order to bring about this desirable result which you advocate, the whole tone of middle-class or secondary education requires great improvement in England?—Yes.

6439. I mean by secondary education all education above primary education, including university education?—That is what is wanted.

6440. Will you explain a little more fully your views with regard to the necessity of the improvement of secondary education from the primary school up to the universities?—The thought that is constantly in my mind is this, that if I took a boy from a purely primary school and placed him in my warehouse, and I took another who has had what is called a good secondary education, I should find that there is very little difference between the two, that the boy who has had the education in a respectable school is only nicer in his manners, but he does not know much more than the lad who has come out of my elementary school, in other words, the primary schools are fast on the heels of the secondary schools.

6441. Would you say that there is a special necessity for lower and middle class schools where the payment for education should not exceed 4 £ a year?—Yes; that is the class of thoroughly good schools wanted, for the prosperity of England.

6442. You are aware of the tendency of all private adventurer schools as soon as they succeed to raise their fees, and rise out of the class in which they succeeded?—Yes.

6443. A private school for the upper working class, or small tradesmen, would, unless some public authority interfered, have a tendency to slide upwards, and get out of the reach of the class for whom it was originally intended?—Decidedly.

6444. Does your experience confirm that opinion?—Yes; but I am not prepared to state that I would

I would interfere with that in the case of a private school.

6445 Are you favourable in Birmingham to one portion of King Edward's School being devoted more especially to science than it is now?—I am.

6446. *Chairman*] Is there anything that you would wish to add to your evidence?—I think that we need special science instruction for groups of trades in order to enable the designers for those trades to learn the scientific conditions which are necessary to be observed in their designs

6447 You mean the laws of form, and the mechanical conditions of their work?—Yes, and the chemical conditions.

6448. Would you extend what you have said with regard to chemistry to the mechanical laws and properties of matter as affecting form and construction?—Yes, certainly, the laws of mechanics should be also studied.

6449 And the laws of heat?—Yes, physical science generally. I could say a good deal upon the application of optics to this subject, and the scientific knowledge of the laws of colour.

6450. You would say that it was not only bad taste, but bad economy, to construct a thing in metal as you would construct it in wood?—It is quite true. Frequently it happens that a designer, having produced a design, is not aware that, even from the scientific necessities which would arise in the manufacture of the article, it cannot be made at all.

6451 *Mr. Acland*] It is your opinion that in all trades which combine both mechanical and artistic considerations, you cannot produce good artistic results without a thorough comprehension of the mechanical conditions of the work?—Yes.

6452. And that requires a good scientific education?—Undoubtedly.

6453. *Lord Frederick Cavendish*] You stated that for the present you considered Government assistance to be necessary for the purpose of carrying out science schools?—Yes.

6454. Have you considered what alterations are necessary in the system under which that assistance is now granted?—I have not considered that question

6455. *Mr. Louth*] I think you stated that there was a large amount of work spoiled from the want of proper scientific knowledge, have you any idea of what would be the average yearly loss in your establishment from that cause?—I cannot say, I have not turned my attention to that point. I am satisfied that we have in time past thrown away at the rate of a couple of hundred pounds a year from want of scientific knowledge in refining, and in dealing with the refuse

6456. *Mr. Potter*] I presume that most of the masters in your trade are small capitalists?—Yes.

6457. What is the largest number of hands employed by any master in your trade?—I should say not more than 60 or 70.

6458. When you said that there were about 8,000 hands employed in your trade, you included men, women, and children?—Yes.

6459 The masters, I suppose, are not a highly educated class?—They have most of them sprung from the workmen's ranks.

6460 Do any of them employ chemists of their own?—Not one.

6461 I suppose the extent of their trade would not warrant that?—No.

6462 I suppose you are aware that the master printers and dyers do employ chemists in their own works?—Yes

6463. But you rather look to Government to supply you with chemical skill for your own special trade?—I do not see any other way in which it could be done.

6464 You think your trade would be superseded by foreign competition, unless the Government stepped in to aid you?—To a certain extent, especially where price is a great consideration.

6465 Is there a great import of foreign jewellery into this country?—Not a great import of foreign jewellery into England, but our markets abroad have been taken from us

6466 There is no duty on jewellery imported into this country from abroad?—No

6467. Then how is it that it does not supersede our jewellery?—It does not do so to a large extent. It is very much a matter of taste, and the taste of France, Germany, and Switzerland in jewellery is not exactly all that the English like

6468. *Chairman*] But is there not a considerable import of foreign jewellery into England?—Not considerable, compared with the quantity manufactured in England, though the imports are much larger than they used to be

6469. Is there not a very serious competition with English jewellery in neutral markets?—A very serious competition.

6470. *Mr. Potter*] But you do not know the quantity imported?—No.

6471. *Mr. Dixon*] But you know that the import is increasing?—Very much so

6472 So as to make you anxious for the prosperity of your own trade?—Yes

6473. *Mr. Potter*] Is not the import very slight, have you any figures to show that it has increased within the last two years?—No

6474. *Chairman*] Is there any scientific chemist in Birmingham who devotes himself to consulting practice, and who could give advice to manufacturers, and could conduct analyses for them?—I do not think there is one, we have repeatedly applied to chemists, but they have always said, "This is a good deal out of the line of our ordinary operations, and would require specific study;" in fact, we have never received satisfactory assistance from a chemist.

6475. *Dr. Percy* formerly resided in Birmingham, did he not?—Yes, and if we could get him, or one like him, we could get something from him that would be worth having.

6476. You think if you could get a man like *Dr. Percy* in Birmingham, he would be of great value?—Yes, no doubt.

6477. *Mr. Potter*] Do you think it would be worth the while of your trade to give 500*l.* or 1,000*l.* a-year to a man like *Dr. Percy* to induce him to reside in Birmingham?—Yes, I think it would be worth the while of the jewellery trade in Birmingham to give 2,000*l.* a-year, but the difficulty would be to persuade the masters to give even 1*l.* a-piece. Most of them would need to be instructed up to that point of true economy and prudent foresight.

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6478. *Chairman*] I BELIEVE you are a working gunsmith?—Yes

6479. You were selected by a Committee formed in Birmingham to visit the French Exhibition under the auspices of the Society of Arts?—Yes

6480 And you made a report upon what you observed in Paris during that visit?—Yes, I made a report upon the gun trade

6481 *Mr Dixon*] Is it true that since your return a society has been formed among the artisans, originating mainly in those who went to the Paris Exhibition, which society is formed for the purpose of advancing the interest of the working men, specially with regard to education?—That is so

6482 Have you consulted them upon the subject before this Committee, before coming up to give evidence to-day?—Yes, they had taken up the subject on their own account before they knew that one of their number would be asked to come here to give evidence, but since then they have devoted themselves more specially to that subject, and, in fact, they have done nothing else at present since their formation than attend to this subject of scientific education.

6483 Are you able to express, to a considerable extent, their views as well as your own?—I am commissioned by them to express their views to this Committee

6484 Were you able, when you were in Paris, to form any opinion with regard to the education of the foreign artisans, especially with regard to scientific attainments?—Generally I was; that is to say, we thought we could distinguish their superiority in the manner in which they went about their work Various processes which we saw there appeared to be very direct and simple, evidently guided by persons who had a knowledge of science, those processes were, in fact, direct applications of scientific principles

6485 Did you consider, on the whole, that their artisans were better educated in a scientific point of view than the artisans of Birmingham?—Decidedly very much better educated than the artisans of Birmingham

6486 *Chairman*] Did you arrive at that conclusion from seeing specimens of their skill and from their modes of working, or from direct contact and inquiry among the working men?—Partly from inquiry through the foremen and interpreters that went with us; we were told that the working men were more scientifically and artistically educated than is generally the case in England; for instance, we were told that in one jewellery establishment, out of 200 workmen there were only four who could not draw, whereas in Birmingham there would not be four in 200 who could draw

6487 That drawing would, I suppose, be designing and geometrical drawing?—It would be, of course, such drawing as would be suitable for the jewellery trade I presume designs for jewellery work, and also the capability of drawing what they produced

6488 But it would involve a certain knowledge of geometry?—I presume so

6489 *Mr Dixon*] Did you gather any other illustrations of the superior attainments of the foreign workmen besides that one?—Only that in the manufactories that I went through, most

of the foremen, though dressed like the other men and working among them, appeared to be men of superior education to those of the same class in England. I was told that one of them, whom I noticed, had been educated at one of their technical schools and held a medal which had been given to him for his attainments

6490 Was that in a manufactory of fire-arms?—It was a gun barrel manufactory.

6491 You were not able to judge of the attainments of the working men whom you came in contact with?—No; I do not understand French, but some of the processes which I saw were direct applications of science, such as we have never thought of here in that manufactory

6492 And they would require a superior education in the person who applied them, I suppose?—They would require a person well acquainted with science to invent them or to carry them out

6493 Can you give some illustration of what you have just now stated?—Yes; one would be the way in which the gun barrels were planed; I own that was a very beautiful application of mechanical science, our method in Birmingham is by turning them on a lathe; the object, of course, is to get them perfectly true; by the mode employed in France it is impossible to deviate from a perfect plane, but in England we sometimes do deviate a little, the process is very beautiful, but it is not so certain as the French method

6494 *Chairman*] Are you speaking now of the best organised manufactories in England, or of the ordinary manufactories?—Of the best

6495 Would you include the Enfield armoury, for instance?—As far as I know our manufactories in England, I think the method which I saw used in France, is preferable

6496 *Mr Dixon*] Suppose that the machinery you saw in France were introduced into Birmingham, do you think the English workmen would be able to use it as successfully as the French workmen use it?—The English workman would decidedly be able to use it as well as the French workman if he only adopted it, but the thing is, we are slow to move in England; if we are wedded to a system we do not like to leave it unless the advantages of the new system are very plain indeed. I have explained this process to many gunmakers since I came home, and though they all acknowledge that it was a superior process to that which they used themselves, I could not get them to see the advisability of going to the additional expense

6497 Do you think that arises from want of general intelligence or from want of special scientific knowledge?—I should say from want of special scientific knowledge, though it may be partially due to want of general culture.

6498 Were you able to judge as to whether the articles produced in the manufactories which you visited in Paris were of a better description or cheaper than similar articles produced in England?—They were not cheaper, but as far as I saw, they were as good as we make in England though I cannot perhaps say that they were better, but I have heard since I came back that they have very strikingly improved since 1862, especially in the manufacture of gun barrels. I do not see the 1862 Exhibition myself, but those who were there tell me that in some particulars in which

which they were deficient they are now excellent, showing that they have profited by the lessons which they have learned.

6499. *Chairman.*] Is it not the case that very great improvements have been made in France in the production of gun barrels drawn in solid steel?—I believe so.

6500. *Mr. Dixon.*] Is it your impression from what you saw at the Paris Exhibition, that you have much to fear from the competition of foreign manufacturers on the ground of their labour being cheaper?—No, by no means. I do not think as a rule it is cheaper.

6501. All you have to fear, you think, is the result of their superior scientific education?—I think so.

6502. *Chairman.*] When you say that their labour is not cheaper, do you mean to say that their daily wages are not lower?—The wages are lower than the wages of our workmen, but they do not work so hard, we were all unanimous upon that point, namely, the pace at which the common workmen in France do their work.

6503. It is much slower than the English pace?—It is much slower than the English pace.

6504. To a certain extent the effect of that is to neutralise the lower rate of day wages or wages per hour?—In the majority of cases I should say it was so. There may be some instances in which their labour is really cheaper than ours, of course. I should suppose that artists and designers do not get so well paid as in England, because there are more of them, and they are more on a level with those about them.

6505. But you speak now of the artizans in Paris, more especially those engaged in mechanical occupations?—Yes.

6506. And particularly those engaged in trades which are parallel to those of Birmingham?—Yes.

6507. *Mr. Dixon.*] Would you say that there was any scientific education at all among the artizans of Birmingham?—I am afraid there is very little; and where there is any, it is where the knowledge has been attained for the love of it. It does not come in their way as artizans, and there is no special provision for the acquisition of it.

6508. Do you think that there is now, at this moment, a demand for that kind of education among artizans. Do you think, in fact, that the want of it is becoming generally felt?—I am afraid not. It was felt very strongly by those of us who went to Paris, but we have not been able to infect many of our fellow workmen.

6509. *Chairman.*] How many persons are there in your association?—53 only, but we are very young at present.

6510. *Mr. Dixon.*] And your members are all thoroughly impressed with the want of scientific education among artizans?—Yes, especially those who went to Paris.

6511. Do you find that your society meets with support and encouragement from the artizan class?—As far as we have gone, it does; but we have not proceeded far at present.

6512. Will you state to the Committee what are the precise objects of the society formed in Birmingham under the name of the "Birmingham Society of Artizans"?—I have here the prospectus, which says, "The objects of this society are to consider and discuss, from an artizan point of view, all such subjects as specially affect the artizan class; to promote, and seek to obtain, all such measures, legislative or otherwise, as shall

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appear necessary or beneficial to that class, and to render to each other mutual assistance, counsel, and encouragement."

6513. What are the terms of membership?—The membership is not restricted to artizans, but is open to all, and the rate of subscription is 1*s.* a quarter. We stated our object very generally in that prospectus, in order that when the subject of scientific education was done with, we should have no necessity to break up the society, but could take up other questions, such as co-operation and dwellings for working men, but we had it in our minds when we formed the class, that scientific education would be the first subject to which we addressed ourselves.

6514. *Chairman.*] And, in fact, it was the first subject to which you devoted yourselves, and you are at present confining your attention to that one subject?—Yes.

6515. *Mr. Dixon.*] Have you directed your attention to the machinery which already exists in Birmingham, for giving scientific instruction to the working classes, are you aware, for example, of the existence of certain schools for that purpose, and of the manner in which they perform their work?—I know very little about them. I have an impression that the Midland Institute is not exactly suited to meet the wants of the artizan class.

6516. In what way does the Midland Institute, in your opinion, fail to meet those wants?—It is a very admirable institution for those who wish to procure this knowledge, or who wish to pursue the study of science for its own sake, but it is too general for our purposes; it does not come down to our special wants enough. If an artizan wanted to learn what he required specially in his own trade, he would have to wade through a good deal of what he did not want to know. If I wish to learn the branches of science which were applicable to my own special trade, I should have to learn a great deal which was not applicable to my own special trade, and I have not time for it.

6517. What sciences would be particularly useful to your own trade?—Mechanical science, of course, and a knowledge of drawing would be useful, and the chemistry of metals. I could join a class in the Midland Institute in the chemistry of metals, and all that I learned there with regard to the chemistry of iron and steel would be useful, but what I learned of the chemistry of gold and silver would be of no use to me.

6518. But do you not think it would be necessary, in order to your making any successful application of scientific knowledge of your trade, that you should first be instructed in the principles of the science?—Yes, but I think I ought to have had opportunities of learning them when I was young. The great mass of artizans when they are married, and have got families, have but little time for acquiring the principles of science.

6519. But still a knowledge of the general principles is necessary to be acquired before you can apply the details, is it not?—Yes.

6520. Then you do not object to the general principles of science being taught in the Midland Institute?—Certainly not.

6521. Then what you mean is that in addition to places like the Midland Institute, which is for youths or adults, you would wish to see the elementary principles of science taught in elementary schools?—Yes.

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6522. In all our primary schools you would have the elements of science taught?—Yes.

6523. Do you think that that could be done at the present time, taking into consideration the age up to which children stay at school, and the irregular attendance?—I am afraid I am not able to give a decided answer to that question, but I think it could be done, it is done in other countries. I think that a great deal which is now taught in elementary schools might be taught in a simpler and easier form, so as to economise the time.

6524. Do you think that the artizans who have joined this society of yours are generally in favour of compulsory attendance at primary schools?—The question has never been raised among us, as a body, but from my knowledge of the working classes of Birmingham, generally, I think there is, generally speaking, a feeling among them in favour of compulsory education.

6525. We have it in evidence from high authority, that at present it would be impossible to give elementary scientific instruction in primary schools for the reasons I have mentioned, namely, that the children are not at school long enough, and that their attendance is not regular enough. Now, if that were so, would you be in favour of adopting any measure to enforce attendance, and to improve its regularity in order that you might give elementary scientific instruction?—I think elementary scientific instruction could be introduced, and a good deal taught within the time for which children now go to school, but I am not prepared to say that I would enforce their attendance on that ground alone.

6526. But supposing this elementary instruction in science not to be given at primary schools, what measures would you adopt for giving it, would you be satisfied with, for example, what is done at the Midland Institute, or any other science classes which now exist in Birmingham?—I should not. I think that scientific instruction should be very much more diffused than it is, and made a good deal cheaper, if not entirely free.

6527. Are you aware what are the fees paid at the science classes in Birmingham?—At the Midland Institute it is 3s a quarter to each class.

6528. Do you think that that is too large a fee for those people who are sufficiently intelligent to desire this scientific instruction?—No, not for them, but we want to get hold of the others, we want to bring the knowledge of science lower down.

6529. *Chairman*] Do you think the cheapening of the fees for those classes would have much influence in that direction?—It would make them much more popular, and working men would in some measure become interested in the subject, I think.

6530. *Mr. Dixon*] Do you advocate Government interference in this matter?—Yes.

6531. In what way would you wish the Government to assist in the spread of scientific education?—By grants in aid of the expenses. I look at it in this light, that as there is not sufficient public spirit to provide it by private means, and as it is a matter of national interest, the Government should take it up, and do for us that which we are not inclined to do for ourselves, inasmuch as every trade that leaves this country is a loss to the whole nation, and diminishes our capacity for bearing taxation.

6532. Are you aware that the Government now makes payments on results in the science

classes of Birmingham and other places?—I am aware of that, but I think that is not near enough.

6533. But suppose science schools were to be established by Government aid, do you feel sure that the artizans would attend them?—I am afraid I cannot say; there are only a few of them at the present time who take an interest in the subject, but I fear it will come home to them very shortly.

6534. You would not hesitate to establish these science classes, with the expectation that if not immediately, yet very soon, the working classes would attend them?—I think they would.

6535. You think, however, that if we were to wait before establishing them, till the working classes demanded them, we should have to wait too long?—Yes, the mischief would be done.

6536. *Chairman*] Are you aware that at Saltney, near Birmingham, where there is a waggon factory, classes have been established, in connexion with the Science and Art Department, which are attended almost exclusively by artizans, and are answering very well?—I have no knowledge of that.

6537. Are you not aware that in connexion with the Science and Art Department, there are in Lancashire, and also in the neighbourhood of London, science classes, which are very largely attended by artizans?—I was not aware of that, and I am very glad to hear it is the case.

6538. *Mr. Dixon*] Do you think the establishment of museums in large towns like Birmingham would be advisable?—They would undoubtedly be useful, and especially if each trade had its own museum, illustrating its progress and history, and the processes carried on abroad in that trade.

6539. Would you have all that in one museum, or would you have separate museums for different trades?—They might all be grouped together under one roof, perhaps, but each trade should be kept separately.

6540. Would you advocate the granting of Government aid for that purpose?—To a certain extent, I would.

6541. *Chairman*] In aid of local effort?—In aid of local effort.

6542. *Mr. Dixon*] Do you think that the Government might do more than is being done now in the distribution of honours and rewards to successful students in science classes?—I think they might extend the system, so that it might act as a more general incentive.

6543. You would not advocate the formation of these by the Government exclusively, but you would suggest that the Government should aid others to do it?—I should like to see the Government initiating the movement with regard to their own manufacturing establishments, and I am of opinion that every trade should have its own school to teach the sciences which are involved in it, a school in which the youths and young people employed in that trade should get a competent knowledge of all the sciences used in that trade.

6544. *Chairman*] Are you aware that the amalgamated carpenters of Manchester have already established such a school for their own trade?—I was not aware of that.

6545. If you were informed that that was so, would you say there was anything to prevent the artizans of Birmingham doing for themselves what the artizans of Manchester have done for themselves?—There is certainly nothing to prevent

vent them, but if they are not inclined to do it, I think the Government might wake them up a little.

6546 But if the example of the Manchester carpenters does not wake them up, do you think the fact of establishing Government schools would induce them to come in?—It would make the thing more widely known; I was myself not aware that the Manchester carpenters had established a school.

6547. Mr. Dixon.] Have you any further information to give the Committee on this subject?—I should like to add a few words on the division of labour, and the manner in which it operates on artisan intelligence in Birmingham, and I suppose in most large towns. The manner in which trades are divided and subdivided narrows the opportunities of artisans to become acquainted with the principles of their trade, and there is nothing to counteract that tendency. The French have schools and colleges in which foremen and managers are trained and taught the principles, and a great deal of the manipulation of their trades from beginning to end, now in England, or at least in Birmingham, there is no opportunity at all for such training.

6548. Chairman.] You are referring to such schools as the *Ecoles des Arts et Metiers*?—Yes; there are a variety of trade schools in which the trades are actually practised.

6549. Do you think those trade schools are useful?—As far as the practice of the trade is concerned I do not think so; but for understanding the general principles of the trade I think such a plan would be very useful indeed.

6550. You would never, for example, introduce a 30 ton steam-hammer into a school?—No, but I should like to see models introduced to illustrate the scientific teaching of trades.

6551. You think that artisans should have access to museums in which models of various tools, not otherwise accessible, should be open to their inspection?—Yes; and I think those museums should be made very complete.

6552. Mr. Dixon.] Would you advocate that for the advantage of artisans as a whole, or merely for the training up of foremen and managers?—It would be a better school than anything we now have for the training up of foremen and managers, but it would also benefit artisans as a whole.

6553. Mr. Potter.] I presume you are afraid that the subdivision of labour will make men into mere machines?—It has that tendency; in Birmingham a vast number, and I was going to say the majority, of manufacturers have risen from the ranks of workmen; if they have not their fathers did; there are very few of them that you can trace back as manufacturers beyond the grandfathers, and, generally speaking, they cannot have had a very perfect or thorough knowledge of their trade when they become masters, the consequence is, that all they can do is to group each of those classes of work in subdivisions, and give out the work to be done by those workmen who pass it on from hand to hand, but that no one person knows the process from beginning to end.

6554. Except the master?—Not even the master as a general rule, because he himself rose from the ranks.

6555. Have you any knowledge of Mr. Whitworth's machinery?—Only from reading of it.

6556. Are you not aware that he has a much

higher class of machinery than exists elsewhere?—I believe so, the gun trade has had a better opportunity of developing itself than any other trade in Birmingham; during the last few years a great impetus has been given to it; first, by the adoption of the rifle, and then by the adoption of the breech-loader, and that has awakened the mental activity of the trade.

6557. You were speaking of improved machinery in use at Paris; if that machinery were once introduced at Birmingham, do you think the workmen would be ready to use it?—I do not think there would be any difficulty on that score.

6558. Mr. Dixon.] There was no difficulty in working the machinery that was introduced into the small arms factory?—I believe not.

6559. Mr. Potter.] But were not some of the workmen brought from America?—A good many of them.

6560. Chairman.] Were not those workmen rather trained labourers than skilled mechanics?—Yes; a large portion of them, I suppose, would have been trained labourers.

6561. Mr. Potter.] The tendency of machinery is to enable you to employ common day labour rather than skilled labour, is it not?—Yes; and that is a misfortune in my view.

6562. But the general result to the public is good, is it not?—It may be so in the way of getting money, and increasing material wealth.

6563. It cheapens production?—It cheapens production, and of course it increases it; but it lowers the tone of artisan intelligence, which is a great misfortune.

6564. Mr. Acland.] A misfortune which you wish to overcome, as far as you can, by a higher scientific education?—Yes.

6565. Lord Frederick Cavendish.] Do you think it possible for children to learn the elements of science at ordinary day-schools?—I do.

6566. At what age do children in Birmingham ordinarily leave school?—At 12 to 14 years of age.

6567. Is the Half-time Act in force at Birmingham?—It has only just come into operation.

6568. Would many of the children in Birmingham come under its provisions?—A large number, taking the whole town.

6569. Do you think the artisan class generally would be willing to have the age of 13 raised, in order that the children might learn more science at school?—I am scarcely prepared to answer that question; the intelligent artisan would perhaps be willing; but when a man is himself ignorant, he does not himself see the want of education for his children, which it appears to me creates a necessity for what I would call violent action on the part of the Government, a kind of action to which I would be opposed to on principle, but which I would like to see commenced in the actual circumstances of the case.

6570. Up to what age would you say attendance at school ought to be compulsory?—It is compulsory now up to 13 years of age, with respect to half timers.

6571. You have spoken of the difficulty of the artisan learning his trade fully, owing to the great subdivision of labour?—Yes.

6572. Is it possible for an artisan who wishes to qualify himself for a foreman, to change his department, so as to learn his trade fully?—It is

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very difficult, and there is no inducement to do it.

6573. Except the desire to rise and attain a better position?—But the man would not see that in all its force while he was learning his trade; it would only be when he had come to man's estate, and incurred responsibilities, that he would feel the pressure of that desire to better himself.

6574. *Chairman.*] If he did see it, would there be any practical difficulties in his way?—A great many practical difficulties.

6575. *Lord Frederick Cavendish*] But may we not presume that in a community where so many of the manufacturers and foremen have sprung from the artisan class, there is a considerable amount of general feeling among the men, that it is at least possible for a working man to rise in that way?—I do not know that there is that general feeling, there are, no doubt, instances of the kind, but I think they are exceptions.

6576. *Mr Acland*] To what age would intelligent workmen be disposed to send their sons to school in Birmingham?—I should say generally up to 14 or 15 years of age, the age at which they are apprenticed.

6577. If there were good schools for boys of from 12 to 14 years of age where they might learn something more than is now supposed to be taught in elementary schools, do you think there would be any difficulty as to the parents foregoing the earnings of their children up to 14, if the schools were such as were satisfactory to them?—I think the great majority of artisans in that case would send their children to school.

6578. In putting the question, I am supposing that the earnings of the father are from 25 s. to 35 s. a week?—Many circumstances would modify that; if a man had a large family, 30 s. a week would not be much, while on the other hand a young man with 25 s. a week would be better off.

6579. Do you think it is one of the great wants of your town that there should be thoroughly satisfactory schools of a rank above national and British schools for the purpose of educating the sons of artisans up to about the age of 14?—Yes.

6580. Do you think, supposing the schools to be established, and to be quite what the working men wished, that they would be willing to pay 10 s., 15 s., or even 1 l. a quarter for the education which would be supplied through those schools?—I am afraid not, when I say that such education is a great want in the town, I must add that I am afraid the majority of the working men do not see the want, so that I am afraid the majority would not be willing to pay such an amount as you have mentioned.

6581. I understand you to be decidedly of opinion that in elementary schools some of the elementary facts of science might be taught; have you any doubt that, if some of the most interesting and simple facts of science were introduced into such schools, the boys would learn reading, writing, and arithmetic all the quicker, and that there would in fact be no time lost by the introduction of science?—I certainly think that that is true.

6582. Have you had any opportunities of testing that opinion by experience?—No; but I have directed my mind to the subject a good deal, and I think that the whole process of instruction

to boys might be very much simplified. For instance, I would not employ any of their time in learning spelling, as it is called. I should teach them spelling by means of writing. I would let them read, for instance, a lesson in geography, and then, instead of their committing it to memory, I would let them write it down.

6583. Do you think arithmetic might be better taught than it is generally taught?—That may be so. but arithmetic requires a good deal of practice. A boy must learn, for example, the multiplication table, and then he must have practice in the use of it.

6584. But, suppose a boy to have thoroughly learnt the first four rules of arithmetic, decimals, and vulgar fractions, and the rule-of-three, and to have possessed himself thoroughly well of the principles of those rules, do you not think it is rather a waste of time to keep that boy copying out sums in books, as it is so often done?—Yes, I think so; but the majority of working men's children do not go any further than the point you have just named.

6585. And you think the reason is that a great deal of their time is wasted at school?—Yes.

6586. A great deal has been said in this Committee about the practice of the Science and Art Department, and the Government assisting on particular class of persons in science. Now, as matter of general principle, do you think that those who earn their living by wages, however important a class they may be to the country, have any more claim than other classes to have gratuitous instruction given to them, or instruction very much below its cost; as between the man who earns an income of less than 100 l. a year by wages, and a man who earns about the same income as a shopkeeper, do you think the working man has any more claim than the tradesman to have his education given to him as a matter of charity, or, at all events, gratuitously by the Government?—I do not look upon it as a matter of charity. I look upon it as one of the duties and functions of Government to provide national education.

6587. Do you think the Government is more bound to provide the cost of education for those who live by wages than to do the same thing for other classes of the community; do you, in fact, think that the Government should relieve working men from that necessity of paying for the education of their children which belongs to a class in a slightly different position?—Yes.

6588. Why do you think working men have more claim than, for instance, small shopkeepers?—In the first place, because education, especially scientific education, is of more direct value to them in their occupation, and also because their occupation is the source of the material wealth of the country.

6589. But do you think the labour of a good artisan in Birmingham is very much more important to the country than the brains and time and labour of a master manufacturer, who employs, perhaps, very few hands, whose income is probably not much larger, and is certainly more precarious, than that of the wage-earning class?—I think the working classes have a greater claim than the better classes, because they are less able to provide education for themselves.

6590. But do you not think the working man's mind, at the end of a day's work, is much more disengaged than that of a small capitalist, who perhaps, when the ostensible work of the day is over

over, has to think a good deal about the way in which he shall meet his engagements?—Speaking from my own experience, I am afraid I must say that the mind of the working man is pretty well engaged during the day, and that when he has done his day's labour he is not inclined to study.

6591. Are you of opinion that one advantage of scientific instruction is that it would tend to disabuse all classes of the community of many of the misconceptions which now impede cordial co-operation among them, or have you no such opinion?—I might answer that very generally by saying any kind of intelligence must tend to soften asperities of that kind.

6592. You think there is on social and economical questions a good deal of misunderstanding which might be removed by a better scientific education?—Yes, and equally so by general education.

6593. You do not consider social science, or political economy, to be science in the sense in which the word is used in this Committee?—No, I think scientific education is very valuable, but that the diffusion of general education would equally have the effect you refer to.

6594. *Chairman*] Do you believe that the working men, who, since the abolition of compounding, are now direct ratepayers, would be prepared to sanction a general educational rate in Birmingham?—From all that I know of the working men in Birmingham, I think they would.

6595. *Mr Acland*] Do you mean an educational rate for any one class of the community, or a rate generally beneficial to the education of the lower middle class as well as the working class, or, do you limit your opinion to primary education?—I have a strong opinion that all education should be free, or nearly so, and that it should be provided for by local or Government rates.

6596. *Chairman*] My question related to what you think may be practicable in the present state of the public mind, with more immediate reference to the fact that all householders are now ratepayers?—There is a very strong opinion among the working men in Birmingham that there should be free education provided, and I think their opinions generally run in favour of its being supported by local rates.

6597. *Mr. Acland*] You would not propose, would you, to educate the sons of the wealthiest bankers in Birmingham free at the public expense?—I think I should leave it to their honour.

6598. Your idea of free education would not stop at primary schools, but would go on to secondary schools?—Yes.

6599. Supposing it were desirable that buildings should be provided for secondary education, at least up to the age of 16 years of age, by a rate, do you think that that would be likely to meet with strong opposition from the working men in Birmingham?—I do not think it would meet with any opposition at all.

6600. *Chairman* (to *Mr. Aitken*)] The Factory Acts have been extended to the trades of Birmingham, and an Act for regulating workshops was also passed during the last Session, both those Acts containing educational clauses, can you state what has hitherto been the effect of those Acts of Parliament with regard to education in Birmingham?—My conviction is thus, that sufficient time has not elapsed to enable us to answer that question satisfactorily, and, in fact, it is only right that I should say that to a certain extent there has been a practice of discharging all who would be compelled to go to school.

6601. Has that practice been general?—I cannot say that it has been general.

6602. If trade had been brisk, do you think that practice would have been conducive to the profit of the employers?—Decidedly not.

6603. They have been able to discharge children in a few instances, because trade has not been brisk?—They have done so. I cannot say the cause.

6604. But would not the difficulty have been greater if trade had been brisker?—Decidedly; my impression is, that they would not discharge them if trade were brisk.

6605. And, in fact, when trade revives, they will be compelled to take on half-timers?—Yes.

6606. (To *Mr. Hibbs*) What is your opinion upon the questions I have just addressed to *Mr. Aitken*?—I have no personal knowledge to guide me. I do not work in a factory where boys are much employed, but it has always seemed to me an anomaly to provide by law for compulsory attendance at school, when the schools themselves are not provided free.

*Mr
C. Hibbs.*
—
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Thursday, 25th June 1868.

MEMBERS PRESENT

Mr. Acland
Mr. Akroyd.
Lord Frederick Cavendish.
Mr. Dixon.
Mr. Graves.
Mr. Gregory
Mr. M'Lagan

Mr. William Lowther
Lord Robert Montagu.
Mr. Edmund Potter
Mr. Powell.
Mr. Read.
Mr. Samuelson

BERNHARD SAMUELSON, Esq, IN THE CHAIR.

CAPTAIN DONNELLY, re-called, and further Examined.

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6607 *Chairman*] You wish to put in some letters from Dr. Sydney, the Secretary of the Royal College of Science in Dublin, Minutes of some of their meetings, and also a joint letter of several of the professors of that College, and a separate letter from Professor Galloway?—Yes (*handing several Papers to the Chairman*).

6608. Lord Robert Montagu] Have the Treasury agreed to your proposal with regard to building grants for science schools?—Yes, a letter has been received from the Treasury sanctioning it

6609. Two shillings and sixpence per square foot of internal area up to a maximum of 500 L?—Yes (*handing in the Minute, vide Appendix*).

6610 *Chairman*] Will you read the letter of the five professors?—I will “Royal College of Science, Stephen’s Green, Dublin, 8th June 1868 Sir,—We, the undersigned professors in the Royal College of Science, having had our attention directed to certain statements recently made before the Committee of the House of Commons on Scientific Education, reflecting on the position of the secretary of the College, and expressing disapproval of the present constitution

of the College as regards the separation of the executive from the educational department, take this opportunity of stating, first, that having regularly attended the meetings of council, we can testify that the secretary has never exceeded his legitimate functions as such; and, secondly, that, so far as we are concerned, the system whereby the executive or purely business details are left to an officer directly responsible to the Government, while everything relating to educational matters is committed to the council, is a beneficial one, inasmuch as were the executive functions also vested in the council they would necessarily fall into the hands of one or two of its members, who would be virtually irresponsible as regards the Government, not to speak of their time being otherwise so occupied as practically to unfit them for such duties. We are, Sir, your obedient servants (signed), *Alexander Dickson, M.D., Professor of Botany; R. Ball, Professor of Mathematics; Edmund W. Davy, Professor of Agriculture; Ramsay H. Traquair, Professor of Zoology; Robert Galloway, Professor of Applied Chemistry.*—To the Secretary, Science and Art Department, South Kensington, London.”

Mr. JAMES CHANCE, called in; and Examined.

Mr
J. Chance.

6611 *Chairman*] You are a Glass Manufacturer, and Chemical Manufacturer at Smethwick?—I am a Glass Manufacturer and Chemical Manufacturer in the neighbourhood of Smethwick and Oldbury, both of which are near Birmingham

6612. You and your relatives have been engaged in those trades for a great number of years?—I myself have been occupied for 30 years in those works

6613 And I believe you have been a prominent exhibitor at all the industrial exhibitions that have taken place, including that of 1851?—I was an exhibitor in the Exhibitions of 1851, 1855, 1862, and 1867

6613 * How many workpeople do you employ?—About 2,500

6614 Have you paid considerable attention to science education yourself?—I have

6615 Mr Dixon] You are a graduate of the University of Cambridge, I think?—I am

6616. You came out with honours?—I was seventh wrangler

6617 Did you receive any scientific education at Cambridge?—The degree will indicate to what extent I pursued mathematics

6618 Did you receive any other instruction in science after you left the university?—Previously to going to the University of Cambridge, I was two years at the University of London, just after it was established

6619. *Chairman*] That is what is now called University College?—Yes

6620 Mr Dixon] The principal part of your scientific training was received there, was it not?—I received the basis of my mathematical education there; I received a thorough education in theoretical chemistry, and I attended also the classes in natural philosophy, and all the scientific classes.

6621. Have you found your scientific knowledge to be of great value to you in your manufacture?—Unquestionably.

6622. Have your partners or your foremen and managers, many of them, had much scientific training?—Nearly all the chief manager

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have a scientific education to the extent of what is required in their respective departments; the manager of the large chemical works at Oldbury is well versed in all those branches of chemistry which concern the manufacture there carried on, and so also the heads of the different departments in the glass works are not deficient in scientific knowledge, so far as it concerns their branches of the manufacture of glass; and I may add, that in the manufacture of apparatus for lighthouses, in which we stand alone in Great Britain, I have men who are well versed in optics, as far as is necessary for practical applications.

6623. Have you ever found any difficulty in obtaining men to conduct the various departments of your manufacture?—The only difficulty that I have ever experienced has been in finding, first of all, men of good conduct; secondly, of tact in administration, knowledge of character, and power over others. I have not found any difficulty in their obtaining for themselves such scientific education as is necessary for their position.

6624. Have you ever had any foreigners in your works?—I never made a distinction: if I can meet with foreigners better than English I always take them.

6625. But you have had foreigners?—I have some still; I have one foreigner as a foreman in the mechanical shop connected with the apparatus for lighthouses.

6626. Have you any reason to believe that the foreigners are more scientifically educated than the Englishmen?—No, not from the experience that I have had in my own particular pursuits, the man to whom I am alluding has a degree of inventiveness, a quickness of apprehension, and a certain versatility, that I do not find generally in Englishmen.

6627. You have no reason, from your own experience, to believe that foreigners are more scientifically educated than Englishmen?—No, certainly not, from my own experience.

6628. To what extent do you think scientific teaching is desirable for working men?—For the working classes I would always provide the best possible general education compatible with the limited time they have to give to the subject. I have done so for the last 25 years at my own works, having had, at least, a thousand children in training. As far as time could be found for the scientific element, I would introduce especially some knowledge of animal physiology, so as to make them see the importance of cleanliness in themselves, and also cleanliness and ventilation in their dwellings.

6629. But with regard to their being better fitted, as mere workpeople, for the performances of their duties, what is your opinion?—I have not had any reference to that particular object; I have found by experience that scientific teaching is chiefly wanted for the directors, managers, and foremen, rather than for the workpeople.

6630. Do you, in your own schools, have any science classes?—Yes, to a certain extent chemistry is taught, of course very slightly. Instruction has been given to a certain degree in such matters as concern their health, and drawing has been taught, and very successfully taught, both the artistic kind and also mechanical drawing, as a part of the best education that we are able to give them during the limited time they have; they all leave school generally at about 13.

6631. This teaching has been given in the day schools?—Yes; this teaching has been given

in the day schools, with evening classes to supplement the teaching of the day school, but it has been given in the day school chiefly.

6632. Have you special masters to teach the science classes?—There has been a teacher of chemistry of late; the School of Art in Birmingham has usually supplied the master for drawing.

6633. Do you think it is advisable that elementary science should be taught in the primary schools of the country generally?—Unquestionably, as far as possible, as a branch of a good education.

6634. Do you think it is possible to teach children, up to the age of 14, in primary schools, the elements of science?—To a certain extent of course it would, I have always advocated teaching a little Euclid.

6635. Do you think the result of this elementary science teaching would be to enable boys to become afterwards more intelligent working men?—As the foremen, for the most part, rise from the ranks of the workpeople, so in proportion as the working people are educated would there be a greater opportunity and larger area for obtaining foremen; because the practical knowledge which a working man has is one of the most important qualifications to render him subsequently a good foreman.

6636. Then, in the event of his not rising to be a foreman, the scientific part of his education would not be of any value to him as making him a better workman?—According to my own experience, not as apart from the general intelligence which all education gives to men, I should prefer an intelligent workman to one who is not educated, he would do his work better, and would have a resource in the evening instead of going to a public-house, which is a very important point, but with regard to any particular work which he has to do, I do not think scientific education important.

6637. Do you think that the foremen and managers of large works like your own should have a special training in science beyond what is given in primary schools?—Their education would certainly have to be of a higher character than that of the mere workman. I think generally they would have an opportunity of teaching themselves, they would be stimulated to maintain their position as foremen. I have found it so practically, each of my foremen has taught himself, how, I have not inquired, but he has generally made himself acquainted with the particular subjects in which he becomes concerned as a foreman; and of course the existence of a school of a high kind would tend to increase the opportunity to obtain that education. I have not found any insuperable difficulty arising from the non-existence of central instruction.

6638. But do such higher schools for foremen and managers exist in your neighbourhood?—The only one that I am aware of is the Midland Institute.

6639. Do you think any of your men avail themselves of that institution?—I am not aware that they have done so, the distance may perhaps present some little difficulty.

6640. But you think it desirable that there should be means opened out to foremen and managers of getting higher scientific instruction, than it is possible to give them in primary schools?—The existence of such institutions would present very great benefits to them; it would give them opportunities which they are not now possessed of.

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6641. Do you think it would be advisable for Government to encourage the formation of such schools and to assist them?—I think the manufacturers, where they require such schools, ought to provide them.

6642. Do they, in fact, provide them?—From what I have heard, the Midland Institute is not supported by the manufacturers as it ought to be. It is supported by outsiders who have not a direct interest in scientific education. I look upon it as an element in manufacture, the same as raw material or any other expense of trade. I am ready to admit that Birmingham is somewhat different from other large centres of industry, inasmuch as it consists of factories of a moderate size; but in other places where the factories and establishments are of a very extensive character, I cannot imagine that the great capitalists of those establishments would go to Government to provide that kind of education which, without much pecuniary outlay, they could provide, and provide in a manner more directly suited to their wants than would be done by the Government.

6643. Still, however desirable it may be that the manufacturers should provide those higher schools, they do not do so?—I have understood that the Birmingham and Midland Institute is not supported liberally by the manufacturers.

6644. Since you think it desirable that there should be such schools, and the manufacturers do not provide them, would you approve of Government stepping in and giving aid and encouragement?—Certainly not. If manufacturers do not appreciate the benefits of science, I would not force it upon them.

6645. But the working men appreciate the benefits of science, do they not?—I am not able to speak with regard to them. I would give them the best possible education consistent with the short time allowed, but I think the great difficulty in this country is the education of the employers, and the foremen under them. When employers and great capitalists are made sensible of the importance of scientific education, they will take care to give a good education to their sons, and then we shall hear no more about the need of technical education, they will then supply it even without Government giving a helping hand, but in Birmingham it is notorious at what an early age the sons of the middle class leave school.

6646. At what age do they leave school?—I think I should not be wrong in saying as early as 13 or 14, but I do not pretend to strict accuracy. The notion is that they are doing better for their sons by introducing them early into business rather than giving them a more lengthened education.

6647. *Chairman*] At all events you would say that it is customary for the children of the middle class to leave school before they are 15 years of age?—At all events, before they are as well educated as they ought to be; I cannot give the exact age.

6648. *Mr. Dixon*] Do you think that means exist for giving to the sons of employers a good scientific education?—I have not heard that the Midland Institute has had a demand upon it at all equal to the staff and the other opportunities provided. I believe that any educational institution would by degrees be accommodated to the public demand.

6649. Are you not aware that the Midland

Institute is merely a night school, intended originally for the working classes?—I certainly thought (I must have been in error) that the sons of the middle class might go there.

6650. They may go there, but it was not originally intended for them, are you aware that it is not a day school?—I am quite aware of that. I am now alluding to the supplementing of his education when a youth has left school.

6651. *Chairman*] I believe the question of the Honourable Member was directed rather to secondary education, and to the provision for teaching science in secondary schools, are you aware whether there is any provision in Birmingham in secondary day schools for boys from the age of 13 to 16, for the teaching of science?—I should say not at present.

6652. *Mr. Dixon*] You would not be satisfied with that which is provided by the Midland Institute?—Not as it is at present developed, certainly not.

6653. You would think it desirable that some means should be provided for giving such scientific education?—The best possible means should be provided in my opinion for giving opportunities to the sons of middle class people for completing their education in science.

6654. *Chairman*] Do you mean during the ordinary period of their education, or subsequently?—I mean quite as much subsequently as during the ordinary period of their education.

6655. *Mr. Dixon*] You are a governor of King Edward the Sixth's Grammar School at Birmingham?—Yes.

6656. Is there not a chemistry class at that school?—Yes.

6657. I believe that is the only science class there, is it not?—It is the only class in natural science. Mathematics is taught there.

6658. Do you think that the teaching at that school is sufficient to supply the wants of the middle class in Birmingham with regard to science, or would you advocate a considerable extension of the science teaching in that school?—It is certainly not sufficient for the requirements of the middle class.

6659. So you think that it would be better that the science teaching given to the boys of the upper middle class should be given at their ordinary day school, or do you think that it should be given separately in a science school or college established for that purpose?—I should be inclined to prefer the latter, that is to say, a school especially established for that purpose.

6660. *Mr. Acland*] I understand you to say you think that the teaching of science for the economical and industrial wants of the middle class in Birmingham had better be given in a separate institution, distinct from the ordinary school?—I am quite inclined to think so.

6661. Are you speaking of boys now who remain at school up to 18 years of age, or of boys who leave school younger?—I am taking what now exists; as a general rule, boys now leave at an early age, if boys stayed at school till 18 years of age, I should say by all means let scientific education be given in the school at once.

6662. Have you noticed the recommendations of the Schools Inquiry Commission with regard to King Edward the Sixth's Grammar School at Birmingham, namely, that in the upper part of that school there should be three departments, one of which should be of a distinctly scientific character?

character, that is to say, that scientific instruction should predominate there, as an instrument of general education?—I am not in favour of the tripartite division of the school.

6663. Are you unfavourable to introducing the elements of natural science into the general curriculum of that school?—Under present circumstances, considering the age at which students leave, I should be unfavourable to it.

6664. You would be unfavourable to the introduction of the elements of natural science into the curriculum of boys leaving King Edward's School at Birmingham at the age of 14 or 15?—Yes; if I understand you to refer to natural science being taught in its various branches.

6665. Then may we take it that you would be favourable to the introduction of some of the elements of natural science into elementary schools, and unfavourable to the introduction of natural science into middle-class schools?—I should certainly not be unfavourable to the introduction of some of the elements of natural science into middle-class schools. I was guarding myself with regard to natural science generally, which is a very large subject involving the necessity of some years of study.

6666. With regard, then, to such elements of natural science as the laws of matter, and those which have been recommended to be given by the Schools Inquiry Commission, and many other authorities, as a natural part of a liberal education, you would have no objection?—I should have no objection to that at all.

6667. *Chairman*] Do I understand you to mean that you would not, in such a school as King Edward the Sixth's School at Birmingham, carry science teaching much further than you would carry it in an elementary school?—No; I only wished to guard myself against saying "Yes" to the introduction of natural science in all its largeness, which would involve superficial teaching, and, on the other hand, I wished to guard myself against saying "No" to the introduction of those portions of natural science which may be taught without being necessarily learned in a superficial manner. In an establishment like King Edward the Sixth's Grammar School at Birmingham, one is not supposed to advocate the teaching of any subject which is not taught thoroughly, the knowledge communicated is supposed to be intended to have an educational effect, as well as to serve a useful purpose.

6668. *Mr Acland*] The pupils in King Edward's School are, of course, to a very limited extent, pupils preparing for the older universities?—Yes.

6669. And there are only a few boarders, I suppose?—Very few.

6670. Therefore the education to be dealt with in connection with King Edward's Grammar School is the education of the sons of the resident middle class in Birmingham, to whom it is not convenient, for whatever reason, to send away their sons to expensive boarding schools?—Yes.

6671. Bearing that in mind, and considering that the primary object at that school is to give a liberal education to the extent to which the pupils at that school can receive it, do you think that Greek should be continued through the whole of the teaching of that school?—In answering that question in that exact form, I might be led into something that would scarcely do justice to my own opinion. I should be anxious, in a school of that kind, whatever was taught, to have it

taught thoroughly in the first place, and then that that should be taught which could never be learnt in after life, and yet, as a general rule, may be of great importance to the recipients of the instruction, for that reason I should continue Latin and Greek. The very fact that the boy leaves school at an early age would be a sufficient reason for giving him an elementary knowledge in those two subjects, the want of which he might very much feel in after life. I am impressed myself with the conviction that the mere knowledge of natural science, more or less, may be acquired without any fundamental teaching of it at school.

6672. You are aware that the revenues of your school are very large, and that the education there is gratuitous, or nearly so?—Nearly so.

6673. Are you favourable, with a view to making those large endowments as efficient as possible, to the recommendation of the Schools Inquiry Commission, that fees should be charged as a general rule, and that the endowments should be used to stimulate and elevate education rather than to cheapen it?—Yes; that is the feeling which the governors have for a long time had, but they have been prevented by certain particular obstacles from giving effect to it.

6674. Looking to the general object to be aimed at in the education of those who are to have the greatest influence in the development of English manufacturers, will you kindly state what you consider to be the most important qualities in the heads of great manufacturing establishments?—I think it is impossible that such a man can be too highly educated. I think it is a mistake to look on his pursuits otherwise than as having a high professional character. I think it is a great error to suppose that the conduct of large works does not require a variety of the qualities of mind which are wanted for certain professional pursuits. I have heard from men of very considerable position, and I participate in the feeling, a very strong statement that it is not difficult to find persons to fill a variety of occupations which in the public mind hold the highest place, and yet that it is next to impossible to get a good manager for large works, he requires, not only education, but he requires certain qualities of mind which are very much brought out by education, and are partly natural. With regard to the capitalist who has large works, and whose influence acts upon all who may be under him, I consider it is of the greatest consequence to this country that men in that position who have immense influence should be highly educated. The only difficulty which I see in connection with university education for them is the risk of other tastes growing up during their residence at college, tastes somewhat at variance with business pursuits; otherwise, I should advocate that everyone who is to be at the head of a large manufacturing establishment should have a university education, the only drawback is the one which I have mentioned, namely, that at present there is a risk that tastes would be engendered in the mind of a student while he was at the university which might incline him afterwards to give up the pursuit he was intended for.

6675. I understand you generally to say you think it is not simply the art of making money, nor yet scientific knowledge, which makes an ideal or a very good master manufacturer?—I have not a doubt that even if a man thinks little about

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about making money, he may nevertheless make a large fortune if he makes it his main object to carry out his pursuit to the highest state of perfection, I mean with regard to the article that he produces

6676. *Chairman.*] Then may I ask you whether you consider that the chances of a young man being diverted from business pursuits by a university education would or would not be diminished if science formed a part of the university curriculum?—I do not think that would have the slightest effect, the danger to which I adverted being of a purely social character.

6677. *Mr. Acland.*] Are you of opinion that success in manufacture is much affected by a liberal expenditure for educational objects, or, are you of opinion that it depends more upon the attention to minutiae which are often, if overlooked, liable to be very prejudicial?—Unquestionably, success in any manufacturing pursuit depends mainly upon the most minute attention to the smallest points which may be concerned in the perfection of the particular article to be produced, and that is why I think thoroughness of education is so important, a man who has had a thorough education will appreciate perfection much more than the man who has been superficially educated.

6678. *Mr. Potter.*] You have spoken with regard to the education of the larger capitalist, and the necessity for it as a means of enabling him to maintain his ground against competition; is it your opinion that the education of the highest class of manufacturers has wonderfully improved during the last 20 years?—Unquestionably; I think the value of education has been much more appreciated among that class, but it is not appreciated as universally as I should like to see it.

6679. Perhaps a good deal of that appreciation may have resulted from the opening of the London University?—It is quite possible, but that had not occurred to me.

6680. You were a graduate of the London University?—I was educated there.

6681. Perhaps it is within your knowledge that a great many young men who have now risen to the master class have been educated at the London University?—Yes.

6682. A large number of your manufacturers in Birmingham are small capitalists, are they not?—I believe so.

6683. Perhaps that is more the case in Birmingham than in any other town in the kingdom?—I believe Birmingham is exceptional in that respect, what I have been saying has reference to large employers.

6684. Is it your opinion that with a sound elementary education diffused throughout the land generally, our manufacturers would be perfectly safe from any foreign competition?—Taking that coupled with the high education of the employers, I should say yes.

6685. Would not the pressure of competition compel our manufacturers to seek out the highest education for themselves and their sons, and do you not then suppose that with sound elementary education diffused throughout the length and breadth of the land, the manufacturers of this country would be perfectly safe from any competition?—The question is rather general, because other elements than competition in price enter into the subject; for instance, the public appreciation of the quality of manufactures; but,

ceteris paribus, as it concerns primary education considered as an element in the matter, I think we should be perfectly safe.

6686. *Mr. Aroyd.*] I think you stated that even though a manufacturer never thought of making money, he would be more likely to be successful if he were a man of liberal aims and views, conducting his business in a large spirit than a man of narrow views whose sole object was to make money?—That is what I mean. Timidity with respect to the outlay of money is a very serious obstacle in the way of success and unless a man has been scientifically educated he is liable either to be very timid or very rash that is to say, afraid to take up a good enterprise and rash in taking up a foolish one. I think this is a most important point with respect to the education of capitalists and employers of labour.

6687. *Chairman.*] By a scientific education would you mean a liberal education generally?—I mean that a man should be highly educated not merely that he should have a knowledge of the facts of science, but that, whatever the subject be, chemistry, mathematics, or anything else, he should understand it thoroughly.

6688. *Mr. Powell.*] You mean that his mind should be efficiently trained?—Yes.

6689. *Mr. Aroyd.*] Did I understand you to say that you would not apply to Government for aid to the education of the sons of manufacturers?—I think I intimated that, with regard to large manufacturers, I would not apply to Government to supply education.

6690. Can you inform the Committee where your own foremen and managers acquired the scientific knowledge which they now possess?—They are all self-taught, by reading in the evening and otherwise; there is a great deal of information, too, which an intelligent man may get from the processes themselves in all large mechanical workshops nine-tenths of the knowledge which they possess is obtained in that way, a kind of knowledge which they could never acquire so effectually, whether in a school founded by the Government or not, because in the workshop itself there is a comparison of general ideas with the object before the man on the spot; he sees not merely models, but tools of the highest character as they are actually at work.

6691. But taking the subject of chemistry, would it be possible for a man to acquire his knowledge of chemistry simply by self-study?—I think, although the study of chemistry is a very large study indeed, including inorganic and organic chemistry, that almost every chemical manufactory embraces only one particular sector of the subject which is applicable to one or two substances only, and the knowledge required for understanding the processes, coupled with a general knowledge of the laws of combination, is not really difficult to be acquired by self-instruction.

6692. Technical knowledge may no doubt be acquired by self-instruction; but do you think it is so easy to acquire general scientific knowledge by self-instruction?—A workman or foreman sees before him every day what can never be shown him in the laboratory; that is to say, chemical operations on a large scale, involving combinations of a different kind from any that he sees in the laboratory. Very likely he may have made experiments in the laboratory himself, but when he comes into contact with these operations under other conditions, some of which are part

of a commercial character, he is generally quite at a loss I greatly value that kind of instruction which is compounded of self-education in theory based upon the practice in what the foreman sees with his eyes. But taking theoretical chemists of the highest character, those whom I have consulted upon operations in which I am myself concerned, I have found them incompetent to deal with conditions of which they are naturally enough ignorant, I believe that theoretical knowledge is easily obtained, when the great practical illustrations of theoretical knowledge which present themselves in the processes themselves are before the eye

6693 You would rather proceed from practice to theory than from theory to practice?—I would rather have a foreman whose instruction consisted in the application of theory to what is before his eyes than one who had been instructed in the laboratory of a scientific school

6694 You have day schools of your own, have you not?—Yes

6695 Are they aided by Government?—By capitation grant only

6696 For geometrical drawing have you any grant from the Science and Art Department?—Yes; the usual grants

6697 Have you evening classes in connection with your schools?—Yes.

6698 In those evening classes have you inculcated science of any kind?—Whatever is in demand is supplied to some extent, and it would be supplied to any extent to which the demand existed

6699. Have you any science teachers in connection with your evening classes under the Science and Art Department?—I think to a certain extent.

6700 Although you repudiate Government grants for managers and foremen, you do not object to them for those classes?—That aid has been given, and has been received, and I do not shrink from it.

6701. You find that by making your work-people intelligent, and giving this scientific education, you make them something better than machines, I suppose?—We have not refused Government aid, but we should not object to its being withdrawn altogether.

6702 *Chairman.*] You have stated that you have yourself received a scientific education?—Yes.

6703. I suppose you have many managers who have been employed in your works for a very considerable time?—Yes.

6704 And you come in contact, and frequent contact, with those gentlemen?—Yes.

6705. And those, again, are in communication

with the junior managers and foremen?—Yes

6706 Is it not your opinion, that the character of your own mind, and the education which you have received, would give a decided colouring to the pursuits of those who were employed under you?—Unquestionably

6707. And therefore that any capitalist holding a similar position to your own, without scientific attainments, but would not find in those subordinated to him the same diligence in respect of scientific study which would prevail in your staff?—*Ceteris paribus*, that would be so

6708 You stated that you believed that amongst some of the continental nations there was greater vivacity, and a greater tendency to develop improvements submitted to the work-people?—I have found that in my own experience

6709. Do you believe that is a question of race or a question of education?—What I have observed I have considered to be a question of race

6710 The difficulty you meet with among Englishmen is a tendency to adhere to routine and precedent?—No, I do not find that.

6711 Not as compared with the workmen of other nations?—I do not find the same quickness in the English people as compared with foreigners

6712 You have stated that you consider that a sound elementary education is of the greatest importance to foremen, and, consequently, to workmen, because it is from the workmen that the foremen are drawn?—Yes

6713. Do you think that that especially would be the case in regard to manufactures, for this reason, namely, because it is desirable that these men should become accustomed to the idea of law governing the operations in which they are concerned; or, in other words, do you think it is desirable that they should understand that there is a reason for everything which occurs in their work?—No, I could not share in that idea

6714. Then in what way do you think that a good elementary education bears upon the value of a man as a foreman?—A workman may by nature have certain qualities of mind which may be essential in a foreman, and yet may be wanting in that extent of elementary education which a foreman requires, and that circumstance would be a barrier to his becoming a foreman When I advocated a good sound elementary education for working people, with reference to the contingency of one or more among a large number of workmen becoming foremen, I advocated it as removing an obstacle, not so much as giving any positive advantage as in taking a difficulty out of the way; that is to say, giving the workman that without which he cannot rise at all

Mr ALFRED FIELD, called in; and Examined.

6715. *Chairman.*] I BELIEVE you are a Merchant in Birmingham, engaged chiefly in the trade with the United States?—Yes, with the United States and Canada.

6716. You are the chairman of the Birmingham Chamber of Commerce?—I am chairman of the Chamber of Commerce.

6717 *Mr. Dixon.*] Your trade consists in exporting the manufactures of Birmingham and the neighbourhood to foreign countries, does it not?—The manufactures of Birmingham and the district especially; but also the handicraft

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manufactures more especially produced all over Great Britain

6718 Have you resided in America for any considerable period of time?—I have resided a very long time in the United States, 14 years together, and I have been there a good many times since

6719 Had you when you were there an opportunity of comparing British manufactures with those imported from other countries?—In my own line of business I had very good opportunities of doing so. I have been engaged in business

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with the United States more than 30 years I have lived there more than half of that time, and have visited the United States very frequently since I ceased to reside there; last year I was six months in America.

6720. What is the result of your comparison of English manufactured good with those imported from other countries, or those made in America? —The result of a general comparison of the articles I should give in this way, that the English goods in my line are not altered to meet new requirements; they are not rapidly adapted to changing needs, while the United States goods are rapidly changed. Also, the United States goods are made with a special reference to the immediate use of the object they are making, and our goods are not made with that especial reference. The American sees that the article he makes will answer the purpose it is made for; he makes it for that particular purpose, he frequently omits a considerable portion of that which has been considered important to the construction of the article in England, and he contrives by some direct method to make it efficient for its purpose, and generally more efficient than an Englishman makes it, it is often more simple in construction, and almost always lighter in weight.

6721 When you have received orders for a new class of goods, or goods of a new pattern, have you found that there is any difficulty in getting those goods from English manufactories? —A very great difficulty.

6722 In what did that difficulty consist, how has it been caused?—In giving you what has, I think, caused that difficulty, I will state the opinion which I have come to upon that subject in the course of my business experience of 30 years. I think the difference between the way in which the American workmen will turn out an article that is wanted, and the way that an English workman will turn out an article that is wanted, is to be described in this way. The Englishman has not got the ductility of mind and the readiness of apprehension for a new thing which is required; he is unwilling to change the methods which he has been used to, and if he does change them, he makes demands of price by trade rules which actually oppose the change of the article, or certainly attach to it something in the shape of a fine or an extra demand beyond a fair price for the making of the article. An American readily produces a new article; he understands everything you say to him as well as a man from a college in England would, he helps the employer by his own acuteness and intelligence; and, in consequence, he readily attains to any new knowledge, greatly assisting his employer by thoroughly understanding what is the change that is needed, and helping him on the road towards it. On the one hand I have a man who willingly assists me on the road I am going, knowing some things which I do not know myself; and on the other hand, I have a man who stops me in the road, who puts his own ignorance in the way of my knowledge, exhausting me by the efforts I am forced to make to get past him while he stands before me in the middle of the path.

6723. Do you think this difficulty which the English manufacturer experiences with his workmen would be overcome if a greater amount of education were given to the people in this country?—I would just mention that having been fighting the battles of English products in

my own trade during a very long residence abroad, I have had gradually forced upon my conviction what the difficulties are that we are meeting with. This last year, having made an extensive tour in the United States of 7,000 miles by land, not so much for my immediate business purposes as for the sake of obtaining general information connected with the comparison of the manufactures of the two countries, as well as upon other social subjects, I have come to this complete opinion, that the cause of the whole difference between us is to be found in the education of the workmen on the two sides of the water. On one side, in fact, there is an almost total absence of education, and that is the main difference.

6724. Do you think that a mere improvement in the primary education of the English workman would remove the difference between the two men, or would you advocate a scientific education being also given to the working men to some extent?—I think that both things should be done, because the scientific education and the primary education are but parts of one whole; we must have the whole building in order to get what we want; I think, as a matter of fact, that what is most wanted is primary education, or rather a general liberal education, beginning at the bottom. I think if we could get that, we should find that those parts of the edifice which come at the top would be arrived at more easily, but we should have those parts of the edifice too; and I do not conceive that we should be doing a work of supererogation, and what would not really help us in the right direction, should we at once promote the scientific education of all those who were ready to receive it.

6725. Do you think the American workman has received any scientific education, or does his superiority over the English workman consist mainly in his superior intelligence, derived from his general education?—I think he has received considerable scientific education; he has got it chiefly by his own study; he has received, to begin with, a liberal education; something quite different from what we call primary education in this country, and education that puts him on a level with persons in a higher position than what we call the lower middle class, on a level, indeed with almost the upper middle class, and with his mind so trained, he readily applies himself to acquire scientific education.

6726. Do you think there is also a deficiency of scientific education among the foremen, managers, and small manufacturers in Birmingham?—There is almost a total absence of it.

6727. And with the same class in America, is there a considerable amount of scientific education?—There is a good deal more of it.

6728. During the time you have been engaged in the American trade, has there been a steady increase, or has there been a falling off in the amount of English goods exported in your trade?—There has been a very great diminution; and with the permission of the Committee, I will state some facts with regard to the diminution of the export of hardware goods, and goods that go together with them. When I was first in the trade a hardware store in the United States had one third of its contents imported from Birmingham at the present time a United States hardware store has not more than one-fifteenth part of its contents imported from Birmingham. I am stating the fact guardedly, but it is in truth less than a fifteen

and that covers so many other modes of stating the same thing that perhaps I might pass them by. My invoices formerly extended to four or five pages, where they now only average half a page.

6729. Have you any reason to believe that the same diminution has taken place in imports into the United States of hardware from other countries besides England?—During the time I have been in business the imports into the United States from other countries have almost entirely begun, they scarcely existed at first. And the products of American manufacture in our line were very small, they have all grown up under my own eye. I have had to contest article after article against both European Continental, and American productions. At the present time there is a growth, and not a diminution, of exports of French, Prussian, and Belgian articles to the United States.

6730. Are you able to form any comparative estimate of the amount of the hardware imported into the United States, from the countries which you have named?—No, there are no accessible figures which could be relied upon.

6731. You do not think the total comparative amount is equal to the amount exported from England to the United States perhaps?—Of hardware proper, I think it would be equal.

6732. So that whereas 30 years ago there was no hardware imported from the Continent to the United States, the amount now imported is probably equal to, or greater than, the amount imported from England to the United States?—I think it is greater.

6733. At the same time there has been a very considerable growth of the manufacture of hardware in the United States?—Very great. The comparative figures I gave (after large inquiry all over the United States) of one-third and one-fifteenth are within the truth, and therefore I guess that covers the question of production in the United States and the Continent of Europe put together.

6734. Would you attribute the increase of home production of hardware in the United States exclusively to the high import duties?—I should say certainly not. I think the fact that not only the productions of the United States, but the Prussian, Belgian, and French goods which pay the same duties as ours, are superseding our English goods, shows that it is not the tariff only which is the cause, there is an increase going on of the import of French, Prussian, and Belgian goods into the United States, while there is a diminution of the import of English goods, both paying the same duty.

6735. To what do you attribute that preference in the United States of Continental to English goods?—The workmen have more of that power of adaptiveness which belongs to the American workman than the English workman. I think that is largely the cause, but I am more able to compare the workmen of the United States with the English workmen than with the workmen of the Continent. I see the articles which come in are more suitable for the purpose. As the changes go on the Continental workmen adapt themselves to change more quickly than we do. They have certain advantages, too, in cheap labour, which, to some extent, enables them to export against us.

6736. *Chairman.* But that advantage has not increased on the Continent lately, but rather 0.72.

diminished, has it not?—As a matter of fact, I believe wages on the Continent are approximating to wages in this country, but in the United States of America the American workman in our line gets double the wages per day that the Birmingham workman gets. The American has to take raw material to make hardware goods, costing him double what ours costs, and he pays double wages to his workmen, and yet he makes those goods, not only so as to drive ours out of the United States, but he exports them so as to supersede our own goods in our own colonies all over the world.

6737. There is a large trade in ploughs, forks, and things of that kind from the United States to our colonies; and to the various West Indian islands, is there not?—Yes, and to a great many other parts, Australia, Mexico, and South America.

6738. *Mr Dixon.* Is there a very considerable and growing trade in hardware from the United States to this country?—There is a trade, but it is not very considerable. With respect to the diminution of the export of Birmingham goods to other countries besides the United States in reply to a question sent to the Birmingham of Commerce by the Vice-President of the Committee of Council on Education, I sent up a list of goods in which Birmingham has largely lost the trade during the last 20 years, of which I have a copy before me. I find in this list that there are 25 classes of goods which the United States send to the common markets of the world, those goods being generally made under the conditions of the raw material costing twice what it would cost in England, and wages being twice as high. They send spades and shovels to Australia, which country in fact, uses almost exclusively spades and shovels made in the United States. Then there are axes, the United States supply axes to all our colonies. They largely supply cooper's tools and nails to the common markets of the world. Pumps they send all round the world, or nearly all round the world. To South America, for instance, my house in New York has shipped pumps, and, as we all know, it was an American pump which in Abyssinia supplied our troops with water, which they could not have got from any English pump. Agricultural implements they send to many parts of the world. They send sewing machines all over the world. With regard to lamps for petroleum, I understand from a Birmingham gentleman connected with the Chamber of Commerce, and from other information, that lamps for petroleum are now imported into the East Indies from the United States, and also into China. The United States manufacturers produce these petroleum lamps under the disadvantage of their raw material costing considerably more, and paying double wages, and yet they send them to the East Indies, because the lamps which they make burn petroleum better than anything we can produce. Then, in locks, the United States send a variety of locks to our own colonies, I meet them in Canada, for instance, and those locks are made under the disadvantages of double cost for the raw material and double wages, I have, in fact, before me a list of 25 whole classes of articles in which our goods are superseded in the common markets of the world by those of the United States.

6739. Is it true that there is much machinery used in England which is of American invention?

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—A great deal all over England; in our own part of the country, and in every district, American inventions are extensively used. In Birmingham two of our largest manufacturers are dependent on American machinery. We have manufactories for Enfield rifles, and Snider rifles, which are filled with American machinery. Machinery may be seen in use at Birmingham in the Small Arms Company marked with the name of the maker at Springfield, Massachusetts; the first machines were imported from America, and afterwards they were copied by Birmingham machinists. Our Government imported the machinery with which they made the first Enfield rifles. They take the screw for carpenters' use; that is made in Birmingham, for nearly all the world, by machinery of American invention. The Americans invented it, and took out a patent for it for England, and then the patent was bought by Englishmen.

6740. *Chairman.*] That has been very much improved in England since its first introduction, has it not?—I do not think the English machinery is any better than the American machinery for making the screw, I have a good opportunity for forming an opinion by seeing the results.

6741. *Mr. Dixon.*] Are you of opinion that it would be desirable to promote as much as possible, not only the general education of the working classes, but also to give them as much scientific instruction as possible?—I think the opportunity of getting scientific instruction for all those that were ready to receive it, would tend largely to check this progress of loss in our trade, which is now going on so rapidly.

6742. And you think that is a matter of so much national importance, that it would be advisable for the Government to encourage the building, and assist in the maintenance of the necessary schools for scientific instruction?—I think so. I think we should get better schools established by the Government, than those which we could get by any other means. I have found myself that the schools of the United States, which are Government schools, are better schools than any private schools which are established in competition with them, there is a regularity about them, and an efficiency in the teaching, so that no Boston millionaire sends his sons any where except to those public schools; and I conceive that we should get from Government schools better teaching, and given in better methods than we should get in any other way. I think a Government school is considered so trustworthy, that it would be more readily adopted than any other opportunities which were opened to the people, and which did not carry with them the stamps which ensure their being worthy of reliance. I think too that the experience of continental countries shows the enormous advantages of such schools over other schools.

6743. *Chairman.*] In speaking of the Government schools in America, do you mean the municipal schools?—The schools of America are established under State laws, and supported by rating; they are under local government, but they are also under the general law of the States.

6744. But they are under local superintendence?—They are under supervision which varies as to the extent to which it derives from the locality or the State; but most of it is local, though it is under the general laws of the States, which are always receiving alterations and modifications.

6745. When you spoke of the education given in these schools, did you wish the Committee to understand that there was any general systematic education in experimental science given in the United States in those schools?—I was speaking of general education, the general education given in those public schools is so good that it includes scientific education.

6746. That is to say, the elements of scientific education are given in the lower schools; and inasmuch as they have two divisions above them, namely, the grammar school and the high schools, and in the primary schools the elements of scientific instruction are given; I assume, though I do not know of my own knowledge, that a more complete scientific instruction would be given in the higher schools.

6747. But are you not aware that it was only in 1862, for the first time, that funds were voted by Congress for the establishment of science schools in America?—That is quite a different matter; that is not in connection with the State schools. These funds were given by Congress for agricultural schools, in which scientific instruction should be given. The intention was to form agricultural colleges, in which scientific instruction would be given all over the United States independently of, and separate from the State schools.

6748. You are not, in fact, aware to what extent instruction in experimental science is introduced into the State and municipal schools of the United States?—I am not aware to what extent instruction in experimental science is introduced into those schools. I know the elements of scientific instruction are given in the primary schools, and that in the grammar schools mathematics are taught; and that in the high schools the curriculum of instruction in the best of them approaches the curriculum of education at our colleges; so that I feel sure it will be found that there is a considerable amount of scientific education given in the two higher divisions of the public schools of the United States.

6749. But those higher schools are not school to which workmen resort, are they?—To some extent the workmen do resort to them; they go to the primary schools always, and more or less to the other two.

6750. Have you come much into contact with American workmen yourself?—Having lived there for 14 years altogether, and at intervals since I left America I have been brought constantly into contact with them.

6751. Have you found that they, as a rule, possessed much scientific knowledge?—I do not know that of my own knowledge of individuals in my own department of trade; but the great fact is their general education. They have intelligent and acute minds; and in consequence not simply of their own education, but of a very much higher level of education about them in their own country, they may be said to live in an instructed atmosphere.

6752. With regard to manufacturers in America, would you say from your personal knowledge that they were men who had received a scientific education?—I cannot answer that question of my own knowledge. I know me about the results in what they produce.

6753. On the whole, comparing education in America with education in this country, you would rather speak of general education than a scientific

scientific education?—Yes, speaking from my own knowledge

6754. Mr. Akroyd.] Are there many English workmen in the machine shops of the United States?—A great many.

6755. What position do they take there?—They often take a very good position.

6756. Notwithstanding their defective education, when they come in contact with the sharp Yankees, you find they hold their own?—The English workman, I find, often proves a more efficient man when he has been there a year or two and has had the benefit of the great general intelligence which is all around him in America.

6757. Referring to trustworthiness, do American employers find very often that they can put more confidence in English workmen than American workmen?—My impression would be that that is not the case

6758. Is it not the fact that American workmen generally are not so content to remain long in a subordinate position?—Of course they try to get on as fast as they can.

6759. That makes them much more liable to start in business on their own account, does it not, than to remain as workmen in the employ of their masters?—It certainly may happen to a manufacturer that he may lose his own workmen and have to put up with English instead.

6760. Now, with regard to the export of American hardware and the like, the Americans are very ingenious in bringing out new patents, are they not?—Yes.

6761. They are almost more inventive than we are, are they not?—Yes.

6762. Do you not think that invention has been somewhat stimulated by the higher rate of wages in the States?—I attribute it rather to the acuteness and intelligence of the people

6763. Have they any difficulty from trades unions in America in producing inventions?—Scarcely any difficulty from that source. Trades unions and strikes in America quickly come to nothing, they cannot live in that educated atmosphere.

6764. There is not the same objection on the part of the workmen to new inventions which exists in this country, is there?—It is my own decided opinion that there is no opposition to new inventions on the part of American workmen, and that strikes do not exist of any very serious character in the United States.

6765. Chairman.] Not in the iron trade?—There have been very great attempts within the last year or two at getting up strikes, but I think they all came to nothing.

6766. Was there not a strike which lasted nearly 12 months in the iron trade in the United States?—Not to my knowledge

6767. Has it not been given in evidence before the Trades Union Commission by Mr. Hewitt, who is a large American manufacturer of iron that there was such a strike?—I was not aware of it. I know of many efforts in the United States to get up strikes, but they have always been seen to fade away very quickly, I think.

6768. Mr. Akroyd.] Do you not think it some reflection on English manufacturers that paying a lower rate of wages, and having cheaper raw material, they should be driven out of neutral markets by American manufacturers?—A very great reflection

6769. Should you say that was from the supineness of the English manufacturer, or from

other cause?—I should say it was mainly from the want of a diffusion of general education, and also from the want of scientific education, and I think there is no other cause of any moment.

6770. Mr. Potter.] Has the trade of Birmingham decreased much on the whole?—The whole trade of Birmingham has grown very considerably

6771. I suppose it has in some degree changed its character of late years?—Certainly

6772. And a great number of large manufactories have been established there of late years?—In that respect Birmingham maintains its old character of being a very great aggregation of small manufacturing establishments.

6773. But that is the case in less proportion than it formerly was, I think?—Not markedly so, though it might be found to be the case to some extent, upon careful comparison.

6774. Do you not think the competition you have had from continental makers in neutral markets is in a great degree owing to the price of labour?—The foreign manufactories that I am more acquainted with, are those of the United States, and that certainly is not the case with them. I apprehend it will be found that one cause with regard to the Continent is the better education of the workpeople.

6775. You were speaking of the export of continental manufactures into the United States, in competition with our own?—Yes

6776. But is not that really chiefly owing to the low price of labour on the Continent?—I cannot state the whole of the cause, but I find that the United States are able to supersede our own goods in our own colonies, when they carry weight, two to one; they use brains to balance their difficulties, and they find that they are perfectly successful in doing it. I find that continental goods come to the United States with greater excellences in the way of adaptation than ours attain to. I am very much inclined to believe, though it is a matter I have no personal knowledge of with regard to the continent, that it is the education of the workmen, as well as the lowness of the wages, which is at the bottom of the facts, indeed, I have no doubt of it, in fact, these are but two different parts of the same thing; we maintain a higher rate of wages here, because we have got our raw material cheaper, and because on the whole we have got other advantages in our own trades, but the superior education on the continent and in America seems to outweigh our advantages in price

6777. Are not those articles which are imported into the United States from the Continent the production of hand labour rather than of machine labour?—They are the production of both.

6778. Does not the question of hand labour enter largely into the question of cost?—I believe it is both, whether it will be found on careful examination that there is more hand labour there or not, I cannot say, but I do not think there is more hand labour on the Continent, as compared with our own country, though as compared with the United States it may be so

6779. Are you aware of the amount of the American exports of hardware?—I think there are no figures upon that subject which could be trusted.

6780. Mr. Powell.] What States of America have you visited?—I have been in all the States east of the Mississippi.

6781. Then your answer as to the condition of the

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the workpeople, and to their education, applies to all those States?—My answer applies chiefly to the New England States, and to New York, Pennsylvania, and those western States which have immediately derived from New England in the north-west, not in the south.

6782 In using the term "workmen," you have been speaking of the higher class of artisans, and not of the average of the working classes, I suppose?—I speak of all native born Americans.

6783 Do you state to the Committee that the consumption of English goods in America has diminished absolutely, or only relatively as compared with that of other countries?—I think the consumption of Birmingham goods has diminished absolutely.

6784. You have stated that you were not able to describe in detail the nature of the scientific instruction given in the primary schools of America?—Not accurately.

6785. I think that the goods which you named out of the list before you, were of a rude and simple character, such as the axe, would the observations you made about those goods, apply to goods of a more complex and refined character?—The American wedge axe is one of the most beautiful tools existing in the world, it is as highly polished as a razor, and the man who cuts his tree down with that, would, I suppose, do twice the work of the man who used another axe. The spades and shovels are beautifully finished and polished, if a man were to take one up, he would say he would never touch an English one afterwards.

6786 Mr Acland] Did you mean to say that any particular branches of English manufacture had been entirely superseded or driven out in certain markets by the American or continental makers, or only that we were exposed to a strong competition?—The total value of the United States exports is very great as against ours, and I feel quite certain that in a great many articles we are superseded, but I cannot answer your question absolutely by Yes or No, the goods are of such a multifarious character, that if I were to say that no English spades or shovels were used in Australia, I should be incorrect, but an immense majority of the spades and shovels sold in Australia are of American make. Take, again, locks, a very great variety of locks are brought from the United States to Canada, and yet we send a good many English locks of different kinds.

6787. But can you say that there are, in fact, any articles made in England which it does not pay to send abroad, because we are undersold?—Quality and price may be said to be convertible terms, whether I am understood by an article which is cheaper, or by an article which is better, it all comes to the same thing.

6788. But can you say whether there are articles which it distinctly does not pay to continue to send from this country, of which there used to be a considerable export?—Yes, a very large number indeed.

6789 Chairman] With respect to these exports from England to the United States, has there been much fluctuation in the duties imposed by the United States?—A very great fluctuation.

6790 Has there been any great increase in those duties?—An immense increase.

6791 At the time when the proportion of articles imported from England in the United

States stores, of which you spoke, was one-third of the whole, can you state what was the average duty on hardware?—It was 27½ per cent.

6792. And now that the proportion would not be more than 1-15th, what are the average duties on English hardware?—The duties now vary very considerably; unenumerated hardware is subject to 45 per cent., but there are many specific duties which run up as high as 80 or 90 per cent. During the period that I have been going over in my evidence, I have seen a great many changes in the duties on United States imports; sometimes a considerable increase, and then again a diminution. About 10 years ago the duties on hardware were only 23 per cent., and even then there was a great diminution in the export of English hardwares to the United States.

6793 Comparing English hardware with continental hardware, there is no differential duty in favour of, for example, Prussian hardware as compared with English hardware, imported into the United States?—Certainly not.

6794. Mr Acland] Your answer to a previous question of mine had nothing to do with duties, but assumed that the goods met on equal terms in neutral markets?—It had no reference to any difference of duties, because I am not aware of any port in the world to which the United States can send goods at a lower duty than we can.

6795 Mr Dixon.] Can you state whether the falling off in the export of Birmingham goods to the United States has been larger in the case of those articles where the duty is highest?—The articles on which the duties are highest, are those on which we chiefly maintain our exports, and those on which they are lowest, are those on which we are mostly driven out. A very large proportion of the goods that I send, pay 80 per cent., and upwards of duty, in going into the United States.

6796 Probably you would conclude from that, that the increase of duties is not the cause, or the sole cause, of the diminution in our exports?—I do not think it has anything to do with the diminution of our export.

6797 Mr Acland.] Do you think that if scientific instruction is required by the English manufacturers as an investment for the successful prosecution of their businesses, it is desirable that the expense of that education should be provided by the public?—Yes. I think it is desirable because we want it very much, and if you cannot get it except by the very slow process which voluntary education would imply, it is far better to get it in the other way, besides, which, you can get it better, and there is also great justice in its being so paid for, because the whole State would be enormously benefited by the increased wealth which would result from a small outlay in that direction. I believe that through the dissemination of scientific instruction the product of existing taxes would be increased by a much larger amount than the whole outlay for establishing Government schools of science in the leading centres of manufacture.

6798 Then, do you think that the expense should be provided by municipal or local taxation or by imperial taxation, or by a combination of the two?—I think that if we had a general system of education, we ought to get it paid for by a combination of the two, but, for the present we might very well establish Government schools of science in the chief centres of manufacture and pay them entirely out of the Consolidated Fund.

Dr. GEORGE LLOYD, called in, and Examined.

6799 *Chairman*] You are a Bachelor of Medicine of Oxford, I believe?—I am

6800. And you are also Doctor of Medicine of Edinburgh?—Yes.

6801. I believe you do not practice medicine?—I do not.

6802. You are a glass manufacturer, and a member of the firm of Messrs Lloyd & Summerfield, of Birmingham, are you not?—Yes

6803. How many persons do you employ in that business?—Not a large number.

6804. Are you a manufacturer of flint glass?—Yes.

6805. You have been requested by the Chamber of Commerce of Birmingham to give evidence before this Committee?—Yes.

6806. *Mr. Dixon*] How long have you been engaged in manufacture in Birmingham?—Solely and responsibly, about 15 or 16 years

6807. During that time, have you taken a very great interest in all educational questions connected with the town of Birmingham?—I have.

6808. Are you of opinion that the foremen and managers, and manufacturers of Birmingham, are sufficiently well educated in the matter of science?—I think they are very deficient, generally.

6809. Do you think there would be any advantage in giving scientific instruction to working men?—I do

6810. Are you aware whether they themselves have any desire for it?—I think but little at present.

6811. Do you think their primary instruction is sufficient to enable them to receive scientific instruction?—I do not

6812. Do you think it would be advisable to give them any elementary science instruction in the primary schools?—Certainly

6813. Are you satisfied with the means that exist at the present time for scientific instruction in Birmingham?—I think the means in Birmingham at the present time is very defective; there is no institution that I am acquainted with that is sufficiently well endowed to answer that I would contemplate

6814. What system would you recommend for giving scientific instruction to the industrial classes, speaking now both with regard to working men and the foremen, and managers and masters?—Your question is comprehensive, and includes the scientific instruction applicable to all classes who may desire it. I think that a plan ought to be adopted, not of specific education applicable to one class, as distinguished from another, but that there should be institutions for young men and adults, in which natural science should be taught generally, I think they should be established where all applicants might get very cheaply, or altogether free, and from the best sources of sound scientific instruction, that is to say, from competent teachers and professors of science, purely scientific instruction, not with the view of any application of it to their own branch of trade or manufacture, or what is called technical instruction, because I do not believe in the possibility of such instruction being useful or successful in any way, but that pure science should be well taught, so that all who desire to have it might obtain it. I do not believe in a different chemistry being applicable to brewers or brassfounders, for instance; science is exactly the same always, and I think it should be left to the applicants to decide how they should use it.

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6815. Then you would have entirely separate classes or schools for teaching science; you would not merely include science in the course of general instruction for the middle classes?—Yes; I think that in public schools, for instance, in King Edward's School, science education might be much more freely given than it is now, but that is only for young boys, in my former answer I spoke of young men and adults, I think there should be institution, in which there should be professors of natural science provided for them. As to the extent to which it should be given to boys at school, of course it should be more elementary and not of a profound nature, because of the early age at which they generally leave school.

6816. So that you would have elementary science teaching in the primary schools for boys up to the age of 13, and you would also have elementary science teaching in the middle class schools?—Yes.

6817. And then, in addition to that, you would have science classes, or a college where the scientific instruction should be completed?—Yes, where it might be more fully completed. Science is scarcely intelligible to children under 13 years of age, even in its mildest shape

6818. Would you recommend that the Government should assist in the formation and in the maintenance of those schools where scientific education is to be completed?—Yes, I think that is very important, not only on account of the aid which would be given, but Government supervision I should think most valuable

6819. To what extent do you think Government aid might be given?—In the first instance, probably, in furnishing the necessary buildings, and in the endowment of professorships, and probably in the expense of examinations, and the prizes which might be offered for successful students

6820. In addition to the usual payment on results?—Yes

6821. Is there any other suggestion that you would wish to make to the Committee?—Nothing strikes me at present except that, besides the question of scientific information among foremen and managers, I would wish the question to be applied to manufacturers generally, because I think that manufacturers themselves are, for the most part, entirely ignorant of anything like scientific matters, and that ignorance is felt by both the foremen and artizans, and consequently they do not see, and do not feel, the necessity or the desirability of seeking such information for themselves. Had the manufacturers more of such instruction over and above those whom they employ, it would have a very important influence on those under them

6822. *Chairman*] You stated that you thought Government supervision of schools of science would be extremely valuable?—Yes, I think so.

6823. You would desire to see the instruction in science which had been obtained by children and boys, carried to a higher degree in superior schools?—I should.

6824. I understand from that that you would require the teaching in those schools to be of a very advanced character?—Yes

6825. Would you consider it desirable that there should be Government supervision over science instruction of the highest character in this country, in other words, that that instruction should be of a Government pattern, if I may use

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the expression?—I am now contemplating it as it is proposed to be offered in manufacturing towns. Probably your question would include the older universities, where, I think, the Government supervision would be improper.

6826. But would it not be desirable that schools of science should exist, which should be as high in range in their department as the universities are as schools of literature?—Yes.

6827. Then to such science schools would you consider it advisable that Government supervision and control of the studies should be added?—Yes, everything, except the older universities.

6828. Mr. Acland.] What is your reason for making that distinction?—The jealousy which I know would exist on the part of the older universities, at anything like interference from Government, or anyone, except those belonging to themselves.

6829. Considering that the older universities, including the colleges, possess about half a million of money, is there any reason why the State should not take some cognisance of the employment of those funds?—I am looking at them merely as seats of learning; the disposal of the funds is another consideration.

6830. Chairman.] If it were stated that in Owens' College in Manchester, which is probably the only advanced scientific school now in the provinces, there is the same jealousy of Government interference, and that Government aid would be refused, if coupled with Government interference, would that statement surprise you?—No.

6831. Mr. Acland.] Did I understand you to say that you thought that in a place like Owens' College, in the heart of a manufacturing district, or in a similar college which might be established at Birmingham or elsewhere, you would contemplate the possibility that the students attending those colleges with a view to going into practical business afterwards, should prosecute pure science to the same extent as students aiming at professorships and fellowships in the older universities?—I do.

6832. Then you would contemplate their continuing their scientific studies as students in colleges after they had gone into business?—Yes, that there should be always maintained, if I may so say, a fountain of pure science in those places where all comers should find the very highest science. and I think, were they so established, there would be plenty of applicants.

6833. You are speaking of local colleges?—Yes, in manufacturing towns.

6834. You heard the answer which Mr. Chance gave to my question with regard to the recommendation of the Schools Inquiry Commission, that the older students in King Edward's School should be allowed to diverge into purely classical or mathematical, or scientific education as they pleased. Do you disapprove of that recommendation?—I quite approve of it. I am a governor of the school, and I am only sorry I do not agree with Mr. Chance on that point.

6835. Do you approve of the proposal to charge fees instead of making the education very cheap?—I think fees would be desirable.

6836. Lord Frederick Cavendish.] Have you found any practical inconvenience as a manufacturer, in competition with foreign countries, from the want of scientific knowledge on the part of your workmen?—I have not found any injurious competition that I could trace solely or

6837. As a manufacturer, it would be more important to you to have one trained foreman than many trained artisans?—Yes.

6838. Do you think it important that all your men should have scientific training?—I think it is desirable, although I do not see that it would have much influence in improving them, as manipulators, but seeing before them the prospect of rising first to be foremen, and then to be masters, I think they should have the opportunity of scientific training.

6839. The greater part of the instruction given in your college would be given by evening classes, I presume?—It must be if it were for the working classes, but if the opportunity of getting this instruction were really offered to them, and they felt the necessity of getting it, they would find odd times in the day, Saturday afternoons, and the like, for coming to receive it.

6840. Mr. Powell.] Do I understand you to say that you would not be unwilling to place endowed and other schools of this country under a central administration?—I think it would be a very great improvement if that were done.

6841. Then your confidence in departmental management, and the readiness of departments to adopt suggested improvements, being such as to lead you to think the effect of central supervision upon education would be useful, do you think that the Government pace would be exactly the pace at which the promoters of scientific education would desire to advance?—I can only answer for myself, that I should like to see it tried.

6842. You have no fear of the deadness of routine, and the heavy hand of centralisation?—Certainly not.

6843. Mr. Acland.] You have been asked whether you desired to see the grammar schools of this country placed under central authority, I suppose you are aware that the Schools Inquiry Commission does not propose that they should be placed under a central authority, but under a combination of provincial authority, coupled with the inspection and general sanction of a central authority, now, which of those two plans do you prefer?—I should prefer the central authority of the Government.

6844. Mr. Acland.] Have you considered what effect on primary education two Acts of Parliament passed last session, the "Labour Regulation Act," and the "Factory Extension Act" would have?—At present our want of experience of their working makes it difficult to conjecture what the effect would be, and in my own case cannot judge, because I have no children in my works under 13 years of age, and not many young persons. I am very anxious that those young persons, and those more immediately interested in the object of the new legislation should take advantage of it, but I see a reluctance to do so, which arises partly from the habits of the trade, and partly from the want of intelligence of the younger persons, and also from the lamentable state of ignorance existing in those with whom they are associated, namely, the old ones with whom they work.

6845. Mr. Acland.] Would you have any objection to state your reasons for thinking the provincial co-operation in the management of the schools is likely to be inexpedient?—I did not rightly consider the bearing of the former question in reference to provincial authority, which I think is a wise combination with central authority and inspection.

Mr JOHN SKIRROW WRIGHT, called in, and Examined

6846 *Chairman.*] You are a Manufacturer at Birmingham?—Yes, a manufacturer of buttons and dress ornaments

6847 Were you until within the last 12 months chairman of the Birmingham Chamber of Commerce?—I was chairman four years.

6848 I believe you took an active part in the selection of the articles which the Birmingham manufacturers exhibited in Paris in 1867?—Yes.

6849 You were also instrumental in causing workmen to be sent to Paris for the purpose of making a report on the hardware exhibited there?—I was

6850 *Mr Dixon.*] You have for a long time been practically acquainted with the metal working trades in Birmingham?—For about 32 years

6851 Is the number of workshops in Birmingham very large?—I estimate the establishments in Birmingham, large and small, at something like 6,000 to 7,000

6852 You would say, I suppose, that the majority of those manufactures are working out scientific problems of some kind or other?—Yes, more or less, metal is worked in nearly all of them, and, consequently, the principles of metallurgy and chemistry would be in practical operation

6853 Of the artisans who work in those manufactures, I presume a great many may be called small masters?—Many of them are small masters, and are themselves at the same time practical workmen; a great many of them have been in the position of workmen, working for wages, and when they get into the position of small masters they work at the bench themselves, and employ, perhaps, two men, and two or three boys or women

6854 Probably, in no town in the world is there so slight a difference between the higher artisan and the small manufacturer as in Birmingham?—I think that is so. I believe wealth is more generally diffused, and the workman better paid, and more easily attains the position of master in Birmingham than in other towns

6855 During the last 30 years, has a great advance been made in the Birmingham trades?—I am afraid that in the ordinary methods of working metals and using chemicals, which are necessary in working at the metallurgical trades, they go on working now very much as they did at the beginning of the century. Of course, I must except such trades as "electro-plating," in which science has been very largely applied, and which was not known at all 40 years ago; with that exception, however, the Birmingham artisans work pretty much as their fathers worked.

6856 To what do you attribute that want of improvement in the methods of working in the Birmingham trade?—Generally to the want of appreciation of the importance of scientific methods and to the deficiency of education generally

6857 To what do you attribute this want of education among the artisans of Birmingham?—The cause is the same as it is all over the country, we have not been sufficiently alive to the importance of elementary or primary education, and there has been almost entire indifference with respect to the necessity of anything like scientific education

6858 Are the foremen, masters and managers

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in Birmingham, generally, an educated class?—The smaller class of masters, no. Many of the men have become, comparatively, rich in Birmingham, without having received much education originally, the sons of the larger manufacturers have generally received a better education, but not a very high education, the foremen have not more education, on the average, than the workmen. If they become skilful, they get a good position from their natural ability, and from their long practice and steady application

6859 Do you think that the middle class generally in Birmingham are awakening to the fact that a better education is important to them?—I have reason to believe that they are, and that for two reasons, first, the competition which they are feeling on every hand, and secondly, the attention which has been directed to this matter by the press, having recently canvassed the manufacturers of Birmingham, I have met with a general expression of opinion that it will be necessary for employers generally to be better educated, or that we shall lose a still larger portion of our trade.

6860 Are you of opinion that in Birmingham any portion of the trade has been lost of late?—I have no doubt that several of the old trades have been lost in great part to Birmingham, and in further answer to a question which was put to Mr Field, Birmingham has very much increased in consequence of the introduction of new trades, such as, for instance, that of locomotive tubes and the making of railway carriages, and the manufacture of telegraph wires and telegraphic instruments, and more especially the two great metallurgical trades of the town, that of ship sheathing with compound metal, which was introduced by Mr Muntz, and that of electro-plating, which has worked a complete revolution in the trade, and probably gives employment to 30 or 40 times the number of persons, who were engaged 30 years ago, but many of the older trades, such as the making of metal articles for the ornamentation of the person, as the steel ornaments for which the great manufactory of Boulton & Watt, was so celebrated at the end of the last and the beginning of the present century, have very much declined, and many other similar trades are in the same position. Every day we are finding competition come into various other articles, in wire, for instance, which was formerly considered the staple of Birmingham, we are now interfered with by the Belgian and French producers. I heard the other day that one of our largest buildings had been fitted up with Belgian gas-fittings, and that a Birmingham contractor, a few months ago, procured the iron work for a large contract which he took in London from the Continent. I may state that our merchants and manufacturers are generally suffering from foreign competition, especially in those articles into the manufacture of which hand labour largely enters, or in which there is room for the display of much taste

6861 *Mr Dixon*] Has there been any decline in any branches of your own trade during the last few years?—As to my own trade I must admit, but with great regret, that it has probably suffered more than any trade in Birmingham; some 30 or 40 years ago, I believe, we supplied nearly the whole of the world, including the United

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States of America, and, I think, in Birmingham we should find at the present moment that nine-tenths of the articles similar to those which I manufacture, and which are to be seen in the shops, are of foreign production.

6862. And do you attribute this decrease in your own trade, and in other trades in Birmingham, to the competition of Continental nations?—Yes; there is one article immediately connected with my own trade, namely, that of buckles for ladies' girdles, with respect to which, I saw the other day a statement which I think is correct, to the effect that 200,000*l.* worth of those articles were produced in Paris in 1866, and a great part of them for England, that was at one time a speciality of Birmingham, but I suppose our total production for that year would not have been more than 20,000*l.* or 25,000*l.*

6863. *Chairman*] Would the success of the competition of the French manufacturers in that article arise from the superiority of the design, or from the cheapness of the article, or from any other cause?—French articles generally supersede ours in fancy goods, on account of the superior taste of the French, but we find that the Germans touch us on both grounds, they have good designs and good workmanship, but they beat us mainly where there is much hand labour employed.

6864. *Mr. Dixon*] On account of its cheapness?—Mainly on account of its cheapness, but we find that in many cases the Germans are getting ahead of us, for instance, in the production of different coloured metals, I am speaking now mainly with regard to small articles.

6865. Are you of opinion that the want of scientific knowledge in Birmingham has at all influenced this decrease in some of the trades of the town?—I am of opinion that it has to some extent.

6866. Is there a feeling now growing up in Birmingham in favour of the encouragement of scientific education?—I think the feeling is very general among all classes now, hitherto, I am sorry to say that, though we have depended almost entirely on science for our position, there has not been much appreciation of it, one of the most notable illustrations which I could give, relates to King Edward's Grammar School, it is only lately that they are beginning there to pay any attention to the subject of teaching science. I find that in the year 1864 they spent on chemical apparatus the sum of 10*l.* 16*s.* 7*d.*; and that in the same year they spent in connection with the cricket ground, and the volunteer rifle corps for cadets, 120*l.* I have reason to believe that the whole of the salaries paid to the science teachers in that year amounted to 50*l.*, or about two-thirds of one per cent. of the amount that they spent on the Institution in New-street. It is fair to say that more attention is now given to science, and I believe the salary of the science teacher has been raised to something like 120*l.*, but the total amount spent last year for apparatus, to teach 620 boys was only 13*l.* 18*s.*, while the expenses connected with the cricket ground were 89*l.*; this shows that the most educated men in Birmingham, manufacturers and professional men who have been the governors of that school, have not till this moment been properly alive to the importance of teaching science to the sons of the middle classes, and the future employers of labour in Birmingham.

6867. But seeing that this scientific education

is not given at King Edward's School, why do not the manufacturers of the town establish and support institutions that would give it?—As a manufacturer having risen from the position of a clerk or overlooker myself, I must say that our energies are necessarily directed to the success of our trade, and we have none to spare for looking after educational institutions; those who have to meet the increasing competition in manufactures are not likely to give sufficient attention to a great public subject of this kind. Besides this, I may claim for the manufacturers of Birmingham, that they subscribe to a large number of institutions, and that, in consequence of the rapid extension of the town, they are more heavily taxed for local purposes than almost any other town in the kingdom; so that I think the manufacturers have a fair excuse, seeing that in most cases they have not had the advantage of a first-rate education, for not having established what they begin to feel is absolutely necessary in the way of educational institutions.

6868. *Chairman*.] Do you wish the Committee to understand that the manufacturers of Birmingham devote themselves exclusively to business and neglect other considerations?—They have most of them sprung from the ranks of the working men, and it follows as a matter of necessity that nearly all their energies are required to make their business successful; this is much more the case than in those large concerns which descend from father to son, and are accompanied by a large capital accumulated in previous generations.

6869. *Mr. Dixon*] Do you think that a feeling is growing among the manufacturers of Birmingham that scientific education is almost necessary for the continuance of their prosperity?—I am sure that feeling is becoming very general.

6870. In what way do you think that institutions for scientific education should be provided for them?—My own feeling is, that they will only be made effective by Government interposition. It appears to me to be peculiarly a matter which the Government might take up either exclusively or in conjunction with the municipality. I believe it is not a matter of merely local importance, and I think I am justified in saying, that if the Government have seen the importance of establishing such an institution as that of the School of Mines in Jermyn-street, it is doubly necessary that scientific institutions should be established in places like Birmingham, which exist only by the aid of science. We say that if such an institution could be supported by the aid of private individuals in Birmingham, surely it might be supported by the aid of private individuals in London. We think we have more claim on the Government for establishing such an institution in Birmingham than London had for the establishment of such a school in London. In addition to that, we feel that on the Continent Governments have considered it to be their duty in many cases, either by themselves or in connection with the municipalities, to establish such institutions, and we think it is not beyond the province of the Government in England to do a similar work.

6871. Would you mean that the Government ought to pay the entire cost of the erection of such schools, or only a portion of it?—That is not a matter which I have considered, but I see that it is incumbent on the Government to take

the initiative, because we cannot wait till we have a better system of general education, we may suffer very greatly before that can be obtained; it would be too late when we had lost a large portion of our trade. To illustrate the national importance of the subject, and to give you a reason why the Government might take the subject up, I may mention the value of a better understanding of the laws of combustion, which would tend to an enormous saving of coal. I have no doubt that if our enginemen and stokers generally understood those laws better (and it is not necessary to have had much primary education in order to understand them), and there was a proper application of scientific principles, from 1,000 and 2,000 tons of coal might be saved in Birmingham weekly.

6872 Suppose that in one town the manufacturers had come forward to institute science schools, and that in another town of equal importance no such efforts had been made, would you advocate that the Government should confine its aid and management to the town which showed a disposition to establish such schools, or would you wish the Government to take action in both those towns?—In my opinion the Government should take action wherever it is necessary, and according to the exigencies of the case.

6873. Without any reference to what has been done in the locality?—I am not prepared to say that, in some towns the aggregation of wealth into a few hands is so great that the institutions might be supported with comparatively little difficulty to what would be felt in a place like Birmingham, where the wealth is very much more diffused, and is not so great.

6874. Do you not think that you have rather underrated the amount which has been given in Birmingham for scientific instruction, have you taken into account what has been done by the Midland Institute?—I have not attempted to give you a fair idea of what has been done in Birmingham in the way of scientific instruction, what I gave the Committee was a kind of apology for more not having been done, there are other schools besides the Midland Institute, for instance, there is a Proprietary school, which has given much attention to this subject, while, at the Free Grammar School only six per cent. of the pupils are receiving scientific education (and a few years ago there were not more than four per cent.), while, on the other hand, in the Proprietary School, something like 50 per cent. of the pupils are being taught science, where a few years ago there were only 20 per cent. Then there is the Midland Institute, which, as far as its means have allowed, has done much towards giving science instruction in the evenings to the artisan class, and to young men that have any inclination towards the study of science. But taking it all put together, considering that we are a town so very much dependent on the sciences of metallurgy and chemistry, there has comparatively nothing been done in the way of teaching our artisans, or, in fact, our manufacturers.

6875 *Chairman*] How long has the Proprietary School in Birmingham been established?—I think some 25 years.

6876. Do you know the number of pupils?—I think it is about 120, a little time ago it was about 100.

6877. That school is self-supporting, is it not?—I think it about pays its expenses, but I do not think it pays anything to its shareholders.

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6878. At all events it is a school which has arisen from voluntary efforts?—Yes.

6879 *Mr. Potter*] It is a high-class school, is it not?—Yes.

6880. *Chairman.*] A school for secondary education?—Wholly.

6881. Up to what age would a boy remain at that school?—To 18 or 20 years of age in a few cases, generally to 15 or 16.

6882° Science is now generally taught in that school, is it not?—Science is efficiently taught.

6883. Is there any separation of the departments of science and literature, or is science taught to the boys who are receiving a literary education?—My own sons were taught there, and I believe that science was taught in combination with literature.

6884. *Mr. Ahroyd*] Do you export any articles of your manufacture to the United States?—Yes, but a very much smaller proportion than formerly exported.

6885. Are you able to compete successfully with the American manufacturers in your articles?—Only in one or two articles, formerly, however, the trade exported nearly all classes of the goods, while now it is confined to about two classes.

6886. Some branches of your manufacture have been displaced by articles of American production, have they?—They have been displaced by articles of their own production, and still more extensively by articles of German production, especially from Vienna and Baimen, and also by fancy products from France.

6887. What advantages has the American manufacturer over your firm, has he more machinery for producing the articles?—There is not much machinery in my trade, he has the advantage of 35 per cent. duty, and 10 to 20 per cent. in the expenses, which is a very considerable advantage, he is also nearer to the seat of production of the raw material, for instance, the pearl fisheries in the Bay of Panama, and the forests in Central America which produce the vegetable ivory.

6888. You think he has no particular advantage in the intelligence or scientific cultivation of his workpeople?—I should say that the American working men were, on the whole, more intelligent than our own, sometimes, when our workpeople go there, they find occupation at higher wages, though not materially higher than what they would get in Birmingham.

6889. One advantage which the German manufacturer would have over you would probably consist in the lower rate of wages?—No doubt, but also in the greater attention which he has been able to give to perfection of colour in glass and metal.

6890. Do you employ any young persons under 13 years of age?—A considerable number.

6891. Can you inform the Committee what primary education they are receiving under the new Factory Act or the Labour Regulation Act?—In Birmingham, generally, the effect has been to throw out of employ nearly all the children whom the Act affects. I am of opinion that there is not more than one-tenth of them at present receiving education under the half-time system; almost universally the manufacturers have discharged the half-time children. I was much opposed to their enactment in their present form, believing that they would not do good. I have not discharged the children in my own manufactory, and I think I have about 15 there who are employed

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employed and educated under the half-time system. In the same district which contains 50,000 persons of the artisan class, there are not more than 50 children employed and educated as half-timers. In the town, I believe that while 2,000 or 3,000 have been thrown out of employment, there are not more than 200 or 250 who are receiving education under the half-time system.

6892. I suppose that, as trade has been rather dull in Birmingham, there has been no difficulty in finding young persons above the age of 13 in sufficient numbers to do the work?—None; but the age fixed by the Act when children become young persons is 10 years until 1st July this year.

6893. Where are those young persons of your own sent to school?—I formerly educated about 60 children and young persons, but I have closed my school and the children are now being educated in a neighbouring school.

6894. May I ask why you closed that school?—The main reason was that the children do not care to remain or come back after 6 o'clock in the evening.

6895. *Chairman*] Your school, then, was a night school?—Yes, and we could not get them to come back after they had once left the place.

6896. *Mr. Potter*] Are you referring to the Labour Regulation Act, or the Factory Act Extension?—In both Acts there are educational clauses; the only difference is, that under the Workshop Act the children are compelled to go to school 10 hours in the week, while under the Factory Act they attend 15 hours a week, but almost universally under both Acts, the children are now discharged.

6897. Are you working under the Workshop Act?—No, under the Factories Act.

6898. You referred to the number of small manufacturers in comparison with large manufacturers who exist in Birmingham; that small class of manufacturers cannot of course pay for scientific foremen?—They are their own foremen.

6899. I suppose one of the greatest benefits that could happen to Birmingham would be the increase of large establishments?—Having one of the largest manufactories in the trade myself, I should not look upon it as an advantage to change all the workshops into large establishments. I think it would be injurious on the whole to the independence of the people, and the small manufacturers would probably then have to sink into the position of workmen.

6900. Do you not think the change would be beneficial to the progress of scientific education?—No. It is comparatively as important to a man employing six persons in a shop, which he rents at 2s 6d a week, that his people should be able to colour his gold articles and to compound his metals properly, or to save what is valuable from the residuum, as it is to the largest manufacturer.

6901. Can you conceive it possible, however, that the very small manufacturer should ever do so?—Yes; the smaller jeweller sends his sweepings and the filings from his bench to the refiner and gets so much per ounce for it.

6902. But surely small manufacturers could never remunerate scientific foremen as the large ones could?—No; but it is not the less important to the small manufacturer to have scientific knowledge; as a rule the small manufacturers are their own foremen.

6903. But for economic reasons the small manufacturer never could attain the same amount

of help from science in his business as the large one, could he?—He could get the knowledge for himself, and it is, perhaps, more important to the master who employs only six or 10 hands, than to a master who employs a larger number.

6904. Suppose the whole emoluments of the small master should be a little under 100*l* a year, how could he pay for the education of his workmen or their children in science?—We hope that scientific education will be brought pretty nearly home to the doors of such men at the cheapest possible rate, as it is on the Continent; that is what we are anxious for; if you give us high scientific training at a very high cost, that would not be of very much value to the mass of the people in Birmingham; we want scientific training given to us at the smallest possible cost to the individual, either through endowments, or the municipalities, or the Government, or through all the three systems combined.

6905. From extraneous sources, in fact?—From extraneous sources if not otherwise attainable.

6906. *Lord Frederick Cavendish*] Do you know the details of the present system by which State aid is rendered to science classes?—I know a little of it; there are three or four teachers in Birmingham that receive State assistance; I think the only institution that teaches science in the evening to the artisan middle class received from the State last year 32*l*.

6907. Do you wish to see an entirely new system established, or additions and improvements made in the present system?—I wish to see such a system established as would really be effectual for the purpose; I am sure the present system is not effectual, and that it must be very largely extended if it is to be of much use to the trade of the country; the assistance that we get in Birmingham is the merest trifle, but I think it is quite as much as they get in Sheffield or any other hardware town.

6908. *Mr. Acland*] Suppose it should appear that an endowment of 2,000*l* a year, or some such sum, were necessary in order to establish a science college in Birmingham, should you think it desirable that King Edward's foundation should contribute to that sum?—I think that it would be a very proper appropriation of a part of their income.

6909. You have taken great interest in the affairs of that institution, have you not?—Yes.

6910. Have you paid considerable attention to the Report of the Schools Inquiry Commission on that subject?—Yes.

6911. Have you reason to think that it has been favourably received in the town of Birmingham?—Very favourably.

6912. Do you approve of having a science branch in the upper part of that school?—Decidedly, the only part of that Report which has not been favourably received in Birmingham is that the Commissioners do not recommend any portion of the funds to be applied to more elementary teaching; generally the inhabitants are in favour of some portion of it being applied to elementary education.

6913. Is there any other means which you have not yet spoken of, but which you think would be of advantage for the purpose of scientific instruction in Birmingham?—As far as I can gather, I should say that we are generally in favour of having a museum on an efficient and comprehensive scale. We think that would be

of great use, and we think that if the Government were to supply us with the latest and most approved scientific instruments, and send some of the ablest professors as lecturers to stimulate our people, and if they would also employ some one in connection with the metal trades to give information with regard to new discoveries on the Continent and in different parts of the world, that would be of the greatest possible use.

6914. You think such lectures would very much help the trade of Birmingham?—Yes; and not only that they would help the trade of Birmingham, but that they would be a national good. For instance, if an eminent teacher, like Dr. Percy, were sent down to give a series of lectures on the laws of combustion, or on metallurgy generally, we think it would be very useful.

6915. But why should not the manufacturers supply that for themselves?—I have given the Committee all the reasons I am able to give them on that subject. I think that the Birmingham people have many claims on the Government, and they are not, as a rule, rich men.

6916. Referring to a question asked you by an Honourable Member not long ago, do you not think the fact, that you have something like 7,000 masters who must be their own foremen, very much strengthens the case for the diffusion of scientific education in Birmingham among the lower and middle class?—Yes. I think it would not be possible to mention anything which more strongly shows the importance of the diffusion of scientific education in Birmingham.

6917. You would say that scientific education was more wanted where each man must be his own foreman than in an establishment where there were, perhaps, 3,000 people employed, and a large capitalist paid his own foremen?—I think so, obviously the rich manufacturer is better able to pay the teacher or the foreman.

6918. Mr. *Ahroyd*.] Do you not think you could make your night school available for evening science classes, under properly-certified science teachers?—The teacher that I formerly employed was a certificated teacher, but I do not think that I could at this moment find a properly-qualified science teacher.

6919. Assuming that you could get one from the department, do you not think you would be able to do a good deal in the way of science education in your evening class?—I could do it for myself, but I want the Government to do it for the town generally. It could be done by the manufacturers themselves in some cases; but as the establishments are generally very small, it is obviously impossible that it could be done in the greater number of cases.

6920. *Chairman*.] You stated that your workpeople were unwilling, after they had left their work, to return in the evening to receive scientific instruction?—Yes, Birmingham covers a great space. I believe we give nearly double the space to each inhabitant that is given in other great manufacturing towns, so that a large number of our workpeople live a considerable distance, and we cannot get children and young persons to come back from their homes to attend the evening and night school.

6921. But those young people being unwilling to return to the night school, which I suppose is an ordinary elementary school, do you think they would be more willing to return in order to attend science classes?—We have had no science teaching in my school.

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6922. But if there were science teaching in your school, do you think they would be willing to return in order to attend science classes?—Probably we should have a different set of students in the evening classes, and in all probability the position of the school would be more convenient to them, but we can easily understand that when young persons have been in the atmosphere of a manufactory all day they do not care about coming back again to the school of the manufactory at night.

6923. Do you mean that your neighbours would attend rather than your own people, exclusively in the event of science classes being established there?—I should get, I think, a different class of scholars—my scholars were mainly girls, and I think if I established science schools I should get some employed in my own factory and also young men from the neighbourhood.

6924. You think that they would then return after they had left their work for the day?—I have no doubt that if I could find an efficient teacher, and set up a science school with proper apparatus, that a good deal of interest would be taken in it, and a considerable amount of good effected.

6925-6. There is a good teacher at the Midland Institute, and good apparatus, is there not?—There is a very excellent teacher who was trained in the institute itself, but there is only indifferent apparatus. That institute was established for various objects, and they have not been able to appropriate sufficient funds from those various objects to the purpose of science teaching.

6927. Do you think it is from the deficiency of the apparatus that the imperfection of science teaching in great measure arises in Birmingham?—Certainly not entirely, people have not been sufficiently alive to the importance of it, and there is an additional cause, namely, the deficiency of elementary education, and it is only recently that our manufacturers and workpeople have felt it is absolutely necessary for them to have scientific teaching if they are to hold their position.

6928. Then the absence of scientific instruction would arise in Birmingham rather from the want of interest in it, than from any want of sympathy and encouragement on the part of the Government?—I think it has arisen from both causes, I think if the Government themselves took more interest in the matter, they would necessarily stimulate the workpeople and the manufacturers.

6929. But inasmuch as the Government make payments on results, which in other towns amount to a very large sum, while in Birmingham they amount only to an inappreciable sum, does not that seem to show that the want of scientific education in Birmingham arises rather from the fact that the manufacturers are not willing to take advantage of it?—I was not aware that the Government appropriated a large sum in any town to science teaching, I am speaking now comparatively, and taking Manchester or Sheffield or Leeds, as far as I have seen, it is a comparatively insignificant result which has been obtained.

6930. Mr. *Acland*.] Do you think that the establishment of a central college of science in Birmingham would be beneficial to the surrounding districts in which hardware goods are made as well as to Birmingham itself?—I believe it would

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be of the highest use; the facilities for reaching Birmingham from the hardware districts of the neighbourhood are great; there being three lines of railway, and I have no doubt large numbers of people from South Staffordshire would avail themselves of such a college if it existed in Birmingham.

6931. But do you contemplate that young men who came to that college would come in merely for an hour or two of instruction, or that they would, by some arrangement of exhibitions or otherwise, migrate for a few months to Birmingham in order to pursue their studies?—I have no doubt that both classes of students would come to its college.

6932. (To Mr Field.) Have you considered the question which I have put to Mr. Wright?—I think such a college would be of great use for the districts of which Birmingham is the centre, Birmingham itself is chiefly a place of small handicraft work, but it is the market, in fact, for about a million inhabitants, we have one day in the week on which the iron masters come in to sell their goods in our market, and the outlying districts are connected with us by almost a continuous line of gaslight, if Birmingham had such a school as we are contemplating, it would be a school for the whole of that large district.

6933. Do you think the whole of that district would be inclined to contribute towards the support of a school?—I think they would be very glad to use it, and if the teaching were efficient we should have a very great advantage in our midst. I think all the work of the iron trade, which has now left South Staffordshire, would have been preserved if we had had this scientific instruction.

6934. *Chairman.*] Suppose such a school were

devoted chiefly to the instruction of young men of from 17 to 19 and 20 years of age, and that the instruction were so systematic and continuous as to require them to reside near the school, do you think that the parents would more readily send their sons to Birmingham than to London?

—(Mr. Wright.) Yes, undoubtedly. (Mr. Field) I think if we can get a scientific school of a sufficient size with quite efficient teaching, that teaching would find its way by its own channels into the whole of the neighbourhood, and get into what is called the black country; and, no doubt, in one way or another, we should get men who would come from the surrounding districts to such a school for a few hours in the day only, with the railway communication, half an hour or an hour's walk would bring them in. I should like to add one word about the small manufacturers, it is very natural and necessary, as far as we can see, as to a very large part of the Birmingham trade, that it should be diffused through an immense number of manufacturers, and if we can only get the scientific instruction afforded, in such a school as I have spoken of, I think it will find its own way to those parts of the manufacturers themselves, where it is most needed.

6935. Mr Acland.] Do you think that when public interest is once aroused on this subject, it would be possible to found exhibitions, either from existing endowments or municipal sources enabling persons to pay the expense of removing from home to go to this college of science?—(Mr Wright) Yes, but I think that is not the most desirable plan. I should prefer to take the instruction home to the people. I should certainly prefer my own sons being taught in Birmingham itself. (Mr. Field.) I have not thought sufficiently on that question to give an answer.

Monday, 29th June 1868

MEMBERS PRESENT

Mr Akroyd
 Mr Bazley.
 Lord Frederick Cavendish
 Mr. Dixon
 Sir Charles Lanyon

Mr M'Lagan.
 Mr. Edmund Potter.
 Mr. Powell
 Mr. Samuelson

BERNHARD SAMUELSON, ESQ., IN THE CHAIR

SIR CHARLES LANTON, a Member of the Committee, Examined

6936 *Chairman*] I BELIEVE you wish to hand in a Memorandum from the Chamber of Commerce at Middlesbrough?—I do

6937 Will you have the kindness to read it?—Yes It is a Memorandum on the want of means for affording Technical Education to those connected with the Industries of Cleveland "The subject of technical education has engaged the careful attention of the Middlesbrough Chamber of Commerce, and they therefore regard with much satisfaction the appointment of a Select Committee on the motion of Mr Samuelson to inquire into this important subject Whilst admitting that the great want of the community at the present time is such a system of primary education as should secure a sound elementary education for every child, they believe that it will be a work of time before such a social reform is brought about, and they therefore consider it would be highly advisable for the Government to extend greatly the means hitherto adopted for diffusing a knowledge of those branches of national industry which are intimately associated with the manufacturing and commercial interests of the country. The iron district of Cleveland has risen into importance with great rapidity, the manufacture of iron on a large scale having only commenced 15 years ago The locality of which Middlesbrough is now the principal town has become famous for the production of pig and finished iron for the construction of ships, engineering work, and many other secondary manufactures, the majority of which come within the range of foreign competition. It is a matter of great importance that not only should a class of more intelligent workmen be trained up, but that those occupying more influential positions in connection with the local industries should have the means of obtaining scientific knowledge The development of the national resources of the district will depend, to a large extent, upon the amount of scientific knowledge available in the locality, but the recent growth of Cleveland as a manufacturing and commercial centre has not allowed of the establishment of seats of learning or of educational institutions of an advanced type at all equal to the requirements of the rapidly-increasing population The Chamber consider that the formation of a science school in the locality would be productive of much ultimate benefit to the industry of the district; and they

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believe that if liberal assistance were given by the Government the large employers of labour in Cleveland would readily co-operate in the foundation of such an institution They would recommend the establishment of an institution where practical instruction in the following subjects would be obtained. practical mechanics, mathematics, machine construction, navigation, chemistry, metallurgy, geology and mining, drawing The expense of conducting an establishment of this kind would be altogether too heavy for the district itself to bear, but if a moderate grant from Government could be obtained towards the payment of the requisite teachers, and liberal assistance could be obtained from the same source towards the erection of a good laboratory, with the requisite fittings, the Chamber consider that a local science school or college for Cleveland would be successful. The Chamber is well aware that grants to science teaching are at present made on results; but they consider that, in order to ensure the confidence and co-operation of the capitalists of the district and of the public, it will be necessary to appoint at least one professor of a high class, who could scarcely be expected to accept a remuneration based entirely or chiefly on such payments. They therefore desire to submit these views to the Select Committee on Technical Education." This is signed "*Ino Jones*, Secretary, Middlesbrough Chamber of Commerce." I also produce a communication from Dr. Andrews, Vice President of Queen's College, Belfast, with regard to science and art instruction in Ireland.

6938. Will you kindly read that letter also?—"Queen's College, Belfast, 13th June 1868. My dear Sir Charles,—As you have requested me to state my views on the subject of technical education, especially with reference to the wants of this locality and the best means of supplying them, I beg to submit, for your own information and that of the Select Committee on Scientific Instruction, the following observations. The industrial training of a population must be considered under two aspects, the first, the general improvement of the adult working or artisan class, the second, the education of a number of young men who may afterwards be qualified to fill responsible situations in connection with manufactures, and to apply their scientific knowledge to the improvement of the processes in common

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common use. The improvement of the adult workman or artisan will be chiefly effected by short courses of lectures, carefully prepared and judiciously adapted to their capacities, and evening classes, in which those who have a taste for improvement may remedy their defects of education and augment their stock of knowledge. Libraries and reading rooms will be essential auxiliaries. The intelligent artisan should also be encouraged to amuse himself with philosophical instruments. The telescope, the microscope, the air pump, the induction machine, &c., will furnish an exhaustless source of profit and delight. But care must be taken not to push these things too fast or too far. The working man is fatigued at the end of a day of toil, and his bodily frame calls for relaxation rather than a renewal of labour. I can speak from personal experience on this point. For some years, I have delivered annually, within the walls of this college, a few lectures to the working classes on different branches of physical and chemical science. Tickets of admission were carefully distributed among the more intelligent operatives of the town, and none others were admitted. After a struggle, which at one time deterred me from persevering, this effort for the improvement of the working classes may, I believe, be regarded as entirely successful, and I hope to be able to make arrangements which will secure its permanence. I was so fortunate this year as to obtain the co-operation of one of my colleagues (Dr. Wyville Thomson), and next year I expect to be able to enlist the services of other members of the college. The attendance on the last course was, as nearly as possible, commensurate with the number of tickets issued (320), and at the request of the working men, an additional lecture was delivered. Without entering into more detail, I will only further remark that even this humble effort has only succeeded after several years of quiet labour, and that to this circumstance as much as to anything else its present favourable position is due. The elevation in intelligence of the adult workman will have an important and direct influence on the general industry of a country. It will have an indirect influence in the same direction from the better training which the sons of the intelligent artisan will receive at the hands of a parent who has himself learned to estimate at its true price the value of knowledge.—The training of a superior class of young men, who may be able not only to superintend efficiently the existing processes of manufacture, but to apply scientific knowledge to their improvement, is a subject of the highest moment to the whole nation, involving as it does, to a large extent, the continuance in a prosperous state of the great national industries. But in proportion to the importance of the present movement would be the serious consequences, even of its partial failure, and I deem it to be my duty distinctly to state that, in my opinion, it will be a task of uncommon difficulty to carry it to a successful issue. If permanent results be desired, and no others are of any value, time must be allowed for the new arrangements to be adapted to the wants of each locality, and to become generally known; and above all, those spasmodic efforts, proceeding from central authorities, which have of late ended so often in lamentable failure, must be avoided. In the district, of which Belfast is the centre, the flax manufacture, from its earliest stage in

the retting pool to the last finish in the bleach green is, as is well known, the special industry upon which the prosperity of this part of Ireland mainly depends. It is an old industry in this locality, and its history can be traced back for upwards of 200 years; of late it has received a remarkable extension not only absolutely, but comparatively to the progress of the same industry in other countries. The bleaching of linen has been brought here to a high state of perfection, and for purity of colour the linen of the north of Ireland is probably unequalled. The bleaching processes have been the slow growth of time, and have received little aid from the direct application of modern science; but great advantage has been derived from the use of new materials, supplied by the chemical manufacturer, and the mechanical arrangements of the bleach-works have also been improved. It is difficult to suggest a change where work, on the whole, is done so well; but I am of opinion that the methods of bleaching are susceptible of improvement, and that it would be greatly to the advantage of the bleacher to have a scientific foreman or manager at the head of his works. A well-devised course of technical instruction, particularly in general and technical chemistry, ought to be the means of training a superior class of such men; and, in the end, of improving the staple trade of the district. But in attempting to carry into execution a scheme of this kind, a difficulty at once presents itself, which it will require both time and patience to overcome. The foremen who conduct the bleaching operations are usually men of little education, and receive a low rate of wages. The manufacturer will, I have no doubt, in the end find it to be for his advantage to employ men of scientific education, and to pay higher salaries. But this change will be a work of time, and, meanwhile, the pupil of the technical school, on the expiration of his studies, will find great difficulty in procuring employment at an adequate rate of remuneration. Belfast gives employment to a large number of skilled mechanics in its great foundries and workshops. It has also extensive manufactures of soap, artificial manures, &c.; but none of these present any peculiar features requiring special notice. An efficient technical school would doubtless, in time, be of essential use to them all, but its organization must be very complete, and its pupils, even if well educated, will for some time find difficulty in procuring suitable employment. I am of opinion that a more promising field exists nowhere in the United Kingdom for the establishment of a good technical school than the town of Belfast, and I am also of opinion that such a school ought to be connected with the Queen's College. I agree with Sir R. Kane, that two additional professors would be required to enable it to be conducted with efficiency; but I entirely dissent from his proposal to interfere with the existing arrangements of the college. For many years I have been in the habit of admitting, by examination, the most deserving students of my class as free working pupils to the laboratory, and I have always regarded this to be one of the best features in our educational arrangements. In summer a large class of medical students occupies the laboratory, to whom I give myself regular instruction in their practical work during their whole course. In addition to this instruction they receive also aid from my assistant, who

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himself an accomplished chemist. The laboratory of this college is therefore fully occupied at present, and if a chair of Technical Chemistry be founded, a new laboratory and lecture room would be required, together with appliances for carrying on the work of instruction. The latter condition I consider to be so important that I should greatly prefer the appointment of one professor well furnished, with the means of performing efficiently his work, rather than of two professors inadequately provided. I remain, yours very faithfully, *Thomas Andrews* To Sir Charles Lanyon, M.P.

6939 You also produce an estimate of the cost of scientific education from Owens' College, and a letter from the Rev T. A. Southwood, of Cheltenham, giving an abstract of what is being done there, and the cost of a secondary science school?—I do

6940 Will you kindly read them?—I will Mr Roscoe writes in these terms "Owens' College, Manchester, 24th June 1868. B. Samuelson, Esq., M.P., Chairman of Committee on Scientific Instruction. Dear Sir,—I beg to hand to you herewith a statement drawn out by me in accordance with Mr Acland's wish, of the probable annual cost of maintaining a first-class science college for 200 students, not including the prime cost of buildings, museums, stock of apparatus, &c.—1st. Endowment of five science professorships at 500*l* per annum each: 1. Mathematics, 2. Physics, 3. Chemistry; 4. Biological science, 5. Engineering science (The exact nature of these two last chairs to be decided by the requirements of the district)=2,500*l* 2nd. Departmental assistance for experimental sciences 1. Physics: salaried assistant, 150*l*; expenses of purchase of apparatus, working expenses of laboratory, servant, &c, 250*l*. 2. Chemistry: two salaried assistants, 300*l*; expenses of working large laboratory for, say 100 students, purchase of apparatus, servants, &c, 400*l*. 3. Biology: Assistant steward and specimens for museum, 300*l*. 4. Engineering assistant, drawing master, purchase of models, 250*l* = 1,650*l*. 3rd. General working expenses Registrar or secretary, 250*l*; office expenses, 100*l*; library fund, 150*l* = 500*l* Total endowment, 4,650*l*. Add to this the income from students, say 200 at 10*l* = 2,000*l*, to be divided partly amongst the professors, and the other portion to defray working expenses or increase the teaching staff. Hence the estimated cost of instruction will be about 33*l* per head I remain, dear sir, faithfully yours, *Henry E. Roscoe*" The communication from the Rev. Mr Southwood I will also read: "Cheltenham, 1st June 1868 Dear Sir,—I have great pleasure in answering your inquiries respecting the course of teaching, &c followed in the military and civil department of the Cheltenham College. The special teaching does not commence until the ordinary subjects of

a good general education have been pretty well studied. These subjects are Latin, English grammar, reading, history, geography, French, arithmetic, algebra, Euclid, and elementary drawing. The special course commences about the age of 15, then Latin is dropped, unless in a few exceptional cases, and the studies are confined to mathematics, French drawing (scientific and free-hand), physical science, and English. By the time the pupil reaches 18, he has made considerable progress in mathematics (such as would enable an undergraduate at Cambridge to obtain a wrangler's degree) Drawing consisting of free-hand, perspective, geometrical (including plans, sections, and projections of military works or machinery) Physical science (including chemistry, heat, electricity, and geology) English consisting of grammar, composition, and literature. Surveying in its different branches is included under the head of mathematics. The time occupied in passing through the special classes is from three to four years. The tuition fees amount to 28*l* annually, and the average yearly expense for books, mathematical instruments, drawing materials, and chemicals is about 8*l*, making a total of 36*l*. The cost of erecting a building, complete in all its parts, furnishing it thoroughly for 300 pupils, would be about 12,000*l*, and a school of this magnitude can be efficiently worked for about 25*l* a head, and leave a sufficient margin for casualties. You ask if I think it desirable, and see any way to make the course of instruction in the military and civil department of the college more special, I scarcely think it would be desirable to do so. Let us consider what our present system does. It makes the pupil a good mathematician, and competent to apply his theoretical knowledge to practical purposes, makes him a good draftsman, and gives him a knowledge of geology, chemistry, heat, and electricity, and to these is added the English subjects of history, geography, grammar, and composition, which though, perhaps, not regarded so much of a special character as the other subjects, must have their due proportion of attention in any well-considered system of instruction. I have given our special training here much consideration with reference to the Whitworth scholarships, and I believe it would answer admirably for the Whitworth candidates, by adding to the instruction in chemical science and diminishing, in the same proportion, the study of English. The cost of working a school of this magnitude and character would be about 5,000*l*, sundries, taxes, repairs, insurance, &c, 450*l*; interest on 1,200*l* at 4½ per cent 540*l* = 5,990*l*. To meet this, 300 pupils at 25*l*, 7,500*l*; or 250, 6,250*l*. With the 300 pupils, allowing for an occasional diminution in the number, a sufficient margin is furnished in the fee of 25*l*. I remain, dear sir, yours very faithfully, *Thos. A. Southwood*."

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MR R. CALVERT CLAPHAM, called in; and Examined.

6941 *Chairman*] You are a Chemical Manager at Walker, on the Tyne?—I am.

6942 I believe, also, you are a Fellow of the London Chemical Society?—Yes.

6943. And honorary secretary of the Newcastle Literary and Philosophical Society?—Yes.

6944 You have been requested to give evi-
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dence on behalf of the Newcastle Chamber of Commerce?—Yes, and the Literary and Philosophical Society of Newcastle.

6945. You have paid much attention to the education of the working classes, have you not, for the last 10 years?—Yes, for many years.

6946 You know what is being done, not only in Newcastle and at Walker, but also in the smaller

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smaller manufacturing towns on the Tyne, do you not?—I do.

6947. And on the Wear also?—Yes.

6948. Have you prepared any statement showing the number of children that are at present in the elementary schools in the district?—Yes. I have endeavoured to draw up a paper, which I will submit to the Committee. The population might be considered to be about 230,000; calculating the inhabitants on both banks of the river, from Tynemouth to Newcastle; and I include all the elementary schools, both Government schools and others. The number of scholars at the schools, chiefly connected with the large works, might be taken at about 10,000.

6949. Those are schools connected with large manufacturing establishments?—Yes. At some of those schools only do they receive any scientific education.

6950. And that number does not include the whole of the schools; it does not include parish or village schools?—No, nor the private schools.

6951. It does not represent the whole number of children at school in the district?—No.

6952. You speak of those schools as representing the instruction given where the proprietors of works take an interest in the education of their workpeople?—Yes, exactly. In some of those schools scientific education is given. In connection with nearly all the chemical works of that district, of which there are some very extensive ones, the number of pupils who receive a good scientific education, chiefly chemical education in the laboratories connected with those works, might be taken at about 50; that is, as far as I can ascertain the facts.

6953. Is there anything more that you would wish to state about the elementary schools in your district?—I might refer especially to the school in which I am myself interested at Walker. At that elementary school there is a system of what may be called compulsory education carried out, that is to say, the workmen employed in the chemical works and the iron works (the number of whom might be taken at about 2,000 men) are obliged to pay 2d per week towards those schools.

6954. Mr Powell.] Whether married or single?—Yes, whether married or single. Each boy pays a penny. For this 2d. a workman may send any number of children that he may have, the boys and single men attend the evening school without any further charge. This 2d. a week is sufficient to raise a fund in ordinary times to pay for the expenses of the school and to carry out a very good system of education.

6955. [Chairman.] Do the proprietors of the works make any contribution towards the maintenance of the school in addition to that fund which you have mentioned?—They make up the loss, if there is any, in ordinary times there is scarcely any, last year there was a loss of 150*l*.

6956. The number of workmen employed last year was not so large as it usually is?—No; the school itself cost about 2,000*l*.

6957. The building and fittings?—Yes, in those schools education is given to upwards of 600 children, boys and girls, and the evening schools consist of about 80 or 100 grown-up persons.

6958. Is aid received from the Committee of Council by the day schools and evening schools?—It is received at those schools for boys, but not for girls.

6959. Is it not for girls?—It was not

thought advisable to put both boys and girls on the same system. We tried both plans, one under the Government, and one not under the Government.

6960. Is the girls' school inspected or not?—It is not inspected by a Government inspector; it is inspected privately.

6961. Does the night school receive Government aid?—To some extent; mechanical drawing is taught.

6962. In addition to that elementary instruction, you have science classes which receive aid from the Science and Art Department at South Kensington, have you not?—We have.

6963. What are those classes?—They have been in operation only a limited time, since about 1865; what I say of those must apply only to that time. The number of workmen (chiefly workmen of the better class) who attend those science and art classes may be considered about 40, during the winter months; they receive education in chemistry, engineering, and mechanical drawing. Those are the only classes at present.

6964. Have those persons generally received a sufficient education in a primary school to be able to avail themselves of the evening classes, or do they receive subsequent instruction in elementary subjects in the night school before they attend the science classes?—Many of them attend the night school as well as the science classes.

6965. And some of them, I suppose, would not be qualified to attend the science classes until they had received instruction in the night school?—No.

6966. I suppose examinations in connection with South Kensington have been held in your science classes?—Yes.

6967. What has been the result of those examinations?—The result on the whole has been pretty satisfactory. Some of the students received prizes; but we find a difficulty in this respect with regard to the higher class of foremen. In that case, although they attended those classes pretty regularly, they received no prize which I consider had a very bad effect on them and discouraged them from attending the classes.

6968. You consider that a small prize, even worth only 2*s*. or 3*s*., would have been treasured by them as a mark of approval?—Yes; students are allowed to make a choice of mathematical instruments, books, or money, for prizes.

6969. The effect would have been very cheaply bought at the expense to the country of bestowing these prizes?—Yes; those are a class of workpeople whom it is very important to encourage to go to the science classes, especially with regard to chemical works, because all the operations that are carried on require a certain amount of scientific skill. Many of those foremen receive good wages, to the amount of 100*l*. or 130*l*. a year, and we have really a right to expect that they should possess some little knowledge of the operations which they are conducting.

6970. You think if the country is to pay for the instruction of the workmen, or of the foremen, that, in an economical point of view, the result of paying for the instruction of the foremen would be greater than the results of paying for the instruction of the workmen?—Yes, it is much more important matter to educate the foremen; but the foremen should pay a certain portion of the expense themselves.

6971. You think that it is a mistake, if there is to be any State contribution at all to the cost of science education, that it should be confined to workmen, and not given also to foremen?—I think it is a great mistake.

6972. The nation would get more value for instruction given to foremen, than for instruction given to workmen?—Yes.

6973. Who was the master of your science school?—Mr. Gillesthorpe, a certificated master.

6974. Can you state what his training has been?—He has had a pretty good scientific education, he is quite capable of teaching chemistry, and other scientific matters.

6975. How is he remunerated?—He is remunerated from the results of the examination of the pupils.

6976. Does he receive any other remuneration?—He receives no other remuneration.

6977. Do you recollect what amount he has received upon results?—No; I know it is very small, and so small, that he was discouraged very much from proceeding farther.

6978. But still those classes are continued?—Yes.

6979. That teacher has some other occupation, of course?—Yes, he is an analytical chemist.

6980. Does he give instruction in any similar school elsewhere?—He does not; he has an income independent of the schools altogether.

6981. Are there any other science schools in your neighbourhood beyond your own?—There was a school connected with the Newcastle Mechanics' Institute, but I am not sure whether that is still in operation.

6982. Is there any other?—There is another at Gateshead.

6983. Is that a large school?—It is doing pretty well.

6984. How long has it been in operation?—It has been in operation two or three years.

6985. Is there a science school in North or South Shields?—No.

6986. At Sunderland is there a science school?—I am not sure, but I think there is not.

6987. Is there such a school at Blyth or Morpeth?—I think not.

6988. As far as you know, there is no science school in Northumberland except the school at Walker, at the present time?—Just so.

6989. With the exception of Walker and Gateshead, there is, in fact, no science school on the Tyne?—None that I know of, but I am not speaking of such institutions as the mining institute.

6990. You have at Newcastle an institute of mining engineering, have you not?—Yes.

6991. Is there any science school in connection with that Institute?—None.

6992. You have a Literary and Philosophical Society at Newcastle?—Yes.

6993. Is there any systematic science instruction given in that society?—The society devotes about 400 £ a year towards scientific and other lectures, about half of those lectures, or perhaps rather more, are of a scientific character, and after they are delivered the lectures are printed and circulated among the members, and in that way they form to some extent a useful means of scientific education.

6994. Are those lectures sold to the public?—No, they are not sold to the public, they are only circulated among the members; but the public are admitted to the lectures, on the payment of 0.72.

10s. the session; that is to say, a non-member may get a lecture ticket for 10s. The number of members in the institution altogether is about 1,500. In addition to those lectures, we are now getting up a system of classes, with examinations; this is quite a new matter, so that I cannot say very much about it, but at present the number of names attached to the list is about 100.

6995. Are the classes already in operation?—No, we are merely organising them at present.

6996. By whom is the instruction proposed to be given in those classes?—It is proposed to be given, if possible, by local scientific men. We have already had offers of voluntary help, in the shape of instruction, for nearly every department of those classes; that is by way of experiment; if the result is found to be satisfactory, we should, of course, engage teachers, and pay them for their labour, charging a small fee to every student.

6997. You have several eminent scientific men at Newcastle, have you not?—Yes.

6998. Mr. Pattinson is a chemist of very considerable ability?—Yes.

6999. And some of your engineers are sufficiently educated in science to be able to give instruction in the theory of their profession?—Yes. There is a general desire on the part of chemical manufacturers that scientific education should be extended; but up to this time the means have not been organised for doing it; and we are very deficient in information with regard to the best plan for adoption.

7000. In the large chemical works you have laboratories, I suppose?—Yes; in all the large chemical works on the Tyne we have laboratories.

7001. And in those laboratories pupils are received?—Yes.

7002. I suppose the instruction given in those laboratories is practical instruction in the processes which may be carried on in the respective chemical manufactories?—Yes, it is so to a large extent.

7003. No general theoretical instruction in chemistry is given in those laboratories?—No.

7004. From what class are the pupils who attend those laboratories generally drawn?—They generally come from what may be called the better classes, well-to-do tradespeople, and others; in some cases we have the sons of workmen, who make, generally speaking, as good chemists as the other classes.

7005. Do you receive premiums with any of those pupils?—No, we positively decline to do so, they are generally bound for five years, and they receive a very small remuneration.

7006. Does that apply to pupils of every grade?—To pupils of every grade.

7007. Is that the general practice in the chemical works on the Tyne?—Yes, generally; but in some cases premiums are paid.

7008. It is not the rule, however, that premiums are paid?—No, it is not the rule; but we have, in addition, two scientific laboratories in Newcastle where premiums are paid.

7009. Laboratories conducted by scientific chemists, where premiums are paid?—Yes.

7010. In the laboratories of the manufactories on the Tyne, what do you suppose would be the total number of apprentices?—About 50.

7011. That is to say, exclusive of the apprentices

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tices in the laboratories of the scientific chemists? —Yes, just so. In connection with the College of Medicine, I should say, they have about 80 pupils studying chemistry.

7012. Those are medical students, I suppose? —Yes.

7013. In your own laboratory at Walker, how many apprentices have you? —We have five young men.

7014. Do those young men, after their apprenticeship is completed, readily find employment either with you or with other people? —Yes, I could give two instances where, after leaving the Walker Works, the young men got situations as sub-managers at pretty fair salaries, say 150*l* a year, to commence with.

7015. I suppose they are apprenticed to the chemical departments of the works? —Yes, only to the chemical departments.

7016. That is to say, to the scientific and practical departments, but they do not learn the business of the office? —Just so.

7017. But they learn the entire course of the practice in the works? —Generally they do; not always, but they are confined to the laboratory.

7018. Is each one confined to a special department? —No.

7019. He has the run of the entire laboratory practice of the works? —Yes, he goes into the works if he wishes.

7020. So that he would receive a knowledge of the operations carried on in the works? —Yes.

7021. He would learn what goes on in the works, except as to the financial department? —Yes.

7022. What do you produce at Walker? —The manufacture carried on at Walker consists chiefly of soda, bleaching powder, and acids.

7023. And are the other manufactories on the Tyne of a similar character? —Yes.

7024. Felling is very similar, is it not? —Yes.

7025. Are you aware how many pupils are instructed in the two scientific laboratories of Newcastle? —I am not sure, but I should say perhaps 25.

7026. What becomes of those young men after they leave those laboratories? —They are almost always drafted off into the various chemical works of the district.

7027. Do they receive a preparatory education in the scientific laboratories before they enter the laboratories of the chemical works, or is the one a substitute for the other? —As a rule they go first to the two scientific laboratories, where they pay for their scientific education, and after they have been there a certain number of years, they generally get some situation in connection with the chemical works of the district.

7028. That is to say, if they have gone through one of those scientific laboratories they at once receive a salary instead of a mere nominal payment, as they would otherwise do? —Yes.

7029. Speaking from your own experience, would you set a greater value on a pupil of one of those scientific laboratories, or on a pupil who had gone through an apprenticeship in the laboratory of some chemical works? —I would give the preference to a student who had got his information at chemical works; but that is no doubt a matter of opinion.

7030. And probably you would prefer one who

had gone through both laboratories? —I certainly would.

7031. On the whole, do you consider that by means of these scientific laboratories and the laboratories of the chemical works, the needs of the district with regard to chemical instruction are fully supplied? —By no means.

7032. Then where does the deficiency arise? —I think we ought to have a much better system of education in connection with our foremen; our foremen are getting good wages, and they are many of them extremely deficient; and I think that, either by the development of the South Kensington system, or by something of that kind in which grants were allowed by the Government, we might find the means of encouraging the attendance of that class of men to scientific instruction, as well as of the better classes.

7033. Your foremen being derived from your workpeople? —Yes.

7034. And consequently they have not had the opportunity of becoming instructed in either of those two kinds of laboratories of which we have been speaking? —Just so.

7035. At what time of the day would you propose that that instruction should be given to foremen? —In most cases in the evening, but in many cases it might be done in the daytime. I am in favour of keeping these science classes open during the day.

7036. Do you think these people would be able to attend during the day? —In some cases they would, because we have night foremen as well as day foremen.

7037. You have two shifts of men? —Just so.

7038. And the men who have been in the night shift, after having rested, would be able to attend school during the day for an hour or two? —They would be able to attend school in the afternoon of the day.

7039. I think you stated that you gave instruction in chemistry in your night school? —Yes.

7040. Does not that meet the want of which you have spoken? —No. We have found the greatest possible difficulty in getting teachers to take the trouble to attend the classes; the remuneration is exceedingly small, and a thoroughly well-educated chemist will not take the trouble to teach those classes for the money; the difficulty appears to me to be in the practice of the department in only paying on results, and if a grant were given for attendance as well as results, I think it would be a great improvement. I do not see why, when under the ordinary Government inspection of elementary schools, the attendance is paid for, it should not also be paid for in science education.

7041. But you would not expect attendance to be paid for, unless some results could be shown? —Certainly not.

7042. You think that the payment should be based jointly on attendance and results? —Yes, exactly the same as with the ordinary elementary schools.

7043. You think that in relation to science schools, there is the same reason for granting payments on attendance as there is for granting payments on attendance in support of the ordinary elementary schools? —I cannot see why the Government should object to extend a principle which is already admitted.

7044. Either both are right or both are wrong? —Yes.

—Yes. As far as funds are concerned for such education, I think it would be very important, supposing manufacturers assisted in any way, that the workmen should do their part, and how the expense could be met, would be a matter for serious consideration. I am very much in favour of a compulsory rate on workmen, and if a compulsory rate were levied upon the manufacturers, it would be a question whether the manufacturers could not recoup themselves a little from the workmen.

7045. You mean that the manufacturers should be rated for the purpose, and that they should be allowed to distribute a portion of the sum they paid rateably among the workmen on the wages they received?—I think that would be quite fair.

7046. How do you think the rate should be levied on the manufacturers?—That would be a very difficult question, no doubt.

7047. Have you a local board at Walker?—Yes.

7048. Do you think that if a rate in aid of elementary education, or science education, were proposed to the ratepayers of Walker, that it would be sanctioned?—I am afraid not. I think if it was possible to extend the rate to those who got the benefit of it, some of the difficulty would be got over.

7049. You would rather propose that the manufacturers should join and make the rate on themselves?—If it was practicable, I should; but I am afraid that it would not be practicable.

7050. But if that is not practicable, can you imagine any municipal or Government plan which would be more likely to succeed?—The question of a public rating has been often discussed at the meetings of the Literary and Philosophical Society, and I have not heard anything said against it; but I am afraid that if it were practically tried there would be a difficulty. I have thought that if the manufacturers were allowed in some way to recoup themselves for the tax by taxing the workmen, you might get over the difficulty.

7051. You would separate this from the other rates, and make it a rate applicable only to manufacturers, would you?—No, I do not see why farmers should not pay the tax, because the schools would be open to all classes.

7052. In fact you would have the rating on the parish?—Yes.

7053. I think you have stated that your literary and philosophical institutions have frequently considered the question, and that they are not averse to rating?—No, they are in favour of it.

7054. Do you think they would be fair specimens of the ratepayers generally?—I am not sure about that.

7055. Mr. Powell.] You suggested a system of rating for the establishment of science schools, but under whose management would you place those rate supported schools?—They would undoubtedly have to be to some extent under the local board of the district where the rates were made.

7056. Do you consider that the popular mind is so far advanced in those districts that a rate for education upon the ratepayers generally could be levied, and that efficient schools would thence arise?—It would be extremely difficult to answer such a general question, a great many of the ratepayers would no doubt object to it but we have been endeavouring among ourselves to get better information in connection with the facilities which

Government already hold out for scientific education. The Chairman of this Committee has been kind enough to give me an introduction to the secretary at South Kensington, and we propose to go there and endeavour to induce some one to come down to Newcastle, and give us some general information upon the subject.

7057. Before committing yourselves to the precise system you would like to adopt, you would probably feel it necessary to be sure of your ground, and in particular that the schools you suggest would be efficient?—Yes, among manufacturers there is a general feeling that these things should be done by individual effort, that is already done to some extent, for manufacturers plan and establish schools as we see, and take an interest in them.

7058. Schools independently of South Kensington?—In most cases it is so, but it is both ways.

7059. Would you think that such a system of voluntary action, either with or without South Kensington, would be more likely to commend itself to popular feeling in the district than a system of rated schools?—I am afraid it would, though I am myself in favour of rating. In connection with the higher classes of education, it has been suggested that the fees of the University of Durham might be better applied than they are at present. I am not able now to go into the figures connected with the income of the University of Durham, but I should be very happy to forward the Committee the statistics if they wished it.

7060. Is there not some school for mining or scientific education in connection with the University of Durham?—No, it is merely in connection with the College of Medicine, the scientific education at Durham is very deficient indeed.

7061. At what age do the children leave your primary school?—At various ages, I should say, at 13 or 14, and some of them younger.

7062. I presume a large proportion would leave school at an earlier age than that?—No, not now. We are not allowed to employ boys under 13 years of age.

7063. And you find that their general education is so far advanced before they leave school, that they are able to receive some elementary scientific knowledge?—Yes, in many cases.

7064. In such a number of cases, that you think they might fairly be considered in dealing with this question?—I think so.

7065. Assuming that your school contained 300 boys, could you give me roughly the number who you think would be fit after leaving school to receive elementary scientific knowledge?—Perhaps 50, or a little more.

7066. I think you complained that prizes were not given to some of the students, on the ground of their being of too high a class of society?—Yes.

7067. Is it not the case that certificates to that effect are in such instances given in substitution for prizes?—Yes, but that has not the same effect in encouraging them.

7068. Do you think it would be a heavy draw upon the liberality of a wealthy chemical manufacturer to give prizes from his own resources?—No, not at all, but the general feeling of the manufacturers is this, that as soon as they have found the school, and put the power of getting the education into the hands of the workmen, the workmen should do the rest for themselves, that, I say, is the general feeling, and I think it is a very proper one. The schools that I am now

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referring to were at one time carried on upon what may be called the voluntary system; that is to say, that each child paid 3*d.* a week; the schools were very badly attended indeed, the first thing the parent seemed to think of was the saving of 3*d.* a week on the education of his child, but as soon as each workman was taxed 2*d.* a week for the education of his child, the school was filled. I think a compulsory rate is the proper way for getting these people educated.

7069. Does that feeling, that if the schools are once established they should support themselves, arise from any failure of the liberal impulse after its first action, or from the conviction that if people are in receipt of good wages they are able to maintain their own schools?—I believe what has very much led to that feeling of late years is the independent position workmen have taken with regard to strikes, and so on, they have declared themselves to be independent of the masters, and I know that the feeling which I have now spoken of exists.

7070. You think those unhappy movements in the nature of strikes have diminished the sympathy which previously existed between the master and the workmen?—I believe so, to a large extent; and, of course, an increase of education, both elementary and scientific, would be the means, in a degree, of cementing the two interests.

7071. Are the schools you have mentioned under the management of masters, or under the management of a committee?—Under the management of a committee, not in connection with the workmen.

7072. No profit is ever made out of those schools, I suppose?—None.

7073. *Chairman*] Not only do the pupils not receive prizes, but the teacher is not paid on results in the case of persons who earn wages which make them liable to the income tax?—Just so.

7074. *Mr. M'Lagan*] In stating that you propose to have a rate for the support of these schools for scientific instruction, you mention that you would rate farmers as well as manufacturers, because farmers as well as manufacturers would benefit by the schools?—Yes; and I do not see how you could separate one class from another in making such a tax.

7075. Will you point out how agriculturists would be benefited by the establishment of such schools as you are now describing?—We all know very well that agriculturists are now taking an interest in scientific questions, their sons and the children of their workpeople require scientific education almost as much as the sons of manufacturers.

7076. As you approve of a general rate for the support of science schools, I presume you would also approve of having a general rate for the support of elementary schools?—Yes; one would follow from the other.

7077. It is your opinion then, that there should be a general rate for the support of elementary schools throughout the country?—I did not give that as my opinion, but I said that if it was possible to make a rate so that the workmen should pay a portion of it, I believe manufacturers would agree to it, but that they would not consider themselves bound to pay for the education of the workpeople, unless the workpeople did something for themselves.

7078. You think that schools should be supported partially by a rate?—Yes.

7079. Elementary as well as scientific schools?—Yes.

7080. *Mr. Aroyd*] Have you many children working in your establishment under the age of 13?—Very few.

7081. That is, the only portion of the children you employ, who would come at a future period under the provisions of the Factory Extensions Act?—Yes, we have had them examined already.

7082. For what hours do your scholars attend your day school?—From nine to twelve in the morning, and two to four in the afternoon.

7083. They attend school during the whole of that time, do they?—Yes, and those who are employed in work during the day attend the evening school.

7084. At what age do those children in your establishment usually go to work?—They usually go at about 12, or 13.

7085. Do any of them go later than 15?—Not very many.

7086. Had you any difficulty in getting the school rate from your workpeople, many of whom would of course have no children?—We had at first a very great difficulty, but we were quite determined, and now they have acquiesced.

7087. How long have you had that regulation in force?—Five years.

7088. And after five years' experience of the working of it, you think your people are satisfied with it?—Quite.

7089. At any other establishment in the neighbourhood is there the same regulation?—Yes, Sir William Armstrong has taken it up, and I believe with very advantageous results, but he has extended it; he charges 3*d.*, instead of 2*d.*, and that includes attendance at the Mechanics' Institute.

7090. Before those children are allowed to go to their work in your establishment have you any examination of them in reading and writing?—Yes, we have a partial examination, but we do not make it a standard with regard to their going to work.

7091. Then I suppose some of them are very imperfectly educated when they leave your school and go to work?—Yes.

7092. And if the cost of their education were to come out of a rate, it would make very little difference with regard to the knowledge they possessed unless there were an examination, I suppose?—I am afraid that if the payment came out of a rate, the children would not be at school. Unless the parents are obliged to pay, they do not send their children to school at all.

7093. Then, in fact, payment out of a rate would not secure any more efficient education than is now given them?—I am afraid it would be worse.

7094. Suppose an Act of Parliament were passed, enacting that no child above 13 years of age should go to work on full time unless he has previously passed an examination with respect to competency in elementary education, would not such an enactment as that guarantee a sufficient amount of elementary education to those children and young persons?—I think such an enactment would be very beneficial indeed.

7095. Do you not think it would act beneficially in stimulating the employers and parents of those children to exert themselves to secure a sufficient amount

amount of education for the young people before they reached the age of 13?—I think it would have the effect of making the parent insist upon the child attending to his studies.

7096. Would it not stimulate employers to provide schools, and assist the parents in that respect?—Yes, I think so.

7097. And would not the burden of education be in that case more equitably placed upon the shoulders of the parents, and the employers?—Yes; I believe that in many cases the feeling among the employers is that they can do something towards the education of the children, but that the workmen who are their parents should do their part, if we paid for the children to go to school, I am afraid they would not go.

7098. And, moreover, the principle would be a sound one, that of making the parent primarily responsible for the education of the young people, and the employer secondarily responsible?—Yes.

7099. There would then be no complaint on the part of the single men, that they were taxed to provide education for those in whom they were not interested?—No.

7100. You were laying some stress on the scientific education of foremen, do you select your foremen from the more intelligent portion of your young men?—Yes.

7101. Do you select a good many of your foremen from the apprentices?—Yes; we pick out the best boys from the schools too.

7102. If you could place scientific education within the reach of the more intelligent portion of your working men, you would be adding to the number of persons from whom you could select your foremen?—Yes.

7103. Do you think that would have a wholesome effect on the progress of education in your establishment generally?—It would.

7104. You receive Government support for your day school, do you not?—Yes.

7105. And you have, moreover, the advantage of Government inspection?—Yes.

7106. Do you not think that inspection is an immense advantage, independently of the pecuniary aid?—An immense advantage.

7107. Therefore, in advocating Government aid for these day schools and evening classes, you do so not merely with reference to the money grants, but with reference to the advantage of Government inspection?—Yes; I am very much in favour of Government inspection.

7108. *Chairman*] Perhaps you will kindly state why you do not have Government inspection for the girls' school?—We are very fortunate in having in Newcastle a lady, Miss — Richardson, who is a most efficient person in connection with schools, and she takes so much interest in our schools, that as she objected on principle to Government inspection, we have left the matter entirely in her hands.

7109. It is an exceptional case?—Yes.

7110. If it were not for the presence in Newcastle of that lady who interests herself in your schools, and gives such valuable assistance, you would be anxious to have Government inspection for your girls?—Yes.

7111. *Mr. Basley*] Does this lady test the progress of the children?—Yes.

7112. *Mr. Akroyd*] You are aware that the Department of Science and Art have done much to raise the standard of education in this country generally?—Yes.

7113. Without such aid, do you think it would have been possible for manufacturers to combine among themselves, and provide masters, and do much for the progress of scientific education?—It is possible, but I fear they would not do it.

7114. They would consider it unfair that they should have to educate, not only their workpeople but the community at large?—Yes. We are very fortunate in having Sir William Armstrong, who takes an active part in such matters, and there are others who do the same, but not many.

7115. So that without Government aid, and Government inspection, you think employers could not carry out among themselves the amount of scientific education which you would consider necessary?—No.

7116. *Mr. Potter*] You have 2,000 workpeople in your establishment, have you?—Yes, in the iron and alkali works.

7117. Are there any women among them?—No.

7118. How many boys?—About 100 or 200 boys.

7119. What are the wages of the adults?—In the chemical works, what are called furnace-men earn 27 s. to 30 s a week, but the iron-men get much more, I should say the iron-men get 35 s. or 40 s a week, it depends upon the state of trade.

7120. Yours is one of the largest establishments in the district, is it not?—It is a large works.

7121. There are smaller ones of the same kind scattered all over the country, I suppose?—Yes.

7122. Do you suppose it would be possible that small manufacturers could enforce this compulsory system of education?—Some of the small manufacturers have not got schools.

7123. But could they enforce it if they had schools?—I think so.

7124. Do you think the workpeople would stand it?—I have heard Mr. Palmer, the large shipbuilder of Jarrow, state that he believed it would be impossible to carry it out among his workpeople.

7125. The small manufacturers would not have the same power over their hands as the large ones?—Perhaps not.

7126. And it is hardly probable that they could enforce such a rule?—No.

7127. *Chairman*] Is there anything you wish to add to your evidence?—No.

Mr. WILLIAM COCHRANE, called in, and Examined

7128. *Chairman.*] I BELIEVE you are a partner in the Collieries and Iron Works of Messrs. Cochrane & Company, in the North of England, and in Staffordshire?—I am.

7129. You and your brothers have succeeded to your late father, who, I believe, was in partnership with two late Members of this House, have you not?—Yes; and one of my late father's

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partners was a Member of the House of Commons.

7130. You, yourself, were educated at King's College, London, were you not?—I was.

7131. You come here as the representative of the Northern Institute of Mining Engineers?—I do.

7132. And you would wish, more especially,

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to call attention to the requirements of the foremen and managers of collieries, with regard to scientific education?—That is my wish.

7133. Are there any peculiar circumstances attending the position of collieries which would render the treatment they should receive, in this respect, different from that which might answer in large towns?—Yes; the isolation of the collieries, being at considerable distances from any great centre, and being confined, as it were, to special localities; large collieries may be two or three miles apart from each other. A colliery employing 2,000 or 3,000 workmen and their families included, may be at such a distance from another, and each of them at such a distance from large towns, as, for example, Newcastle, that it would be quite impossible for the men who want this education to travel from their work into those towns to get it. If scientific and technical education is to be given them, it must be taken to their very doors. They are employed from morning to night, and could not go into the large towns to seek that education; and therefore where a central system might be adopted in the towns, for collieries it needs to be furnished by means of travelling teachers.

7134. When you speak of persons employed in collieries wanting this education, do you state that as a fact or as a hypothesis?—I think it is the fact that the foremen, over-men, assistants, joiners, and smiths, and especially engine-wrights, are really anxious to improve themselves in the scientific part of the work which they have to do, and they have no means whatever of doing so.

7135. Do you think that those men are sufficiently prepared, with regard to primary education, to avail themselves of scientific education?—No, but their children and the young men are.

7136. The rising generation?—Yes; these are getting a better primary education at the collieries themselves, but it is entirely the result of individual effort, and to a great extent of individual capital, which are now doing very much indeed in the north country for the education of the children of workpeople.

7137. The owners of the collieries are doing this, you mean?—Yes.

7138. Is that generally the case also in the midland counties?—I think not so generally in the midland counties.

7139. And the owners of ironworks in North and South Staffordshire?—Yes, they are doing a great deal.

7140. Both in Staffordshire and in the north country?—I ought to qualify that by saying that there are not many large collieries in Staffordshire; they are mostly of small extent: but there are large collieries in the midland counties which, of course, are exceptional.

7141. The general tendency of the introduction of capital into the mining and manufacturing districts is to promote education?—I believe so. In the north of England, where there are large collieries, there are large means being applied for the education of the children of the workmen.

7142. But that education does not extend to scientific subjects, does it?—No, it is entirely elementary.

7143. In the elementary schools no scientific instruction whatever is given, is it?—No.

7144. At what time do the boys and girls ordinarily go to work in the colliery districts of the north?—Girls are not employed, but boys

go at 10 years of age, if they can read and write, subject to certain regulations. Boys may go to work at 12, whether they can read and write or not, and without a certificate.

7145. The girls are employed in some other way, I suppose?—I think not; there is no work whatever for them, and they are not often near the towns; generally you will find that the girls at the large collieries have no employment.

7146. Do they generally continue at school up to 13 or 14 years of age?—Yes, at the colliery schools; but they are married very early, and some of them go out as domestic servants.

7147. But there is no employment for the young girls?—No.

7148. And they avail themselves of the opportunities of school instruction by remaining at school longer than the boys?—As a rule, that is so.

7149. On the whole, you would say that primary education in the collieries districts of the north of England was tolerably advanced and efficient?—Yes.

7150. And the population better educated than in the midland counties?—Decidedly. I refer chiefly to South Staffordshire.

7151. In order to continue that education after the young people have gone to work, are there any night schools?—Yes.

7152. Are they well attended?—At the collieries, no; but at the iron-works the evening classes are well attended.

7153. And you now propose that for the purpose of giving scientific instruction, teachers should visit the various pit villages in rotation?—Yes.

7154. Are you aware that there is an organisation of that kind among the Cornish mines?—I had not heard of it till this morning.

7155. That organisation has been described to you?—Yes.

7156. And do you believe it is an organisation which might be adopted with success in your own pit district in the north of England?—Yes speaking roughly, and judging of it as it has been described to me, I think it might be adopted in our own district; but it would have to be extended, because there would be more subject requiring to be included in the course of instruction.

7157. What subjects would you include in a science school for a pit village in the north of England?—Every subject which would appertain to mechanical engineering, building, and construction, and every branch of science which would be necessary for the ventilation and drainage of the mines.

7158. Chemistry and physics?—Yes, mathematics, of course, mechanical drawing and the elements of geometry.

7159. As you were not aware of the existence of an organisation of that kind in Cornwall, it is probable that the other large colliery proprietors in the district were equally ignorant of it?—Quite probable.

7160. You now know that organisation in Cornwall to be supported by the subscriptions of the mine-owners, aided by the grants from the Science and Art Department of South Kensington?—I should think that they are mostly ignorant of it as they were ignorant of the means already offered by the Government generally for scientific education; till within the last two months I believe the subject has been very little known indeed in the north of England, and perhaps that is our great

great reason why in Newcastle, of all other towns (for it is almost the only large manufacturing town which has neglected the means offered by the Government), it has not hitherto been adopted more largely.

7161 Then assuming that the requisite staff could be provided, for say 500*l* or 600*l* a year, for giving science instruction in the pit villages, the miners themselves and the over-men contributing something, and the Government paying on results, do you think the mine-owners would be prepared to raise 200*l* or 300*l* per annum, by way of subscription?—If it came to a small amount like that, I dare say they might, but I know that there is a very great objection on the part of the coal proprietors to subscribe anything whatever to the education of their men; they consider that the men are earning good wages, and that if a man wants education for his children he is sure to find it; they think that he ought to find it for himself, and that it is not worth much to him unless he does go in earnestly to find that education. I think you would find a very serious objection to subscribing. I do not think that what is requisite could be done for anything like so small a sum as you mention.

7162 Do you think that the mine-owners would provide 800*l* out of the 600*l*?—I think you would find it very difficult indeed to get that sum.

7163 And yet the mine-owners have built schools and are contributing liberally to the support of such schools, are they not?—No, I do not think they contribute much; in many cases they contribute very little, in the cases I have in view the schools are self-supporting, the rooms were found by them, and they have the election of the teachers in their own hands, but the workmen entirely support the teachers, the proprietors of the collieries only finding rent, coals, and firing.

7164 Then if the mine-owners would not be willing to contribute, how would you propose that the staff of these schools should be met?—I think if the grants for teachers were a little more encouraging, so as to enable us to get a proper class of teachers into the district, the Government grants would enable the schools to be carried on. The difficulty is that the teachers are not now sufficiently remunerated, but I think that the schools could be made self-supporting, like the Bristol school, which is very much what we want in the north of England at the present time, the great difficulty, however, is to get the necessary organisation in the north country; for starting a school like that, it would require a committee, of a certain number of gentlemen, and there is much difficulty in working it out. If it could be managed, in connection with South Kensington, that some competent person should go down into the district and organise the schools, and put the matter in train, it would be a very good thing. I think that the machinery provided by the Government, of which the north country has been entirely ignorant, if it were made a little more encouraging to teachers, would enable the scheme to be carried out.

7165 You would scarcely call the schools self-supporting if they received aid from the State, would you?—By self-supporting, I mean without further aid from the proprietors. Those schools that I have spoken of receive grants from the Science and Art Departments on results.

7166 The schools would receive aid from the State, then, and the payments from the pupils, 0.72

but they would receive no assistance from the colliery proprietors?—They would receive assistance in this way: the proprietors have found the rooms for the elementary schools, and they would do the same thing for the science schools.

7167 You think the mine-owners would be prepared to find laboratories, for example, if the Government would contribute rather more liberally?—They would find all accommodation, I think.

7168 The only thing they would object to would be payments in aid of the annual cost of the schools?—Yes.

7169 The first cost, you think, they would gladly undertake?—Yes, in all cases they do that willingly, and they afford every facility whatever for developing the efficiency of the schools; but they do object to letting the workmen feel that he is dependent on them for the cost of the education of his children.

7170 But still if the amount required for supplementing the aid received from the State were not very large, you think it is probable that it might be raised by subscription among the coal owners?—Yes, if it were in respect of one main centre to work the district. If a competent person into, say, the two centres of Newcastle and Middlesbrough to work the two districts, or one in each district, I believe there would be no difficulty in subscribing the necessary amount; for an experiment at least.

7171 In that case the present Government grant would be sufficient to enable the schools to be started, would it not?—I am afraid you could not get competent teachers with the encouragement which is offered.

7172 But if the remuneration from the State were supplemented by a small payment out of a subscribed fund, you would be able to do it, would you not?—Yes, but if you are speaking of teachers and lecturers as well as the person who would be appointed as a centre to work the district, you must increase the encouragement to the teachers and lecturers, as well as have an organiser.

7173 The organisation of a central committee would hardly involve any expense?—On the contrary, I think that is the great expense; it requires a good man, well paid, to go and work the district, it cannot be worked by a committee, that is a large district and really involves two counties.

7174 You meant that, in fact, there should be a paid superintendent of the teaching staff?—Yes; in whose hands the apportionment to various districts of particular teachers, and the regulation of the schools should be placed.

7175 Knowing now that an organisation of that kind exists in Cornwall, would you yourself be willing to discuss the question with your neighbours, and try to bring about a similar organisation in the north of England?—Yes; I should think that there would be every success in doing a similar thing in the north of England.

7176 You have spoken hitherto of the education of workmen, and more especially of foremen in the collieries, but I suppose you would apply the same remarks to the iron works?—Yes, except this; that with the workmen in the collieries night classes will be almost indispensable for science classes. I do not see how you could get any day classes, for comparatively few are employed in the night shifts, as they are in the iron works; the main work in the colliery districts

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is done from 5 a. m. to 5 p. m., and night classes alone would be necessary; but if day classes were held in the towns, it seems to me that the same teachers could go out in the evening and make a circuit of the collieries and villages if all were properly arranged beforehand.

7177 The iron works are situated in the towns chiefly?—Yes, with few exceptions, in and near towns, the main centres are Darlington, and Middlesborough, and Newcastle.

7178 Generally iron works are clustered in large towns?—Yes.

7179. And the same central organisation which would serve the collieries would also serve the towns?—Yes, one in the daytime and the other in the evening.

7180. I presume you are well acquainted with the iron manufactories?—Yes.

7181. You have heard it stated that the competition of the foreign manufacturers is beginning to be very seriously to be felt in this country?—Yes.

7182. What degree of importance do you attach to such statements?—I think it is quite true, and it arises, in my opinion, solely from the difference of wages, and I have a case in point which brings that out very strikingly. Wanting a large pumping engine a short time ago, I had prices sent me from various manufacturers, but I was enabled to go abroad and get the pumping engine, and have it fixed in my colliery in the north of England at about 30 per cent. below the price at which I could then have got it in England. We could not have done it at the price at our own works; and when I compared the circumstances, I found the difference arose solely upon the question of wages.

7183 Have you any objection to state where that engine was got from?—At Anzin, in the north of France.

7184 And that engine was erected at what colliery?—At the new Brancepeth Collieries in Durham, I also got a winding engine from the same place.

7185. And both those engines are made to your own plans?—Yes.

7186 And those engines have been at work for some time?—Yes, all of them.

7187. And you are perfectly satisfied with the execution of the work?—Yes.

7188 Comparing it with the workmanship of the north of England, would you say it was equal?—Quite equal, they generally put a better finish on their engines, they bestow more care on finish than we do in the north of England, unless we are specially asked to do it.

7189. You visited the Paris Exhibition of 1867, I believe?—Yes.

7190 Did you inspect the works of the different foreign engineers there?—Yes, and among others the engines of Quillacq; who manufactured the engines alluded to.

7191. Where is his manufactory?—At Anzin.

7192 Generally speaking, would you say that the workmanship of the engines exhibited by the French or German exhibitors was good?—I think they are proportioned light, but the workmanship is quite as good as ours.

7193 Do you see any reason to believe that they are surpassing us in design?—No, I do not.

7194 Are you acquainted with engineering tools?—Yes.

7195. Would you say with regard to engineer-

ing tools, of any continental nation, that they are superior to us?—I think not.

7196. Would you say rather the contrary?—I should say the contrary.

7197. Now with regard to the superior scientific education of your district, have you any remark to make to the Committee?—That is to say, the education of ourselves. I think there is a great lack of means for obtaining that, we are forced to come out of the district for it. Take the Jermyn-street Institution; it seems to me that it offers great facilities in a very small compass; and if Jermyn-street could be repeated, or transferred to Newcastle, and in that way put into a place where practice could be added to theoretical instruction, it would be of very great advantage. I think it is quite in the wrong place here, where it is in London; it is very good indeed for certain objects, but if a similar amount of money were spent upon a similar organisation in Durham or Northumberland, the benefit to those counties and the country would be infinitely greater.

7198. But what would Staffordshire say to that?—I do not consider Staffordshire a school for mining engineers, but a branch would also be a benefit there.

7199. In fact, you think that an institution like Jermyn-street is out of place in London, but would be very much in place in South or North Staffordshire, or in the north of England, or in both?—Yes; if there were also one in South Wales, and one in each of the coal and iron districts, it would be a good thing, but we have now nothing of the kind, and no means of getting it, and I think the course of education pursued at Jermyn-street would be considerably improved by its being brought within the proper districts.

7200 The instruction would be more valuable besides becoming more accessible?—Yes.

7201. But would you propose that, in addition to the Jermyn-street Institution which now exists and which can scarcely be displaced, the Government should provide schools of the same description in the provinces?—If the Government provides Jermyn-street School, we do not see why it should not do that, it is rather an anomaly that it should provide a school of mines and fix it in London.

7202. You mean that each is an anomaly?—No, I am not prepared to say so.

7203 But one anomaly existing, you would like to see it multiplied for the benefit of those districts?—Yes.

7204. But suppose the State were not willing to do that, but were willing to contribute to the erection of science schools of a high class, do you think the north of England or Staffordshire, or both, would be disposed to make pecuniary sacrifices for the establishment of such schools?—I think the north of England would not, and for this reason, that we have a university at Durham, largely endowed, and the education given in that college, which is directed towards the interests of the mining and the industrial classes is almost nil, what the failure has arisen from I scarcely know.

7205. The University of Durham is not the lessor of coal mines, is it?—No; the dean and chapter hold the minerals. The failure, I believe, has lain in the difficulty of amalgamating anything like an engineering management with the present management; and it is considered necessary for the success of such a scheme that

that the engineering interest should be amalgamated with the ecclesiastical interest.

7206. In the event of any arrangement with the University of Durham being possible, would you propose that scientific instruction should be given in the University at Durham, or that a school in connection with the University at Durham should be established at Newcastle, just as the medical school in connection with the University is at Newcastle?—I should think either plan would work well, but that the Newcastle plan would work best. Durham is very conveniently situated for the whole of the coal-field, however.

7207. Durham would, I suppose, be more convenient for Darlington, Stockton, and Middlesborough, and the whole of that district?—Not much so, the position with respect to distance is nearly the same in both cases.

7208. Mr. *Potter*] With regard to the engines which you imported into this country, I think you stated that you found that the sole difference was in the cost of the labour?—Yes.

7209. It was not owing to any want of scientific knowledge in this country?—Not at all.

7210. You spoke of the foremen as coming from the ranks of the workmen, I think, and you have a large establishment of your own?—Yes.

7211. Have you any difficulty in finding foremen; have you good foremen in your works?—Yes, we have good foremen, but I should not like to say that there is no difficulty in finding them, for I think there is.

7212. It is a question of cost, is it not?—No, by no means.

7213. Have you ever been deficient of persons of that kind in your establishment?—Yes, in the collieries we have a deficiency. In the iron works I do not think we have.

7214. *Chairman*] In engineering establishments is it not the case that many of the foremen are extremely inefficient?—Not generally.

7215. Mr. *Potter*] Does that apply to large establishments; take, for instance, that of Sir William Armstrong?—I should say not.

7216. And take Messrs. Sharp, Stewart & Company at Manchester, does it apply to them?—No; I should say not.

7217. Taking large implement manufacturers, should you say that they were, any of them, deficient in good foremen?—I must refer you to the *Chairman* of this Committee for information on that point.

7218. You would say that a difficulty existed among the smaller manufacturers in obtaining good foremen?—Even what are called good foremen are capable of such gross mistakes, from what I might almost call their ignorance of primary education, that it is really pitiable to see a man in the position he holds and yet capable of such mistakes, mistakes which arise from utter ignorance of the mere elements of science.

7219. But would not the expenditure of a few hundreds a-year by the large employers of labour rectify that in their own establishments?—No, but in the rising generation I believe it will be different.

7220. But is there not a great improvement in this respect during the last few years, both in masters and in foremen?—Undoubtedly.

7221. Do you think the Government ought to be asked to help those large establishments?—Not specially.

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7222. Mr. *Akroyd*] You have no difficulty in getting foremen, but I understand you to say that your difficulty is in getting foremen with the requisite amount of scientific knowledge?—Yes.

7223. Admitting that employers were quite ready to do it, have they the means within their reach of giving those young men that which is necessary in the way of scientific instruction?—The means are not within their reach, and that is the difficulty.

7224. So that, though an employer may be perfectly ready to contribute his quota to what is required, he cannot do it without some aid?—He cannot do it without some aid; that is to say, that you should not throw the education of a set of workmen entirely on the employer. There is some benefit to the country from the education of the men, and to that extent I think the Government ought to afford the means.

7225. But is there not a great advantage derived from a department like the Science and Art Department, in raising the standard of scientific education throughout the whole of the country, when one district is compared with another?—I think so.

7226. Without such a central authority, you might have, in certain localities, much greater advances made in scientific teaching than in other localities, and yet there would be no general standard of comparison?—Yes, that would be so.

7227. That is to say, the level of scientific education in the north might be very different from the level of scientific education in Staffordshire and in Cornwall, and yet there would be no standard to which the two levels could be referred?—Yes.

7228. There are many advantages in having, under Government, one general standard of this kind which may supervise the state of science education throughout the country?—Yes.

7229. Moreover, you derive many advantages from the Government examination being impartial and not governed by local interests?—Yes, just so.

7230. I understood you to say that you would prefer to develop the existing system of education rather than to introduce something totally different?—Yes. I am quite opposed to compulsion myself, it is only an idea, but it seems to me you could get children educated without State compulsion. Mr. Clapham stated that when he made his education compulsory in the way he described, his schools were filled, and I think you would very soon fill the schools if you had a minimum age at which the children should not be allowed to go to any works whatever at which wages were earned, unless they could read and write.

7231. Are you in favour of the extension of the Factory Act, and its application to your locality?—There are two sides to that question. If you keep the boys out of the mines much longer than you are now doing they will not go in at all, because much training and practice in the mines are required, and, also, it is difficult to get any one not accustomed to the work to begin it. If we exclude them from employment up to that age it might be very difficult indeed to find boys enough for employment in the collieries.

7232. *Chairman*] You are acquainted with the laws with regard to the employment of young persons in mines in Prussia?—Roughly, I am

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7233. Are

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7233 Are you aware that no boy is allowed to work underground until he is 16 years of age?— I was not aware of the precise age.

7234. Are you aware that notwithstanding that prohibition, the coal owners of Westphalia are competing with the coal owners of the Tyne and the Wear in the German and Dutch ports?—They are competing, in fact, in all the foreign markets

7235 Would not that rather diminish your fear?—Yes, it is only a fear that I have ventured to express. I do not assert that what I have hinted at would be the practical result.

7236 Mr Akroyd] But do you not think that if a preliminary examination were made a condition of working full time, employers would take good care to have that supplied beforehand by providing a previous education?—I think the employers do not care much about it, and the practical effect is that they will not take the trouble to enquire whether a boy is getting education or not, but they increase the minimum age at which they will take the boys.

7237 But suppose that after 13 years of age the employers could not employ a boy on full time without the examination of which I speak, then in that case would not the employers find it their interest to take care that the boys had received some education?—I do not think the employers would trouble themselves about it; the parents would see to that, the parents are anxious to have the earnings of the children for the purpose of helping to keep the house, and it is the parents who would look after the children's education

7238 But supposing there were found a difficulty in getting a supply of boys of 13 years old, and the only mode of escaping from that difficulty were to assist in finding the means of education, then it being the joint interest of the parents and the employers to find the education, do you not think the employers would be quite ready to do their part of the work?—I should say so

7239 Do you give any lessons in political or social economy in connection with your school?—I should say that no such subjects have been introduced into the north country at all among the artisan class

7240 Do you not think that strikes in many cases arise from total ignorance of the first principles of political and social economy, and those laws which govern the rate of wages?—Undoubtedly that is the ultimate reason.

7241. A little instruction on such matters would, perhaps, prevent much misunderstanding between employers and employed?—Yes I think political and social economy should be embodied in any course of instruction which is offered to the people

7242 Do you think there would be any jealousy or dislike on the part of the workpeople in respect to receiving such instruction?—I think not at all.

7243 Your existing schools would, I suppose, afford pretty nearly all the accommodation you would want for evening science classes?—Yes, except where models or laboratories were required.

7244 So that, in fact, a very little additional expense to that already incurred by large employers in many cases would afford all the means of scientific education which are imperatively necessary?—Yes.

7245 Mr. Dixon] I think you stated that you

did object to the Government being called upon to help the larger manufacturers in the education of the children in their employment?—Yes, specially.

7246. And afterwards you said that you thought the advantage of such education was not derived solely by the larger manufacturers, but also in part by the country at large?—Yes.

7247. Do you think then that it would be just to throw the whole cost of that education exclusively on the large manufacturers, seeing that they do not derive the whole of the benefit?—What I wish to express is, that the Government should not be called upon to interfere more than they have already done, except with regard to the improvement of the grants and the encouragement given to the teachers. I did not intend to say that the Government ought not to aid at all. I do not want the Government to withdraw what they have already done, which would have been implied if I had said that I did not wish the Government to interfere at all.

7248. Chairman.] When you speak of capitalists being able to dispense entirely with State aid, you speak of large capitalists only?—Yes

7249. Mr. Dixon] I think you stated that those engines which you purchased abroad were 30 per cent. cheaper than you could have got them in England, and that the difference was exclusively owing to the cheapness of labour abroad?—Yes; some of the iron was absolutely bought in the Tees to take over to the manufacturers abroad.

7250. Did you inquire very fully into the particulars of that fact?—Yes.

7251. Did you ascertain what the difference was between the nominal rate of wages, that is to say, the rate of wages given to the workmen per day?—Yes

7252. What difference did you find in the nominal rate of wages?—The difference between five francs, equal to 4 s. and 7 s 6 d.

7253. So that the nominal rate of wages was actually nearly double in England?—Yes; for the same class of work we should have paid 7 s. 6 d. in our own workshops.

7254 For the same number of hours of work?—They work longer hours than we do. We work from half-past six to half-past five, and they work from six to six

7255 So that our rate of wages would be fully double in England to the rate of wages abroad for that class of work?—Yes, at that time.

7256 Chairman] Are you speaking of mechanics, or of labourers?—I am speaking of artisans, fitters.

7257. With regard to the men attending on a mechanical tool, I suppose there would be a somewhat similar difference?—Yes; but it would not be quite double in that class.

7258. Mr. Dixon] So that whereas the nominal rate of wages at Anzin is about half what it is in England, the result of that labour in the shape of the engines you purchased, is about one-third less?—Yes.

7259 How would you account for that difference, would it be in the labour not being so efficient?—The labour is quite as efficient.

7260 You think the labour per hour of the artisans at Anzin, would be worth as much as the labour of Englishmen?—It would produce towards its finishing as much upon the machine as the labour of an Englishman.

7261. And

7261 And these answers you are giving from your own personal knowledge?—Yes.

7262 Mr *Bazley*] If I rightly understand you, it is your opinion that the employers of labour should not be the national schoolmasters?—Certainly not

7263. You have asserted that you think the boys presenting themselves for labour, ought to be qualified to read and write before they are employed?—Yes, for every kind of labour, agricultural and otherwise.

7264 In what manner would you suggest that primary education should be given to boys so as to secure that result?—I would have the parent pay for it, and where the parent could not pay for it, I would have some special parish arrangement by which a person unable to pay could appeal to the parish for aid

7265. You would have some local rating system, I suppose?—Yes. In extraordinary cases, such as those of widows and orphans, a general rate upon the locality might be taken; but otherwise, where it could be shown that a man was earning fair wages, I would make him pay for the education of his children. The mere fact that 2*d.* or 1*d.* a-week can do so much is conclusive that such a system could be adopted without inflicting any kind of hardship.

7266 Would you enforce any such system by law?—I would enforce by law a minimum age at which children should not go to work, unless they could read and write. I would stipulate for nothing else, I would let the parent exercise his discretion as to whether he sent his child to school, or whether he would be content with him not working till he was 13 years of age

7267 Is it not possible that by such a system you would still leave a very large number of ignorant children in the country?—On the contrary, I think that parents would be very quick to educate their children by the minimum age.

7268. Are you not aware that there are an immense number of parents getting high wages who still neglect the education of their children?—I was not aware of that.

7269 Are you not aware that there are a million of children in this country who are neither at work nor under instruction?—No, I was not aware of that among such as earn high wages

7270. *Chairman*] You speak more especially with regard to the experience which you yourself have gained in the north of England?—Yes, my experience is not of agricultural districts

7271. You would speak, under correction, upon the general question, if it could be shown that in large towns in other parts of England there was great educational destitution?—Yes

7272. Lord *Frederick Cavendish*] I understand you to say that you think no child should be allowed to work under a certain age unless he had received a certain amount of education; what test would you apply?—I would have a Government examination test confined to reading, writing, and arithmetic; for I think a child would then have sufficient power to supplement the defects of his education, and would seek them out for himself.

7273 But you think that no child should be allowed to go to work under a certain age unless he had passed a Government examination?—Decidedly

7274. Would it not be rather hard to enforce that by law unless you also provided schools?—I would practically compel every parish to have its

school; I would not legally enact that, but I think that the pressure you would bring to bear upon parents in every district would be such that the children must be educated. I was not prepared to hear what the Honourable Member for Manchester said just now, but still my experience is such, that I should think the pressure put upon the parents would force them to provide education for their children

7275 But you would not say that the parents could be expected to pay the cost of erecting a building for a school?—No, then the Government aid comes in. I think those are the emergencies in which the State can be asked to interfere, and if the Government can do a little more in that direction, so much the better.

7276. I understood you to say that as the Government provides education at Jermyn-street, you would recommend it to do a similar thing for the large centres of industry?—I referred particularly to mining centres of industry

7277 Suppose Parliament were not prepared to recommend that the Government should pay the whole cost of such instructions, do you consider that the great centres of mining industry would be prepared to tax themselves to find a certain portion of the cost?—Do you mean for the working expenses or the erection of the buildings?

7278 For both?—I think they would, and then the fees from the students would be proportionately high, and the college, wherever it might be, would be self-supporting if such education as is given in Jermyn-street were taken to the mining centres.

7279 But would you propose that the Government should give large grants for the education of those who would pay high fees?—I do not think that our class wants Government aid at all, but Government has already provided the institution at Jermyn-street.

7280 Then for what class do you wish such an institution to be established?—For the purpose of bringing up mining and other engineers.

7281 And you say they would be able to pay high fees?—Yes, fees such as are paid at King's College, and I presume King's College is nearly self-supporting

7282 *Chairman*] The fees at King's College, I believe, are about 40*l.* a-year, do you think that small manufacturers and managers could afford to pay that sum for the education of their children?—Yes, I should think they were paying more than that now, and yet not getting the kind of education they want

7283 And that 40*l.* a-year would be for the education simply, without the board?—Yes

7284 Lord *Frederick Cavendish*] Do you think the Government could be called upon to give large grants in aid of education solely for that class of men who could pay 40*l.* a-year for it?—I think the Government is spending a large sum of money in Jermyn-street for the attainment of a certain object which is not being attained, namely, the instruction of young men in mining and engineering. I think that object would be attained by placing such institutions at centres of mining industry where what is now taught theoretically in London could be applied practically.

7285 But if this class of persons could pay 40*l.* a-year, could they not send up their sons to London where they would have this education

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almost at nominal fees?—It must be remembered that living in London is very expensive indeed.

7286. Would it be more than 40 l a-year?—Yes, considerably

7287. But are there not advantages in having such an institution in London, from, for example the greater facilities in obtaining first rate professors at low salaries?—There are advantages, but in London you get all theory and no practice

7288. Still, if you found it necessary in your college to have men like Dr. Percy, would it not be requisite to pay very large salaries?—I believe there are local men to be got who are quite competent to give the instruction required

7289. Men of the same high standard?—Not in the same position as men like Dr Percy, but quite capable of communicating the instruction required, both theoretically and practically.

7290. *Chairman.*] Would it not also be the case that the establishment of such schools in the various centres of mining and metallurgical industry would tend to improve the tone of general scientific education, and have considerable influence on the instruction which the lower grades, such as foremen and workmen, might receive?—Yes

7291. Those professors would assist in training

teachers in the district, and they would also teach themselves, giving perhaps lectures, and in other ways promoting the scientific education of working men and foremen?—Yes.

7292. Would you think it desirable, that where ever the Government granted any aid, either by way of endowment or otherwise, the professors receiving such aid should undertake to teach classes or deliver lectures to working men, and those immediately above the working class?—Yes.

In order to economise the amount of material which you would have to bring together in the shape of talent, I think it would be absolutely necessary, because the night classes would have to be worked in that way.

7293. You think it might fairly be required of the professors, and that the professors probably would not object to accept a salary or grant-in-aid with such a condition attached?—I should think not.

7294. *Mr. Ahroyd.*] In regard to education institutions in large towns, to which reference has been made, do I understand you to say that you would require parents in receipt of wages to contribute to the education of their children, and would throw on the rates the education of those children only whose parents were unable to pay for their education?—Yes, that is all.

Mr. JOHN DAGLISH, called in; and Examined.

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J. Daglish.

7295. *Chairman.*] You are the Mining Engineer to Earl Vane's Collieries, I believe?—I am.

7296. And Manager of the Londonderry Estates and Railways and Seaham Harbour?—Yes.

7297. And you are a Member of the Institute of Civil Engineers, and a Fellow of the Geological Society?—Yes.

7298. You are a Member of the Council of the Institute of Mining Engineers?—I am.

7299. You have taken considerable interest in the management of mechanics' institutes, in the north of England, have you not?—A few years ago I was one of the council of the Union of the North of England.

7300. You must have a very large number of foremen and clerks, under your care, on the Londonderry collieries and estates?—Yes, there are above 100

7301. What is the approximate number of workmen employed in the works belonging to Earl Vane?—Nearly 4,000.

7302. Has Lord Vane provided any schools for them?—Yes, there are six or seven connected with the works in the different villages and centres.

7303. Are those schools well attended?—Yes, they are very well attended, the average attendance is about 150 in each school.

7304. Making a total of 900 or 1,000?—Yes, upwards of 1,000 children

7305. Do the workpeople pay for the education of their children?—Yes, they pay 3d. a-week, I think, 2d and 3d

7306. That is to say, upon each child, or does each man pay 2d., no matter how many children he has?—There is no system of each workmen paying, but each child pays 2d.; that is to say, one child pays 2d., and more than one pay 3d.; they do not go beyond that.

7307. That is to say, a man could educate

any number of his children for 3d. a week?—Yes.

7308. Or a single child for 2d.?—That is so; several of the schools are now in connection with Government, and others are not, some of the masters are very efficient, and we could not get Government aid, except by sacrificing them and employing certificated teachers.

7309. They were unwilling to apply for Government aid?—They were not able, there are certain requirements from the Government, some of them were unable to pass through the examination and receive the usual grants, altogether it cost Earl Vane about 500 l per year.

7310. Is attendance made compulsory?—No, not at all, not beyond the requirements of the law

7311. You mean the law with reference to coal mines?—Yes, that is what I mean.

7312. But is there any hesitation on the part of the working population to avail themselves of the schools which are provided?—Yes, the attendance is nothing like what it would be if all the children attended, but there are many reasons for it, 3d. a-week is not a large amount, but the father may be unwell, or other members of the family may be ill, and they do not pay the school for a week or two; then it becomes a large amount to pay up. In one of the schools under my charge, some years ago, a system was in operation of each workman paying a certain amount, and it answered admirably with regard to attendances; the attendances were increased double, because, whether the children went or not they had to pay

7313. Was that upon one of Earl Vane's collieries?—The colliery is now the property of Earl Vane, it was not then; but there is a feeling of dissatisfaction often arising on the part of workmen under that system, and in several places where it has been in operation it had to be abandoned. It was so in this case; the workmen

men said it was not fair for those who had no children to pay.

7314 Was there any allegation that the owners were making a profit out of the school?—No, I think not.

7315. It was simply looked upon as unfair as between the workmen themselves?—Yes, I did not press it, because I thought it was a question which I had no right to press, although I much regretted to have to abandon it.

7316. Was there a falling off in the attendance in consequence of that system being abandoned?—Yes, there was a falling off of fully a third of the attendances.

7317 I believe Lord Vane sent a number of his foremen to the Paris Exhibition at his own expense?—He did; about 10 of them.

7318. Was any report made by any of them on their return?—Yes, the condition was that each should make a report.

7319 Did the reports bring out any striking facts?—I think not, they were not highly educated men that wrote them, and they were crude, but very satisfactory, they gave sketches of what they saw, and wrote descriptions of the different machinery. It is a difficult thing for anyone not accustomed to write reports to write one of very great value.

7320. Did you visit, yourself, the Paris Exhibition?—No.

7321 Have you any knowledge of the position of mechanical engineering on the continent?—Not sufficiently to give any evidence on the point.

7322 You attend here as the representative of the coal trade of the north of England, do you not?—I do.

7323. Will you state what the feeling of the trade is with regard to the extension of scientific education among that class of the community?—The general feeling of the trade is, that it is not only desirable but of very great importance that scientific technical education should be extended.

7324. And beyond that, are you prepared to make any statement on behalf of the association?—No, not at all.

7325 In your own name, will you state whether you believe that the spread of scientific education among the mining population would have a tendency to increase economy and safety in working collieries?—No doubt it would. The foremen in the mines of the north of England are very intelligent, steady, sober men, a very fine class of men, but they are greatly deficient, as they must necessarily be, in scientific knowledge, they have had no means of acquiring it at all. There are some very sensible remarks which I noticed in Dr Frankland's letter, which are extremely applicable, referring to the difficulty of any man who has no scientific training, being able to work out any invention or improvement beyond the mere scope of his own experience.

7326. But, in the first instance, have those men sufficient primary education to avail themselves of scientific instruction?—Yes, certainly.

7327. The foremen can generally read and write, and keep accounts?—Thoroughly well.

7328. Are they generally chosen from the working population?—Yes; they are selected.

7329. They are selected because they are more intelligent men, and also better scholars?—No doubt that is so.

7330 Then if scientific instruction were offered, those men would be able to avail them-

selves of it by their previous elementary education?—They would at once, they themselves feel the necessity of it, and they would be very anxious to avail themselves of it for the benefit of their children.

7331 Do you think it would be possible in the elementary schools to give any preparatory scientific instruction?—Yes, sufficient to give a slight knowledge, and a slight taste for science.

7332 What would you propose to be taught in the primary schools, in addition to reading, writing, and arithmetic?—I should hardly like to give an opinion on a matter of that kind.

7333 Would you propose mechanics and geometrical drawing?—I am afraid that could not be taught in elementary schools, you might describe on the black board some very elementary things, but nothing beyond that.

7334. You could teach them something of the laws and properties of matter?—In a very crude way, but that might be done, and should be done.

7335 What you would propose would be in the nature of object lessons, given in a scientific spirit?—Quite so.

7336 You are aware, no doubt, that the Government does make payment on the results obtained in science classes under certain conditions?—I am only very recently aware of the fact, I think what is required more than anything is that we ourselves should be taught with regard to what Government is doing, and can do, we have not been aware of those advantages.

7337. In the north country, speaking generally, it was not known that considerable sums are now being spent by Government in aid of scientific education?—Quite so. I am now endeavouring to see if classes for technical education can be established on Lord Vane's works now. I am not prepared to say whether the facilities afforded by the Government are great enough or not, or whether it was that we were not aware of them.

7338 *Prima facie*, you would say that if there were two or three thousand persons in London and the neighbourhood, and as many in Lancashire, taking advantage of Government aid, that the same might be done in the north of England?—I see nothing to prevent its being done; I think it is most feasible.

7339. Some modification of the system, in order to meet the peculiar condition of the pit villages, might be required?—Yes. I think the system of itinerary lectures is indispensable, that is the opinion, as far as it has been discussed, in the north of England; that to get at the working classes in the north of England, you must have lectures in villages, and other populous places, where the workmen can, by a short walk, attend those courses, but any fixed establishment in a town would be utterly unavailable for the working mining population of the county of Durham.

7340 You know Mr Robert Hunt, the Keeper of Mining Records, I presume?—Slightly.

7341. Are you aware that he was concerned in the organisation of such peripatetic classes in Cornwall?—I am not aware of it.

7342. Would you consider it desirable to consult him with regard to the organisation of similar schools in the north of England?—I should be very glad to do so.

7343 You would not hesitate to expect that in a district of coalowners the proprietors and manufacturers would sacrifice some of their time in order to organise a fund for such classes?—I think

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think there is this difficulty, that the managers of mines are so very much engaged that, glad as they would be to do it, they would scarcely find the time. I think those who are the managers of elementary schools are aware of the great amount of time and trouble which is required to manage even an elementary school. If it could be possibly arranged that Government should send some person down to do it, that person would receive assistance in the shape of funds, and in the shape of advice; but I think the responsibility of developing, and organising, and maintaining those schools should rest on some separate responsible person, in the same way as the factory inspection is done, which has just come into operation. The inspector and sub-inspector have gone round to various works, and explained the law; and something of this kind is done, I believe, in connection with the Science and Art Department, though it has been quite unknown to the majority of mine managers.

7344. You are aware that there is an organising officer in connection with the Science and Art Department?—I never had the pleasure of meeting him.

7345. If you were told that the Government were prepared to send that officer into any district in which it was proposed to establish schools, would you yourself be disposed to request your neighbours to ask him to visit North Durham?—Most decidedly.

7346. You would not require a permanently resident inspector of such schools, I suppose?—I almost think that to work the thing efficiently there should be a permanently resident inspector, for the large number of classes that there would be it would require an inspection very similar to the inspection of the elementary schools.

7347. But if one of your masters were a man of superior attainments and considerable energy, do you not think that the whole system of inspection might be entrusted to such a man?—We do not find it so in elementary schools, although the masters have generally a direct pecuniary interest in it, the school managers find that that is not sufficient to keep the school in proper order unless the managers themselves attend to it, and even still an inspector is required.

7348. Then you would have some person to stand in the place of managers of elementary schools?—And to stand also in the place of an inspector of schools.

7349. But an inspector is chiefly for the purpose of examination, is he not?—No, he has to look after the appliances of the school generally and the conduct of the scholars, the reports from the inspectors treat of several things besides the mere results.

7350. It being the case that there is already an inspector of that kind for science schools, would you still consider it desirable that there should be a resident inspector of the different districts?—Perhaps, I hardly know sufficient of the subject to speak decisively, but that is my present opinion.

7351. But for the ordinary routine of such a school, superintending the examinations once a year, for instance, which is nearly all that is required, do you not think that gentlemen could be found who would devote one or two evenings for such a purpose?—Yes; but I still think an inspector would be essential to keep up the efficiency of the classes.

7352. Now with regard to superior scientific

education, you having heard the evidence of the last witness, do you agree generally in what he said with regard to the location of our mining school in Jermyn-street?—In great part I do; but still I think that the scientific education of an engineer should be similar to that given at the medical schools, that it should proceed conjointly with his practical apprenticeship, and in that way I think the science schools, or whatever else they might be termed, should be in such centres of industry that the pupils could at the same time carry on the theory and the practice of their pursuit. I think that to establish mining colleges in Newcastle simply for the students to go and live at Newcastle, would be of little service; I believe students would rather prefer coming to London, where they would have the enormous advantages of professors of very high standing, and good museums and libraries.

7353. Then in what way would you educate the superior officers of your mines whose friends would be probably persons of small means?—I certainly think the Government aid is more fairly due to the working classes than to the middle classes; they are less able to look after their own education, and they know its advantages less, and they are less able to afford it.

7354. You would allow the middle classes to make their own arrangements for their education?—I think that the Government has already done a great deal for them at Jermyn-street and at numerous universities. I should like to see a college established in Newcastle very well, but I cannot say that the college at Durham has been any very great success.

7355. Was that a science college?—It was originally. There are engineering classes. Professor Chevalier is a gentleman of very high attainments, and there is a chemical lecturer; but the results are not such as would lead any one to be sanguine of anything better elsewhere in the provinces, in fact, I do not think the country is the place for an extensive science college. I think the advantages offered in London are very much greater, unless you combine the acquisition of practical knowledge of the profession with that of the scientific knowledge.

7356. But do you think it would be possible to do so?—Certainly, in a town like Newcastle where there are a large number of young engineers.

7357. And for engineering you think a college of this kind would be better placed in Newcastle than in London?—Decidedly, if it were carried out on such a footing.

7358. You do not think Durham is a desirable place for such a college?—No, because there are no large works, and a student could not carry out the two branches of his profession together.

7359. Are you aware that 10 years ago an offer was made by the Duke of Northumberland to contribute 10,000*l.* to the erection of science school in the north of England?—Yes.

7360. Do you know the circumstances under which that offer was made?—No, not sufficiently to give evidence about them, but the thing fell through in consequence of the promoters not being able to carry out the arrangements with the University of Durham.

7361. Do you think that if a contribution from the funds of the University of Durham, or a contribution from the Government could be relied on, the north country would be prepared at this moment to make efforts to establish a

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perior science schools by itself providing the funds?—I think that by voluntary subscriptions it would

7362 Assuming that 20,000*l* were required for erecting suitable buildings, and the Government were prepared to find half the money, do you think the district would be prepared to find the other half?—It would rest more with the residents of the town of Newcastle and the local authorities, I should not like to give an opinion

7363. But if it were a mining school would you think the large coalowners would be prepared to contribute?—I think that students in engineering are much more likely to avail themselves of such a college than mining engineers, in Newcastle there are a number of engineering works, and there are a very large number of pupils in those workshops resident in Newcastle

7364 Do you consider that the instruction required by a mining engineer is of a very different character from that which is required by students in engineering?—No, it is very similar, except with regard perhaps to geology and mineralogy

7365 But you would rely rather upon getting pupils from the engineering profession than from mining engineers?—Yes

7366 Why?—The mining engineers reside some distance from the town, and the difficulty in getting into Newcastle would be great, whereas the engineering students live in the town.

7367. The cost of the building in Newcastle would be rather serious, would it not?—If you come to a building in Newcastle you would get few mining engineers, if they cannot carry on the two branches of their profession simultaneously, they would, as a rule, prefer coming to London. There is a certain number of mining engineers resident sufficiently near to the town, and they would avail themselves of the advantage of the college, though the number would be very limited. A system of itinerant lectures, similar to those I have advocated for the workmen, but of a higher class, might be carried out for the pupils in mine engineering, and might be in connection with a science college in Newcastle. But this would be attended with great cost, and the success of such a scheme would be very doubtful. At present, students in mine engineering frequently spend some years at some mining college, either before or after their apprenticeship at a colliery; and there already exists great facilities for this course

7368 The moment they had to board away from home they would rather come to London than to Newcastle, even if they lived within 15 or 20 miles of Newcastle?—Certainly, I think so

7369. Lord *Frederick Cavendish*] Viewing the question simply as one of pounds, shillings, and pence, do you consider that there would be any very great advantage in the mass of those employed in mines having some scientific education, or that it is desirable to confine the advantages of this instruction to managers and foremen?—The foremen are all selected from the workmen, and unless you have educated workmen of course you could not select educated foremen from the workmen, they would be educated as young men, and then as they grew older they would be selected as foremen.

7370. We have heard from a previous witness, that, having regard to the safety of mines, there would be great use in even ordinary workmen receiving scientific instruction?—Yes

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7371. With regard to foremen and managers, do you consider it necessary to have the whole mass of the workmen educated in order to the necessary selection, or do you think that if they had scientific education at a more advanced age a selection is still possible?—I think that is not a desirable course, the foremen are separate from the managers, and require a different kind of education, foremen should be educated as workmen, and managers should be educated in a higher manner

7372 You would say that the managers should be educated in secondary schools, I suppose?—In collegiate schools I should say

7373 Mr *Bazley*] Did I understand you to say that you employed about 3,600 workpeople?—Yes

7374 And you have nearly 1,000 children at school?—Yes

7375 What proportion of your workmen may be married men?—I cannot say but having gone carefully into these statistics on several occasions, it seems to me that the average proportion to a pit-house is something under five, which gives an average of something like three children to a house, and we have 2,000 houses

7376 How many children would come to the school from each house?—I cannot say, some are too young and some too old

7377 Would it be overstating it to say that two children would come from each house?—It would be less than that, it would be one and a-half, perhaps.

7378. Are the pit-houses all occupied by single tenants, or are they in double occupation?—They are all in single tenancies; those that live in regular pit villages

7379 You are friendly to primary instruction?—Decidedly.

7380 And out of the mass of children that must be educated in elementary schools you think you would be able to elect competent foremen?—Yes, but I think the Government aid should be given rather more generally in the way of grants, and affording facilities for the establishment and maintenance of science schools for the use of the many than in the way of scholarships, and selecting a few to go by means of those scholarships to the higher schools

7381 Have you known any instances, in your experience, where primary instruction having been given to a mass of children, some few have risen above the rest by superior mental effort and perseverance?—We have that in almost every case of our foremen

7382 It is from that class that you select your foremen?—Yes

7383 You think that if they had received primary instruction, they would be capable of rising?—Yes

7384 *Chairman*] Would you wish to give them no further instruction after they became foremen?—I would place advantages in their way, and they can, many of them, avail themselves of such advantages to a very great extent

7385. And you think they would be all the more valuable in consequence?—Very much more so

7386. Mr. *Dixon*] You stated that when you ceased to insist on payment from all your workmen for the support of the schools, the number of children fell off one-third, did you not?—No, that was at a single colliery. When I spoke of 1,000 children,

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children, it was the whole of the collieries together; there are seven collieries.

7387. I suppose that after the system was changed, the cost of educating the children would fall more heavily on the parents of the children?—Yes; on those who continued at school, of course it fell much more heavily.

7388. In that case it was not only those who had no children, but also some of those who had children who discontinued the payment?—Yes, a very large number. When those who took their children away ceased to pay, the subscription for those who remained there had to be raised considerably.

7389. Mr. Akroyd.] If you leavened the whole body of your workpeople with scientific knowledge, do you think that knowledge would be a much better guarantee against accidents than any stringent regulations with regard, for example, to the use of the safety lamp?—I do not think there is any connection between the two things. I think the regulations are absolutely necessary, and that the instruction in science would be an admirable adjunct.

7390. You think that a little knowledge of the rationale of the precautions which are enjoined would secure the more strict observance of the precautions?—Yes, the miners would see the object of them.

7391. Have you any evening classes in connection with your day school?—There are evening classes, but the evening classes are generally organised simply by the teachers themselves, who receive the pence. There are spasmodic efforts every now and then to get up evening classes, and then they dwindle down again.

7392. Very few people attend them?—Very few, it depends more on the efforts of the schoolmaster than anything else, and there is little assistance given in any way by Government to those night schools.

7393. At what age do your children cease to attend the day schools?—It depends on the occupation of the parents, those who can afford it allow them to remain up to 13 or 14 years of age.

7394. What is the average?—Twelve to thirteen.

7395. Do you believe that if you had facilities for the formation of those evening classes, the boys would attend in large numbers?—I think they would attend well.

7396. Does not it seem to you that, in the absence of those evening classes, there is a great

want in your locality of means for continuing the education of those people after 13 years of age?—I think so; that is where we require the assistance of Government, in organising and giving grants.

7397. Are you aware that the Government does give grants for those evening schools?—Yes, in connection with elementary education.

7398. Could you not carry out those evening classes in connection with elementary schools?—There is a good deal of difficulty in doing it in isolated places in the country; the Government does not allow certificated masters to teach beyond a certain number of hours in a day, and then an assistant teacher is required for the night school.

7399. An extra staff is required to carry on both?—Yes.

7400. But still the cost of the extra staff for the night classes would be much less than having a separate school entirely for evening classes?—Yes; you could not have a separate staff entirely for evening classes in those small villages, but with itinerating lectures you could have men of considerable ability, passing from one village to another.

7401. I understand that you would advocate a system of inspection for the science schools, the same as there is now for the day schools?—Rather more so; I would give more power to the inspector.

7402. You would let the inspector have a certain district just as he has now?—Yes.

7403. *Chairman*] Would you consider it desirable that the overmen and managers of mines should be subjected to an examination in science before they were allowed to direct operations of superintend a pit?—I think that is a very difficult question to answer; I cannot say that it is my opinion that it is of vital importance; it would be better no doubt, but many men are very able and good practical foremen who have not any scientific knowledge; I think it would be a very great hardship to say that such men should be compelled to pass examinations, though they would undoubtedly be the better for possessing that knowledge that would enable them to pass the examination.

7404. A man would be a better foreman if he were able to pass an examination, but it does not follow that the men who could pass the best examinations are the best managers?—Decidedly not.

Mr. HENRY WATSON, called in; and Examined.

Mr.
H. Watson.

7405. *Chairman*] I BELIEVE you are an Engineer and Brass Founder at Newcastle?—I am.

7406. You are a Member of the Chamber of Commerce of that town?—I am.

7407. And you have been requested by that body to come and give evidence before this Committee?—Yes, I have.

7408. I believe you are also a member of the committee of the School of Arts?—I am.

7409. We have heard it stated that at one time there was a school of science in Newcastle connected with the Department of Science and Art; had you any connection with that school?—None; I was not cognisant of it.

7410. But if that school had been of any

importance, probably it would have come under your notice?—I think so.

7411. Have you yourself been concerned in any educational movements?—Simply in connection with the School of Art, the Mechanical Institution, and the Literary and Philosophic Society, and among our own workpeople.

7412. In your school of art is mechanic drawing taught?—It is.

7413. Is geometry taught?—Yes, slightly.

7414. By whom is mechanical drawing taught in that school?—It is taught by a man who is a self-taught man himself; he has been a pattern maker in one of the foundries; he was appointed at the commencement of the school and still carries it on.

7415 He is the assistant, I suppose, to the regular art master?—He is.

7416 How many pupils are there in the art school?—About 200

7417 How many of those are artisans?—I should say about half of them.

7418. How many of them would be learning mechanical drawing?—About one quarter of the whole number.

7419. That would be 50?—Yes, from 50 to 60.

5420. You have established schools in connection with your own works, have you not?—Yes

7421. Are they day schools?—No, they are evening schools, so that the workmen and the apprentices can help themselves when they are deficient in education. The schools are carried on by themselves, those men who are up in their particular subjects take them, and they have no extraneous aid; a draftsman takes the drawing class, and those up in mathematics take the mathematical class, and so on.

7422. Do you find many of your workpeople avail themselves of that evening school?—About 100 of them do so; we have a reading-room and library.

7423 How long has that been established?—Not more than a year and a half

7424 I suppose you cannot judge of the permanent success of that school?—Not very well yet

7425. The more educated workmen teach the others who have not received so good an education?—That is so.

7426 You have no scientific classes, have you?—None My object in doing this was to provide a means for the men and apprentices to employ their time better than they are in the habit of doing.

7427. Is there any statement which you wish to make with regard to the present inquiry?—I think not

7428. Did you visit the Paris Exhibition last year?—I did, and also some of the workshops in France

7429 Have you any personal knowledge of the state of instruction among the managers and foremen of the French workshops?—Not to any great extent, but those people that I met appeared to be better educated, particularly the foremen and managers.

7430 Are you speaking of the French only?—Yes

7431. Did you inquire particularly into that subject?—Yes, I spoke to some of them, and have met them occasionally in England.

7432 The men you met in England would be selected men no doubt?—I suppose they would be selected men.

7433. Mr *Ahroyd*.] You have no trained masters in your evening classes, have you?—No

7434 They are merely volunteers?—They are merely volunteers

7435. Do you not apprehend that if you had

perfectly qualified and properly prepared masters they would teach more efficiently?—Yes, we should like that very much

7436 But the expense would deter you, would it not?—Yes, we find great difficulty even with the men themselves, in getting them to pay a small amount.

7437. You are acquainted with the Mechanics' Institute at Newcastle, are you not?—I am

7438 Are there any classes in connection with it?—Yes, they have had classes in connection with it

7439 Are they purely elementary classes, or are there any science classes in connection with it?—There are both, I think, but they have been obliged to desist on account of not being able to get masters

7440 Do they lack masters, or do they lack funds?—They have not been able to find funds to pay the masters.

7441. *Chairman*] Is there anything that you wish to add?—I should be very glad to see the education of the industrial classes carried higher, it would give us a better class of workmen, the employers of labour themselves would be benefited if we had the means at our doors, in such a large manufacturing town as Newcastle, of sending our children to good schools or classes instead of having to send them from home

7442 Do you know the Grammar School at Newcastle?—Yes, I was educated there

7443 Is there any scientific instruction given there?—None

7444 Are you speaking now of the present time, or of the time when you were there?—It is much the same, it is a mere commercial education

7445 Has it a considerable endowment?—It has a very fair endowment

7446 So that there would be no difficulty from the want of funds in giving scientific instruction there?—I think not, I believe the school is in a very good position with regard to funds

7447 Mr *Ahroyd*] If you had an increased grant from the Science and Art Department to the Mechanics' Institute, you would be able to establish evening classes for scientific instruction, would you not?—Yes, the masters complain of the want of payment.

7448 The masters are starved out, in fact?—Yes

7449. You have a building and you have all the arrangements complete for scientific teaching in connection with the Mechanics' Institute, but what you want is a little aid from Government with regard to masters?—We want some aid from Government, something on the same principle as the Schools of Art.

7450 You think that if the Science and Art Department were as liberal as it was to the School of Art, your institution might live?—Yes, but it was not liberal to the School of Art, we can just get along, and that is all.

7451 But with an increased grant you would be able to get on better?—Yes just so.

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Thursday, 2nd July 1868.

MEMBERS PRESENT:

Mr Akroyd.
Mr Bazley
Mr Henry Austin Bruce
Lord Frederick Cavendish.
Mr. Dixon.
Mr. Graves.

Mr. Gregory.
Mr. M'Lagan.
Mr. William Lowther.
Mr. Powell
Mr. Samuelson.

BERNHARD SAMUELSON, Esq., IN THE CHAIR.

DR. STEVENSON MACADAM, called in, and Examined.

Dr. S. 7452 *Chairman*] I BELIEVE you are prepared to give evidence with regard to the Watt Institution and the School of Arts of Edinburgh?
Macadam. —I am
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7453 And also as to other mechanics' institutes in Scotland?—Yes

7454. And you wish also, I believe, to make some representations on behalf of the conference on technical education, which has lately been held at Edinburgh?—I do

7455 Will you kindly state what is your position as a man of science, more especially with regard to those institutions?—I have been a lecturer in chemistry in Edinburgh for the last 13 years. I hold the appointment of Lecturer in Chemistry at the Royal College of Surgeons at Edinburgh, and I grant tickets in chemistry for graduation in the University of Edinburgh, and all the universities in the kingdom. I am also Lecturer on Chemistry in the Watt Institution and School of Arts, and am a Fellow of the Royal Society of Edinburgh, and a Fellow of the Chemical Society of London.

7456 Will you explain what you mean by tickets in chemistry?—In Edinburgh, the class tickets of extra academical lecturers are acknowledged by the University to the extent of one-fourth of the total number of tickets required by any graduate in medicine of the University of Edinburgh. Besides qualifying for the University of Edinburgh, those tickets are also recognised by all the other universities in the kingdom, and by the other medical and public boards.

7457. What is the nature of the Watt Institution?—The Watt Institution is a working man's college, an institution for the education in science of artizans. It was founded in 1821, and has consequently survived 47 sessions, and it is now in a more flourishing condition than it has ever been. The attendants of students at this people's college exceeds that at any other educational establishment in Edinburgh, except the University.

7458. What was the origin of that institution?—The origin of the Watt Institution arose from a conversation between men of scientific acquirements in Edinburgh in 1821, who agreed to issue a preliminary prospectus of this artizan college, the commencement of which ran as follows—"PROSPECTUS. School of Arts, for the Better Education of the Mechanics of Edinburgh.

This association has been formed for the purpose of enabling industrious Tradesmen to become acquainted with such of the principles of Mechanics, Chemistry, and other branches of Science as are of practical application in their several trades, that they may possess a more thorough knowledge of their business, acquire a greater degree of skill in the practice of it, and be led to improvement with a greater security of success." Immediately before the opening of the institution another prospectus was issued, which mentioned further the object of the college. It stated as follows "The great object of this Institution is to supply, at such an expense as a working tradesman can afford, instruction in the various branches of Science which are of practical application to mechanics in their several trades, so that they may the better comprehend the reason for each individual operation that passes through their hands, and have more certain rules to follow than the mere imitation of what they may have seen done by another. It is not intended to teach the trade of the Carpenter, the Mason, the Dyer, or any other particular business, but there is no trade which does not depend, more or less, upon scientific principles, and to teach what these are, and to point out their practical application, will form the business of this establishment. He who unites a thorough knowledge of the principles of his art with that dexterity which practice, and practice only, can give, will be the most complete, and probably the most successful, tradesman." Again, on the evening of the introductory lecture—Tuesday, 16th October, 1821—the secretary, in name of the directors, addressed the artizan pupils, and having made reference to the early history of and discoveries of Watt and Renzie, and showing the advantages of a scientific training, he said. "You must always bear in mind that the School of Arts has been established for the purpose of giving you real and substantial instruction, not to amuse a vacant hour and excite your wonder by exhibiting some curious and showy experiments; that it is intended, in a word, to enable you to carry away information which will be of solid advantage to you in the exercise of your trade."

7459. Who were the principal men who took an active part in the formation of this institution?—The founder of the School of Arts is recognised as the late Mr. Leonard Horner, who acted

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secretary for many years, but he was associated with Dr., afterwards Sir David Brewster, Professor Pullans, Mr. Bryson, and others

7460 Have the objects of the institution been fully carried out from that time to the present?—The objects of the institution have been fully carried out from that time to the present. The classes that were organised at first were in chemistry and natural philosophy; but even during the first session the mechanics themselves expressed a desire that mathematics should also be added, and they conducted classes among themselves in mathematics, so as to assist them in understanding the lectures on natural philosophy; and the directors during the next session added a class of mathematics to those on chemistry and natural philosophy. These classes were constituted the fundamental courses of instruction in the institution, and they still remain the fundamental courses of instruction

7461 A class in mathematics was added to those in chemistry and natural philosophy in 1822?—Yes

7462 And it has existed ever since?—And it has existed ever since

7463 Is there a large number of members in the Institute?—Yes During the 47 years of the existence of this institution, upwards of 20,000 of artizan students have received instruction in this people's college The year in which the institute was opened there were 452 tickets issued to students, and during the present session there were 1,032 tickets granted to pupils There are some students who take out more than one class, so that necessarily the number of tickets does not exactly represent the number of pupils; but this year the number of students attending the School of Arts was 709 individuals; and in the preceding year, namely, the session of 1866-7, there were 740 pupils There is therefore a slight diminution in the number this year, which we ascribe principally to one cause It has always been found in the history of the school, that whenever trade was dull, or there was a tendency on the part of masters to reduce wages, such had a most important influence upon the number of artizans who attended the school; and on the present occasion, where we have a decrease of three students, as compared with last session, we attribute the diminution in numbers to the dulness of trade in Edinburgh.

7464 Have you classified the students according to their trades?—I have The last occasion on which I made this classification was during the session of 1866-7 The statistics for the present session have not yet been drawn up according to the trades; but I submit to the Committee the statement in last year's report, where the occupations of those who attended the institution are given These are, architects, bakers, bankers, basket-maker, bell-hangers, blacksmiths, bookbinders, book-keepers, booksellers, bootmakers, bow-maker, brassfounders, brewers, builders, brushmakers, cabinetmakers, wood carvers, chemists, civil engineers, clerks, shopmen, clock maker, clothiers, collector, colour maker, confectioner, cork manufacturer, cutlers, dentists, drapers, draughtsmen, druggists, drysalts, engineers, engravers, wood engravers, excise officers, farmer, gardeners, gilders, glass-stainer, glazier, goldsmith, grocers, gunmakers, hardresser, hosiers, ironmongers, iron turner, jewellers, joiners, land surveyor, librarian, light-house service, lithographers, lithographic writer,

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masons, merchant, musicsellers, opticians, house painters, paraffin works, pattern maker, photographers, pianoforte tuners, plumbers, porter, postman, printers, printer's reader, saddler, sculptor, seedsmen, shoemakers, silversmith, skinner, slater, stationers, students of normal schools, surveyors, tailors, teachers (pupil and assistant), tinsmith, tobacconist, travellers, warehousemen, watchmakers, and some pupils of no trade, being chiefly young people from school

7465. What do you mean by engineers in that list?—Working mechanical engineers, artizans

7466. Are those students mostly adults, or are they apprentices?—The average age of the students attending the School of Arts will be from 20 to 25, but we have some pupils as young as 15, and we have others attending the classes who are certainly above 50

7467. There are a large number of clerks and shopmen, I observe?—There is a large number of clerks and shopmen, but it must be understood that these are clerks who attend small shops, and who cannot get away during the day, they are men in no better condition, so far as status in society or primary education goes, than ordinary artizans.

7468. Have you any idea what are the objects generally of that class of persons attending your institution?—The object seems to be general instruction. We have had instances of students in the school, who were not artizans, who studied the branches of science in the school, and who afterwards devoted their attention to special branches of science, and became connected with certain industrial pursuits.

7469. You have 27 students of normal schools?—Yes

7470. Are those young men who afterwards become schoolmasters in different schools?—Yes; but it will be observed that we have also two pupil and assistant teachers, which, with the 27 students of normal schools, make 39 young men who are in training to become schoolmasters.

7471. Chiefly, I suppose, in parish and other elementary schools?—Yes, just so.

7472. How is the institution supported?—The institution is partly supported by the fees of the students, but in other part it is maintained by contributions which are received from parties in Edinburgh, who take a special interest in the institution The sums received from fees during the last five sessions were, in 1863-4, 177 l. 12 s. from 667 students, in 1864-5, to 170 l. 1 s. 6 d. from 624 pupils; in 1865-6, to 176 l. 1 s. 6 d. from 618 students, in 1866-7, to 193 l. from 740 pupils; and in 1867-8, to 207 l. from 713 students.

7473. Those are the contributions from students' fees?—Yes, those are the contributions from students' fees.

7474. What was the amount of the other contributions?—I find, in taking the 47 years that the institution has been in existence, the fees of the students come to almost exactly half the sum required to keep up the institution; so that the contributions from other sources have been equal to the total amount of the students' fees Latterly we have derived considerable income from letting off part of the premises, so that the contributions from friends are not so much needed.

7475. How did you obtain your premises for

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the institution?—The present buildings were purchased in 1850 partly from a sum of money which had been accumulating from year to year, and which had been set apart from the ordinary income of the school, and partly from a sum which was subscribed by gentlemen for the purpose of founding a memorial to James Watt. The subscribers considered that the best means of founding a memorial to James Watt was to associate his name with this artizans' college, and they handed over the greater part of the sum which they had collected to the directors of the school. At this time the directors changed the name of the college from that of the School of Arts to the Watt Institution and School of Arts. Part of the sum which was collected for the Watt memorial was expended in a statue in stone to Watt, which was erected in front of the school, where it still remains.

7476 Do you know approximately what was the entire cost of the buildings?—I think about 2,500 l., but the present value of the building and site is about 5,000 l.

7477. Is that inclusive of the ground or exclusive of the ground, was the ground a donation from any one?—There is a few duty, a ground rental, which amounts, with insurance and public burdens, to upwards of 12 l.

7478 Did you receive any grant from the municipal authorities of Edinburgh or from any public authority?—We received no grant from any public authority especially for the purpose of building or purchasing premises, but the municipal authorities of Edinburgh have always recognised the school. The Lord Provost has generally been chairman of the meetings of subscribers, and every year the municipal authorities give a donation of 5 l. 5 s. towards the expenses of the school.

7479. Have you any chemical or physical laboratories, or both?—We have no chemical or physical laboratory at present attached to the institution, but during the last session I felt that it would be to the advantage of the students to give them an opportunity of studying in a chemical laboratory; and accordingly I informed my class that if a small number of artizans, strictly limited, would enter their names, I would arrange that they should be accommodated in my laboratory at Surgeons' Hall in the evening, and that instruction should be given to them in practical chemistry. Twenty men put down their names at once, and we had a course of practical chemistry during this session. These students went so far as to be able to recognise, by a systematic application of tests, any metal or solution of metal that was handed to them, although such was previously unknown to them.

7480 Have you any means of testing the progress made by the pupils?—Yes, in the first instance the school grants attestations of proficiency in the fundamental classes, viz, those for chemistry, natural philosophy, and mathematics; and the student who has, during each of the three years of his attendance at the school taken attestations of proficiency in at least one of those branches of science, and can produce the three attestations of proficiency in chemistry, natural philosophy, and mathematics, to the subscribers of the school, has a diploma granted to him. The diploma constitutes the student a life member of the school, and entitles him to attend any class during any subsequent session, and also admits him to the library on payment of 2 s. each year. The attes-

tation is signed by the lecturer of the special department, and by the secretary of the school, and the diploma is signed by the three lecturers on science, by three of the directors and by the secretary. The diploma is acknowledged as of considerable value among artizans, so that they strive to obtain it, and it has been found extremely useful to many of them in seeking for situations of trust, and responsibility in public works.

7481. Are the examinations conducted by the lecturers?—The examinations are conducted by the lecturers themselves, but some of the directors are generally present, and I may state here, that there are special seats for the directors in the lecture-room, so that the directors can attend at any time during the lectures, or during the examinations.

7482. Who are the other professors in the school besides yourself?—The other lecturers in the school at the present time are Mr. James Pryde, lecturer on arithmetic, algebra, and mathematics; Mr. William Lees, A. M., lecturer on mechanical philosophy, along with myself, as lecturer on chemistry. Those classes are the three fundamental branches of instruction. I should also state that there are other classes which were early in the history of the school added to this curriculum, and that we have now Mr. David Pryde, A. M., who teaches the structure of the English language; Mons. Charles H. Schneider (of the High school) for French; Herr John Schopp, for German; Mr. William Carmichael, for architectural, mechanical, and ornamental scroll drawing, and Mr. William Campbell, for ornamental modelling. Those classes were added because it was considered that they would be of advantage to the artizans, but on several occasions attempts have been made to suggest the formation of other classes, which attempts the directors have invariably resisted, as they consider the present curriculum is quite sufficient to occupy the attention of the artizans. It may be thought, perhaps, that French and German are not pure science subjects, but the study of these languages was introduced because so many scientific books at the present time are printed in French and German.

7483. I think you have not yet stated what is the fee per course?—If a student joins any single course of instruction he pays 5 s. for that class. If he takes any two of the fundamental courses of instruction he pays 7 s. 6 d. for the two courses; and if he enters for the four classes chemistry, natural philosophy, mathematics, and English (for English is now recognised as of great importance, though not part of the regular curriculum) he pays 10 s. for the session of six months.

7484. Is the course completed in one session?—A course in science is not completed in one session. I generally lecture during three sessions on chemistry; one session I take up the non-metallic elements; the second session I discuss the metallic elements; the third session I lecture on organic chemistry, but during each session I invariably include instruction in chemical philosophy, so far as such is necessary for enabling the students to understand in a scientific manner the special subject before them.

7485. Is it your experience that a large proportion of the students continue with you during the series of three courses?—We have a considerable number of students who take up the courses of instruction for more than one year, but a larger proportion,

proportion, I should say, do not join the same course of instruction for more than one year. The pupils belong to many different trades, and in studying chemistry they doubtless enter the year when the course which specially bears upon their daily avocations is being considered.

7486. I think I understood you to say that two sessions were required in order to complete a course of inorganic chemistry?—Two courses are required to complete what might be included under the term of inorganic chemistry, but one of those courses is entirely taken up with the non-metallic elements, and the other course is taken up with the metallic elements.

7487. Would a student entering at the commencement of the second course, be able to derive sufficient instruction to enable him to dispense with the first course?—Undoubtedly, for we invariably make it our business to consider in each session that the students when they enter are totally ignorant of the subject to be brought before them, for example, we introduce so much of general chemistry as to make any given department of chemistry intelligible to the pupils who have not previously attended the lectures in chemistry.

7488. That is what you meant, I suppose, by lecturing on chemical philosophy?—Yes.

7489. Have you been able to trace the subsequent careers of many of your students?—The directors have on many occasions received communications from former students who have stated that they have been more than ordinarily successful in life, and that they owed a great deal of that success to the training in science which they had received in the School of Arts. I may mention the name of Mr. William Bam of Edinburgh, who is now at the head of an engineering establishment, and who holds a diploma of the school. He has accompanied me to London, and is ready to state to the Committee how far he considers the training which he received in our school has conduced to his own prosperity. He will be able to mention the names of others who have been benefited in a similar way. Another name which occurs to me is that of Mr. John Kerr, who was formerly a working tinsmith in Edinburgh, but who received the diploma of the school in 1863; and is now the manager of extensive gas works at Copiapo in South America. An annual prize in the school has been founded by Mr. James Newlands, now borough engineer in Liverpool, who is an *alumnus* of the school. I may also mention that another pupil, Mr. Smith, who was an artizan when he attended the institution and took the diploma, became afterwards, and still remains, head mathematical master in George Heriot's Hospital. There are many other similar instances of the success in life of the *alumni* of this artizan college, thus, one pupil who was a cabinet-maker, became schoolmaster in the parish school of Preston Pans, another, a tailor, received a responsible appointment in a large engineering establishment in Glasgow; another, a tinsmith, became a schoolmaster in Perth; another, a basket-maker, was promoted to be manager of the asylum for the deaf and blind in Belfast; another, a tailor, became a private secretary to a nobleman; whilst another, a mason, was appointed an inspector on one of the English lines of railway.

7490. But apart from those examples of men who have ceased to be working men, have you reason to believe that the position of those who

are still workmen has been materially improved by the instruction which they received in the school?—We have great reason to believe so, the directors in their yearly report, invariably state that they have received communications from working men to that effect. Instances have occurred where large employers of labour have intimated to the directors, that in the filling up of the positions of foremen and managers in their works, they would give a preference to a pupil of the School of Arts, and they have also stated that such a candidate had been selected from many candidates in particular for his scientific attainments. The directors further mention that the diploma of this artizan college affords a proof, whenever the pupil may present it, "that its owner has undergone a regular scientific course of education. This document carries great weight with it, and never fails to lead to the best employment in the line of life to which its professor belongs."

7491. Are there any other institutions in Scotland resembling the Watt Institution in Edinburgh?—There is an institution in Glasgow which is known as the Andersonian University, which is principally a medical school, but where the professors deliver lectures on science to artizans, and I believe such lectures were delivered in the Andersonian Institution before they were organized in Edinburgh. Those lectures, however, at the Andersonian Institution did not at that time fulfil any idea of systematic instruction such as was carried out in the Edinburgh School of Arts, and consequently we do not think that the credit of introducing systematic instruction in science belongs to the Andersonian Institution, we think it properly belongs to the School of Arts in Edinburgh; still lectures in science were delivered in the Andersonian Institution before they were delivered in the School of Arts in Edinburgh. After the School of Arts had been organized, in fact some years afterwards, a Mechanics' Institution was started in Glasgow, and it has, I believe, been successful in teaching the elements of some of the sciences. I am not aware that the directors of the Glasgow Institutions give diplomas or attestations of proficiency, or that they strictly abide by a systematic curriculum of study.

7492. Are there in Edinburgh any other institutions of the same kind as the Watt Institution?—We have no other institution of the same kind as the Watt Institution in Edinburgh.

7493. In the other large towns of Scotland, such as Aberdeen, Dundee, and Greenock, are there any institutions similar to the Watt Institution at Edinburgh?—There are mechanics' institutions in Aberdeen and Dundee, Paisley, Greenock, and other large towns in Scotland, but no institutions of a similar nature to the School of Arts, so far as systematic instruction in science is concerned. I believe, however, that those mechanics' institutions in Scotland have done much good in their day in diffusing to some extent a desire to study science. You have at those institutions courses of lectures, and although only a few of those lectures are on science, they do some good. I believe, also, the mechanics' institutes of Scotland might form the basis or starting point for institutions where more systematic teaching would be given in science.

7494. But is there any organisation in Scotland analogous to the union of mechanics' institutes in Lancashire or Yorkshire?—There is not.

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7495. In the case of the Watt Institution, have you connected yourselves with the Science and Art Department?—We have only recently connected ourselves with the Science and Art Department; in fact, it has only occurred within the last month or two, we did not do so previously, owing to some difficulties on the part of the Science and Art Department, first, with regard to the reception of our students, and latterly of our lecturers, as qualified under their regulations in Edinburgh. We considered that, as the Watt Institution and School of Arts had been flourishing for a large number of years, and as our lecturers held appointments which were of much greater moment than mere appointments as teachers in artisan colleges, the Science and Art Department should have acknowledged the school as one which had done its work, and was still fit to do its work. There was some little difficulty at first in acknowledging the school and its lecturers and pupils, as I have already stated, which has now been adjusted, and we are now prepared to enter heartily into the arrangements of the Science and Art Department for the future, and shall conduct our examinations in accordance with their regulations during coming sessions.

7496. Referring to the conference on technical education which was held by the Royal Scottish Society of Arts during the spring, have you any recommendations or any statements to bring before the Committee?—I may state that the conference was very largely and influentially attended; in fact, the meeting was quite national as far as Scotland was concerned. There were represented at the conference the municipalities and other authorities of every important town and district, and the universities and the teaching bodies of Scotland; and after lengthened discussion, certain resolutions were adopted, which I will read. "1. That the time has arrived when it is desirable and necessary that the principles of science should form an important element in the education of all classes of the community. 2. That elementary science should be taught in all schools, and that the Government aid now offered, in the shape of grants of money and apparatus, as well as scholarships and exhibitions, should be largely increased, and much modified, in order that they may be more generally taken advantage of. 3. That for the more thorough instruction of all classes, it is desirable that chairs of applied science be founded in the universities, and that branch industrial museums be established in the larger towns. 4. That the mechanics' institutions of the country should be reorganised and extended, so that systematic instruction in the elements of science may be placed within the reach of all artisans. 5. That the council of the Royal Scottish Society of Arts be requested to appoint a committee to promote the objects of the foregoing resolutions." The council have appointed a committee, which numbers about 120, and represents all the municipal and other authorities in Scotland, besides the universities and the teaching bodies.

7497. Mr. Bruce.] Were these resolutions passed before or after the Science and Art Department had issued their new minutes for the encouragement of science teaching?—Those resolutions were passed after the new minute had been issued by the Science and Art Department. They were passed at a meeting held on the 20th of March this year. I may state that the committee appointed by the council have already had

one meeting, and have taken into consideration the second resolution which refers to Government aid:—"That elementary science should be taught in all schools, and that the Government aid now offered, in the shape of grants of money and apparatus, as well as scholarships and exhibitions, should be largely increased and much modified in order that they may be more generally taken advantage of." At the committee meeting the whole subject of the teaching of science in schools was very fully discussed, and it appeared that there was very considerable difficulty in schools with regard to giving sufficient encouragement to teachers to have science classes, owing to the schools in many districts of Scotland being attended by all classes of society at one time. You have the proprietors' children and the children of peasants associated with each other in those primary schools, and the main part of the teaching being ordinary instruction in reading, writing, and arithmetic, under a Whitehall regulation the teaching of science has been shut out, and as there are few opportunities in the evening for teaching the pupils, and the teacher is exhausted by his labour during the day, it was considered by the Committee a barrier to the teaching of science by the teachers in our elementary schools, that they should not be able to communicate scientific facts during the ordinary time of the day instruction.

7498. Is it your opinion that if they were permitted to teach science in elementary schools they would be qualified to do it?—I believe that the majority of the teachers are now qualified to teach elementary science. We have now a much superior class of men as teachers in Scotland than we had a little time ago. Very strict attention is paid to their qualifications before they are appointed. At the committee meeting necessarily the teaching element was very largely represented, and the second resolution, which was passed at the conference then formed the subject of discussion, and instructions were given to me as secretary of the committee on technical education to frame a memorial to the Science and Art Department on the subject, embodying the following resolution:—"That elementary science should be taught in all schools, provided there be no interference with the ordinary branches of primary education, that the Government aid now offered in the shape of grants of money and apparatus, as well as scholarships and exhibitions, should be applicable to all schools and to all pupils, and that the payments to teachers should be made for successful pupils, whether these be taught in day or in evening schools, and whatever be their position in society." The opinion was expressed very decidedly at the committee meeting that there was a want of sufficient encouragement to teachers in schools to go on with science classes, but that if the Science and Art Department threw open the teaching of science a all times of the day, and threw open inducements upon results of successful teaching for all classes, the pupils and teachers would see it to be their interest to go heartily into the arrangements of the Science and Art Department.

7499. Mr. Bruce.] Will you state what there is to prevent elementary teachers from teaching science in the day time?—I believe there is Whitehall regulation which forbids it being done.

7500. But surely that is a mistaken idea, is not?

not?—I may direct the attention of the Committee to Clause 23 of the Directory of the Science and Art Department for 1868, which says, "All payments to qualified teachers on account of science teaching are made by the Science and Art Department, and are only made in respect of a school in connexion with the Science and Art Department. No such payments are made in respect of any instruction in science that may be given during the three attendances of an elementary school receiving aid from the Education Department, Whitehall."

7501. But my question was, whether there was anything to prevent elementary schoolmasters from teaching science in their schools?—There is nothing to prevent their teaching it, but that clause prevents them from receiving any remuneration for doing so.

7502. *Chairman*] What the conference recommended was, that elementary teachers in day-schools should be paid on results, just as if the teaching had taken place in an ordinary science school?—Just so, that they should be paid for successful results in teaching, whether in day or evening schools, and also for all classes of pupils

7503. You have been speaking about the foundation of chairs of applied science in the universities, is it not the case that in many of the Scotch Universities there are such chairs?—In Edinburgh we have a chair of agriculture, which ought to be considered applied science; we have also a chair of engineering, which has been recently established, and endowed partly by Sir David Baxter, and partly by the Government, the Government in that case acknowledging the principle that whatever sum be raised by the locality, the Government will add a similar sum. Those are the chairs of applied science in Edinburgh, then we have a chair of engineering in Glasgow, but we have no chair of agriculture in Glasgow, and neither in Edinburgh nor in Glasgow have we a chair of technical chemistry

7504. Have you a chair in physics in Edinburgh?—We have a chair in natural philosophy, but not in applied physics.

7505. In St Andrew's and Aberdeen have they any chair of applied science?—In St. Andrew's they have no chair in applied science; in Aberdeen they have a few lectures—but it is not a properly constituted chair—they have, however, a few lectures in agriculture

7506. *Mr. Bruce*] Are the class of men who attend the Watt Institution generally those who might look forward to be managers, or, are they men who simply belong to the class of workmen?—The men who attend the School of Arts are principally men who are strictly artisans in the Science and Art Department sense of the word, they are men on weekly wages, or the sons of men who are on weekly wages; I should say the sons of men who desire to further themselves in the world, and to make a practical use of the instruction which they receive. I have no doubt that these artisans do look forward to holding the position of foremen, or even that of masters

7507. Do you consider that Edinburgh is sufficiently supplied with the means of scientific instruction, taking into account the extent of its population?—I do not think it is sufficiently supplied with the means of scientific instruction, taking into account the extent of its population. I may say that the School of Arts has done its work well as far as its means go, but that the

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institution is one in which accommodation is insufficient. We have only one principal lecture-room, when we ought to have at least three lecture-rooms. We have no chemical laboratory, and I think we ought to have a chemical laboratory, so as to be able to give systematic instruction in practical chemistry, and teaching in practical physics

7508. With more means, in fact, you could do more good?—With more means we could do a great deal more good.

7509. Do you think you would be able to do most good by enlarging your present institution, or by founding a new one, so as to give a more convenient access to persons living in other quarters of Edinburgh?—I believe the best way would be to enlarge the present institution, as it is connected by name with all the intelligent workmen of Edinburgh. At present there is a very favourable opportunity of extending the present School of Arts, because the improvement scheme of Edinburgh will cut right through the building, so that we shall be forced to move a little to the side. A memorial has been presented to the Improvement Commissioners, asking them to permit us to retain our present site as far as possible, so that we may form the corner of the new street; this will necessarily entail considerable expense, but although we have applied for a site to the Improvement Commissioners, and will likely obtain such, yet I do not know if the Commissioners will give anything further towards the new building.

7510. What distance do the pupils travel in order to attend the school?—The directors state in their report that students have been known to come a distance of 10 miles. I have known some of my own students who came eight miles, and walked back in the evening, and I have known other cases where they walked six miles.

7511. What distance would a working man resident in the outskirts of Edinburgh have to travel in order to reach your School of Arts?—Our present institution is favourably situated, being very close to the University, and in the centre of the town, so that the distance from any part of Edinburgh proper, is not above two miles even from the outskirts, but our students also come from Leith, Portobello, and Musselburgh, which is about six miles

7512. You think it would not be a great addition to the convenience of any of your students if a branch institution were made instead of your extending your main institution?—No, I think not.

7513. *Chairman*] What is the distance of Leith from your institution?—We are about two-and-a-half miles from the centre of Leith

7514. Are there cheap trains between Leith and Edinburgh?—There are many cheap trains between Leith and Edinburgh.

7515. What would be the price of a third-class return ticket from Leith to Edinburgh?—The price of a third-class return ticket from Leith to Edinburgh is 3d

7516. *Mr. Bruce.*] Are the teachers of elementary schools instructed in any branch of science at the Scotch training colleges?—There are some facilities for teaching science in the normal schools in Edinburgh, but as far as Edinburgh is concerned, we are rather deficient in such opportunities.

7517. You have spoken of elementary schoolmasters who are quite capable of conveying the scientific

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scientific instruction required by the Science and Art Department; where would those elementary schoolmasters have attained that knowledge?—Many of them attend the School of Arts, and are included in the list of students under the name of students of normal schools; then there are lessons in physics given in normal schools; at least in one of the normal schools in Edinburgh itself.

7518. Are you aware whether at any of the elementary schools of Scotland, instruction in science has voluntarily been given which would have entitled the master to payment on results from the Science and Art Department, had their rules permitted it?—I am not aware that in any primary school in Scotland, strictly speaking, such instruction has been given as you refer to, but in secondary schools in Edinburgh it has been given.

7519. Do you mean that such instruction has been given in secondary schools which receive no assistance from the State?—Just so, they are grammar, or high schools.

7520. What I understand you to say you desire is, that a certain basis of scientific instruction should be furnished to the children at elementary schools?—That is what we desire.

7521. In England the difficulty of giving instruction in science in normal schools, or training colleges, is said to arise from the imperfect state of primary education in which the pupils present themselves, so that the time allowed at the college is not more than sufficient to fit them for the work of masters in the ordinary elementary curriculum; but would that objection apply to Scotland?—I think not, I think the primary education of the teaching class in Scotland is much higher than the point which would debar them from entering on the study of science.

7522. You think, then, that some elementary instruction in science might safely be made an absolute requirement in the training colleges in Scotland?—I consider that whenever anything else than reading, writing, and arithmetic are taught, elementary science could be taught to the pupils.

7523. In all the better schools of Scotland, something more than those three branches of knowledge are taught?—Undoubtedly; and I would say that that something more ought to include geography, for instance.

7524. I suppose that in all the better schools in Scotland, geography and history are included?—Undoubtedly.

7525. Mr. *McLagan*] I think you stated that there was no chair of applied chemistry in Edinburgh University?—I did state so; but I might also have mentioned that there was a chair of applied chemistry founded in the year 1853, and that the first professor of technology was the late Professor George Wilson, who lectured for three or four sessions—his class was very well attended. I believe the number in the year in which he died (he died during the session), ran up to about 90, the chair was apparently very well appreciated, and would doubtless have continued to be well attended; but it was abolished at about that time.

7526. Do you know for what reason it was abolished?—I do not know; there was no reason given; but when Dr. George Wilson died, the chair simply dropped, and there was no re-appointment made. In the University Record, the chair is mentioned with the name of Pro-

fessor George Wilson against it, but as having ceased since 1859.

7527. It was about the same time with the appointment of Dr. Wilson to the chair of technology that the Industrial Museum was established, I believe?—Yes, it was about the same time. Dr. Wilson was appointed director of the Industrial Museum and professor of technology. When he died another director, Mr. T. C. Archer, was appointed, to the Industrial Museum, and he is now the keeper of the Museum of Science and Art, but no appointment was made of a fresh professor of technology.

7528. Are you aware that there is any strong desire in Edinburgh for the re-establishment of the chair of technology?—I believe there is considerable desire in Edinburgh for the re-establishment of the chair of technology. There has been no public expression of opinion upon the subject further than is embodied in the resolution adopted at the conference, that chairs of applied science should be established in the universities.

7529. From what source was the endowment of that chair derived?—I believe it was endowed entirely by the Government.

7530. Out of the Consolidated Fund?—I am not aware of the fund.

7531. Are you aware whether the Industrial Museum has been attended by the working classes in Edinburgh?—It is very largely attended by the working classes in Edinburgh. On one of the evenings when it is opened free, namely, on Saturday evening, when the working men can come with their families, the rooms are generally very crowded, and the men seem to take great interest in the inspection of the objects of industry exhibited there. I have myself gone into the room and stood beside a case when the working men were examining the contents, and I have found them discussing the different stages of the manufacture of the object very intelligently, and apparently connecting one object with another in the different processes of the manufacture. The numbers of those who attend are published every week, and since the opening of the Industrial Museum I believe the number of people who have entered the rooms approaches a million.

7532. *Chairman*.] Since when is that?—The museum was opened about eight years ago, and those figures include all the years since it was opened.

7533. But the number of students has been very much increased since the opening of the new building?—Very much indeed.

7534. Mr. *McLagan*] Was the attendance published before the new building was opened?—No; and the number of those who attended was very small at that time.

7535. Mr. *Bruce*] But the new building has been opened only during the last four years, has it?—Just so.

7536. Mr. *McLagan*.] Do you know whether any of the lectures in the institution allude to the specimens in the Industrial Museum as illustrations of their lectures?—The lectures in science in the Watt Institution and School of Arts often allude to them; and this year I made an arrangement with Mr. Archer, the director of the museum, that he should allow my students to visit the museum; and I likewise requested to know whether, in the event of my doing so, he would allow them to stand over the cases and examine the specimens. He very kindly agreed to that, and

and said, moreover, that if I would let him know when I was coming, he would have the cases opened, when such was necessary for the proper examination of the contents.

7537. I understand you to say that this Industrial Museum has been of great benefit to the working classes?—Undoubtedly.

7538. Have there been any lectures instituted in connection with the Industrial Museum?—During the last year short courses of half-a-dozen lectures were given in the museum on chemistry, on geology, on natural history, on botany, and on natural philosophy, and a charge was made to the artizans of 1 s. for each course. The lectures were numerous attended, though not solely by artizans; the better class of both sexes was admitted on a payment of a fee of 2 s. 6 d. for each course; those lectures were not considered to be courses giving systematic instruction; and, in fact, Dr. Lyon Playfair at the close of the session said very decidedly that they were not to be regarded as giving systematic instruction, they were merely intended to give a taste for science, and that if the pupils wished to acquire systematic knowledge, they must afterwards go to the School of Arts.

7539. Has the attendance on those lectures had any effect on the attendance at the lectures in the Watt Institution?—We consider that while we may regard the slight diminution in our numbers this year as due to the dulness of trade, there is no doubt that the announcement of this course of lectures at the museum led to an impression among many artizans that those lectures were in rivalry with ours, and were substitutes for the course of instruction at the School of Arts. We were rather frightened, in fact, that those lectures might seriously interfere with our arrangements, but I am happy to state that our own courses of lectures go on extremely well, and that now we do not look upon these lectures as having done us any harm; we attribute the slight diminution of numbers at our institution rather to the dulness of trade than to the influence of the lectures at the Industrial Museum.

7540. Do you think it would be an advantage to the public to have the Industrial Museum connected with the Watt Institution and the School of Arts?—I do not think so; I think the School of Arts ought to remain as it is—a thorough teaching institution, devoting itself to the thorough teaching of science. Considering that Mr. Archer is willing that every facility should be given to the lectures in the School of Arts for taking pupils to the Industrial Museum, and showing them everything connected with any special subject of study, I think the connection of the Industrial Museum with the School of Arts is not required.

7541. You think it would be an advantage, however, to have lectures on technology in connection with the Industrial Museum?—I consider that we ought to have lectures on chemical technology in the Edinburgh University, and that we should look upon our School of Arts as intended for the scientific training of our artizans, and that we ought to have lectures on applied science given in the university for the scientific instruction of our foremen and masters, or of those artizans who choose to express a desire to attend the courses of instruction still further than they could possibly go in the School of Arts. Repeatedly working men and artizans have, after studying at the School of Arts, come to attend my more extensive course of lectures which I de-

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liver during each session, and have paid a somewhat high fee to attend those lectures. I have had also instances of School of Arts men, artizans, coming to me during their dinner hours, and working at practical chemistry in my laboratory; and in all the latter cases I have given the instruction free. It shows a desire, on the part of working men, to get scientific instruction more fully.

7542. *Chairman.*] Would you expect that in some way the popular lectures at the Industrial Museum might act as feeders to the Watt Institution?—Undoubtedly, but when we were afraid that the lectures at the museum might interfere with us, no announcement had been made that those lectures were intended merely as inducements to study; the public statements calling attention to the courses of lectures were such as to lead to the belief that they were put forward as systematic courses of instruction.

7543. But that being now well understood, you think it is likely that the persons who have been attracted to science by those lectures, would in subsequent years become students with you?—I do.

7544. How is the expense of the Industrial Museum provided?—The Government supply the funds; there is a grant made every year.

7545. Do the professors receive any portion of the entrance fees paid by the persons attending those lectures?—I am not aware.

7546. *Mr. Mc Lagan.*] Are there any other popular lectures delivered in the evening on science in Edinburgh?—We have popular lectures on science delivered in different districts in Edinburgh, those popular lectures being got up by the residents in various districts; I have myself lectured in many of those courses during the 12 years prior to 1867. I remember when there was a good deal of talk about the Saturday half-holiday movement, an association was formed, called The Saturday Half-holiday Association, and we had popular lectures on science delivered on Saturday evenings, of which I gave several during each year, and occasionally the attendance on those lectures amounted to 1,200 or 1,400.

7547. The people being principally of the working-classes?—Principally of the working-classes.

7548. Did you find that those lectures acted as feeders to the classes in the School of Arts?—I am not aware that we traced any instances where people were prompted solely by those popular lectures to go to the School of Arts, but I have no doubt that such was the case.

7549. Were the lectures given at the Philosophical Institution in Edinburgh attended principally by artizans or by middle-class persons?—Those lectures are not attended by artizans; in fact, the fees are too high for artizans to take advantage of them, being a guinea a session. These lectures are partly literary and partly scientific, and each subject has one, two, three, or four lectures devoted to it. Altogether there are about 20 lectures delivered on all the subjects during each winter session.

7550. Of all the classes in the School of Arts, which is the best attended?—During the last few years the attendance has been largest in the mathematical classes. I will give the numbers who have attended each of the courses during the session of 1867-68: 183 junior mathematics, 12 senior mathematics, 145 natural philosophy, 170 chemistry, 149 structure of the English language, 167 French, 45 German; then during the summer-

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session the attendance was 25 arithmetic and algebra, 64 drawing, 29 French, 34 English, 9 German; so that of the fundamental classes of the school, the attendance on mathematics was 195, natural philosophy 145, and chemistry 170. These numbers are exclusive of life members, who have the privilege of entering the lecture-room at any time, and who often take advantage of the courses of lectures delivered in years subsequent to their taking the diploma of the school.

7551. How far is a pupil taken in the class of junior mathematics, and how far is a pupil taken in the class of senior mathematics?—I will hand in the syllabus of instruction for 1866-7 and 1867-8—(Vide Appendix.)

7552. You mentioned, I think, that there was a very large attendance of the class of clerks, a larger attendance than of persons from any other trade or profession?—It is true that the number of clerks and shopmen is the largest of all the different vocations on the list, but the class of clerks and shopmen referred to there have no higher position than artizans, and no better education.

7553. Then from what class are those clerks and shopmen generally derived, do they come from the country generally, or from the town?—Principally from the town; but we of course find young men from the country drafted into all our large towns.

7554. You find those young men, when they come from those classes, have received sufficient elementary education to enable them to take advantage of the scientific instruction which you offer?—Yes, we have good evidence of that in the examination papers of our students, which are, as a rule, very well written out.

7555. Do you know of any cases in which those young men, after they have attended your classes, have left their shops and offices, and studied for some trade?—There have been a number of instances, but they would come more within the knowledge of the directors; and I am not prepared to give the names. As I come a good deal in contact with the students, I have constant opportunities of noticing how far they have been carried in elementary education. The examinations in my own class are conducted, every lecture evening, for 20 minutes before the lecture begins; I merely require, at the commencement of the session, that those students who desire to be examined will come to the lecture-room a little earlier than the ordinary hour of lecture, and then I ask them questions on the previous lecture. I generally find that about 40 students put down their names for examination during each session, and that they are ready on each evening to answer the questions in an intelligent and masterly manner.

7556. Are you aware of many of the artizans of Edinburgh, from the superior advantages which they have had at the School of Arts, having become foremen in Edinburgh, or in other places?—Yes; there are numerous instances of that kind, some of which I have referred to in a former part of my evidence.

7557. Do you think that that kind of success prevails more among the artizan class in Edinburgh than in any other city or town in Scotland?—I am not aware that it does; we must look upon Edinburgh as not so much a centre of manufacturing industry as many other towns, and I am not aware how the proportion of such cases in Edinburgh would stand with regard to the number in other places.

7558. All these advantages which the working classes have in Edinburgh have been afforded to them without any public grants from Government, or any rate?—Entirely; the Government has never given a penny towards the School of Arts, and there has never been any rate imposed for the support of the School of Arts.

7559. Do you think it would be an advantage that there should be a grant from the Government, or a rate imposed for the support of such establishments, do you think it would thrive any better?—I do not know that the School of Arts would thrive any better for a Government grant, so far as the educational work is concerned, but I think the School of Arts would thrive very much better if the Government would assist in the erection of proper buildings for the systematic instruction of the students; at the same time much of the expense connected with the institution is now borne by voluntary subscriptions, and of course there is an extreme uncertainty about that source of income; and if the Government would apply to the School of Arts the principle which it has acknowledged to be proper in the case of the universities, namely, that whatever is raised by local effort they will add a similar sum thereto, I think that such a scheme would materially improve the position of the School of Arts, and lead among other improvements to the extension of the present library, which is far too small for the scientific acquirements of the pupils.

7560. You spoke of a class of agriculture in the University of Edinburgh, are you aware whether that class has been attended or not?—I believe the number of those who attend the agricultural class is very small, being perhaps a dozen or 20.

7561. Has that always been the case?—So far as my knowledge extends, for a period of 10 years, it has always been the case.

7562. Would you then say that the farming class in Scotland do not appreciate science?—No; I should certainly say that they do appreciate science; indeed, I may say that I know personally that the farming class in Scotland thoroughly appreciate the importance of scientific knowledge. I have attended my lectures on chemistry, and my instruction in analytical chemistry, a considerable number of the sons of farmers, and I know that many sons of farmers attend the university, but why they should not attend the lectures on agriculture I do not know.

7563. Is there a museum attached to the chair of Agriculture?—I think the museum is now placed in the Industrial Museum.

7564. There was a museum of agriculture, was there not?—Yes, and I think the specimens are now placed in the Museum of Science and Arts.

7565. Can you give the Committee any idea of the kind of lectures that are delivered by the professor of agriculture?—I have never attended any of the lectures, and therefore I cannot do so.

7566. Are you aware of any attempts ever having been made to introduce the teaching of elementary science into any of your elementary schools in Scotland?—I am not aware of any attempts to introduce science into elementary schools as a regular branch of instruction. I may mention, however, that on several occasions each year I have myself, from the pure love of seeing a lot of young people delighted with chemistry, given elementary lectures, and have found the children extremely interested, but I have given no systematic instruction.

7567. Do

7567. Do you remember an attempt made in the time of the late Professor Johnston to introduce the teaching of elementary chemistry in these schools?—Yes; Professor Johnston wrote a very simple treatise upon the subject, but how far his plan was carried out I do not know.

7568. You do not think it has been extensively adopted?—No.

7569. But according to the resolutions of the conference, you are of opinion that elementary instruction in science should be given in primary schools?—Undoubtedly, wherever more than reading, writing, and arithmetic are taught, I think there should be instruction in science.

7570. But in our parochial schools there is more taught than reading, writing, and arithmetic?—Yes, they teach Latin in some of those schools.

7571. And Greek?—Sometimes.

7572. And French?—French is generally taught now.

7573. *Chairman.*] If the introduction of elementary science should necessitate an increase in the schoolmaster's salary or the appointment of an assistant master, do you think the additional burden would be cheerfully borne by those on whom the rate falls in Scotland?—I believe that in the country districts in Scotland they are extremely adverse to rates, and I am afraid that any attempt to increase the local rates in any way would be resisted by many of the people. I should not be in hopes that such an increase of rate could be carried out, but I have no doubt of this, that if the Government were to say, "We shall give as large a sum as you yourselves, by local efforts, will raise for communicating science instruction in parochial schools," the resident people would immediately subscribe a certain sum to support scientific instruction in those schools.

7574. Has the Public Libraries and Museums Act been applied in any of the large towns in Scotland?—I am not aware.

7575. *Mr. M' Lagan.*] Do you think that the people of Scotland generally would object to an educational rate?—No, I do not think that. I thought the question referred to local rating. I think that a general rate, meaning by that a rate extending over the whole of Scotland, would be cheerfully submitted to.

7576. *Mr. Bazley.*] Seeing that the students attending your institution are employed in about 80 different occupations, do you think it would be possible to give them a knowledge of the principles of their crafts?—I consider that it is quite possible to give such a knowledge of the principles of chemistry as would be applicable to all those vocations; but I do not consider that it would be possible in a technical school to teach the various trades.

7577. You think you could impart a knowledge of the principles of mechanism?—Yes; I consider so.

7578. Engineering?—I consider so.

7579. And all the great subjects of industry?—Yes.

7580. What do you think may be the leading motive which induces the young men generally to attend your institutions; is it for the purpose of obtaining a knowledge of science, so that they may afterwards spread that knowledge of science, or is it for the purpose of improving their position in life, and taking a higher social standard?—Both; I believe the main purpose which they have in attending our institution is, to get that

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amount of information which will raise them in social position, and at the same time supply them with a fund of information for pure information sake.

7581. To assist them in what has been called the science of get-on-ativeness?—Exactly.

7582. You have hitherto done without the aid of South Kensington?—Yes.

7583. Cannot you still prosecute, by your own spirited self-devotion to science, the extension of your good labours without the aid of South Kensington?—I have no doubt that we should flourish, and continue to flourish, even more than we have, yet done, without the aid of South Kensington, but at the same time the South Kensington Department grant medals and other rewards of study on the part of the pupils; and it has always appeared to the directors of the School of Arts, and likewise to the lecturers, that it would be a further inducement to the pupils to study, if they could receive these acknowledgments from the Government as well as the acknowledgments which they receive from the school. But these things are not at all necessary for the continuance of the school, and I believe we should get on very well without them, though I think we should get on better with them.

7584. In your experience, probably you have discovered that the social advancement of your pupils has exceeded any development of invention or matters of public usefulness arising, irrespective of their mental attainments, in the young men who have received the benefit of the instruction given at your institution?—I believe that great advantage has been derived by our students from their studies in the School of Arts.

7585. But I suppose it is more personal than public advantage?—No; I think it is both personal and public, for I consider that a man who, by his intelligence and skilled labour, improves processes and perfects machinery, is in a position not only to benefit himself, but also to promote public advantage, and I should like to refer here to a statement made by Mr. Leonard Horner, in referring to a visit which he paid to an extensive establishment near Manchester, namely, the Patricroft Works. He was met at the gates of those works by one of the partners, who said, "Mr. Horner, I am most happy to see you, for it is to you I owe my being here. I was one of the students in your School of Arts, and to that institution I owe entirely the acquisition of that knowledge which procured for me the situation I now occupy."

7586. *Chairman.*] Was that partner Mr. James Nasmyth?—The statement has been made to me that it was Mr. James Nasmyth, and the statement has also been made to me that it was Mr. Wilson, but I believe that both gentlemen might have made the statement.

7587. Both those gentlemen are eminent men of science as well as great manufacturers?—Just so.

7588. *Mr. Powell.*] Referring to the answer in which you said that you thought, though a local educational rate would be objected to, a general educational rate would not be objected to, will you kindly explain to the Committee how you would in practice work out such a rate as you describe, both with regard to the collection of the rate and the control of the finances?—The local rate to which I referred was a local rate to be collected in country districts; and I

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have found by experience, in an attempt to introduce the Police Improvement Act into country districts in Scotland, that the idea of taxation is one which is utterly abhorrent to the minds of the Scottish country people, and especially when they have the notion that the moment the tax gatherer appears, their income seriously diminishes; and, consequently, I say that if you get quit of the idea of a local rate, and make it imperative to collect the rate all over Scotland, then you leave the country element behind, and get people with town notions of taxation, who also have an idea of the benefit derived from taxation, and then the town element would overpower the country element, and the tax would be cheerfully paid.

7589. You mean that the amount of the rate would be fixed by the country at large?—I mean that it should be a general rate all over Scotland.

7590. And you think that a rate of that kind being levied, the people in the country districts would be content to pay it, seeing that as you say the predominance of power is with the urban population?—I think so.

7591. But do you think the country districts would be perfectly content in that case?—I think they could not object to it.

7592. Do you mean that they could not, or that they would not?—They might be a little discontented; but if the country people saw that there was no chance of any objection of theirs being successful, I think they would willingly yield.

7593. But what kind of authority have you in your mind, which would be in Scotland the central national authority to impose the rate, and determine for what purposes the rate should be expended, or how would you appoint such an authority?—I am not aware of any authority in Scotland connected with education which has the power of levying a rate; but we have an educational commission in Scotland, and, perhaps, power might be granted to them to levy the rate.

7594. You have in Scotland an educational commission?—Yes.

7595. Do you know how that commission is constituted?—No, I am not aware.

7596. Or by what authority it is defined?—No.

7597. *Chairman*] Have you, in fact, fully considered this question?—No, I certainly have not.

7598. *Mr. Powell*] You have suggested, and I fully concur with you, that there should be elementary scientific instruction given in schools; but could you now, departing from generalities, and approaching details, explain in particular what would be the kind of elementary science which you think could be imparted in primary schools, having regard to the age at which the children ordinarily leave such schools, and that which may be expected in future to be the age at which they will practically leave such schools; and also, of course, having regard to the nature of the schools frequented by the children of the working class?—I consider that the children attending an elementary school could very readily acquire and be benefited by a knowledge of the composition of the atmosphere, and water, and especially of those conditions which minister to the health of a community. They would likewise acquire a somewhat intelligent

knowledge of the relations which subsist between man and the world around him. I do not know that we could go much further than that in teaching the science of chemistry to very young pupils, and knowledge of that kind would have to be communicated in a very plain way; a few simple experiments explaining combustion by means of a candle, and so on, would, of course, very much help to interest the boys and girls in the information given, and enable them to follow it intelligently.

7599. Do you think, speaking generally on a point of detail, that there would be any difficulty in imparting to the children of the working classes such a knowledge of the elements of science of health as would very much improve, in the course of a generation, the health and physical well-being of the community?—No, I do not think there would be any difficulty.

7600. In a previous answer to an honourable Member, you alluded to the subject of workmen carrying out their education more freely?—I did.

7601. Did you mean that they would apply themselves with severity and self-denial to education of a scientific character, or that they would simply follow with ordinary intelligence a series of attractive experiments?—I think our experience in the School of Art shows that it is not the attractive experiments that induce the workmen to attend, the largest number are those who attend the mathematical classes, and I know from my own experience that the lectures which I deliver on chemical philosophy are the best attended by the students.

7602. You refer now to working-class students?—Yes, artisans.

7603. Then you give us the encouraging information that it is not the mere attraction of fascinating experiments in light and electricity, for example, which draw the working class to the study of science, but that they are really willing to devote themselves to the study of abstract science involving close application?—Undoubtedly; and they are likewise ready to afford inducements to others also to study. Thus, the old pupils of the School of Arts, remembering the advantages of the scientific training they received in the school, have formed a Watt Club, and the members annually subscribe and present four appropriate and valuable prizes in books to each class.

7604. When you spoke of the Government assisting institutions like yours, did you refer to the Science and Art Department, or what is the nature of the Government assistance of which you spoke?—What I said had reference to the department which has come forward and endowed our university chairs lately. Such has been done by a Government grant, but I do not look forward to the Science and Art Department endowing us in any way. I look forward simply to their giving us rewards upon successful teaching?—I believe the proper way is that which is carried out by payment on results by the Science and Art Department. I think that is a very fair way of giving the rewards, and if it were carried out fully by being extended to the successful teaching of all classes of pupils, whether taught in day or in evening schools, I have no doubt the good effect would be considerable. I consider, also, that if the Science and Art Department chose to grant a small endowment, it would facilitate matters, but that is not absolutely required.

7605. I understand

7605. I understand you, then, to mean by Government, a central authority which shall, either by permanent endowment or by annual grant, support local action?—Exactly.

7606. Then you wish to secure local action, and you do not object to a central authority?—No.

7607. But you think that good may arise from an intelligent combination of the two?—Yes; whatever be the sum raised by the efforts of the locality, I think the Government might give an equal amount in supplement thereof.

7608. Mr. *Ahroyd*] At what age would you teach sanitary science in elementary schools, and indeed, elementary science in general?—At the age of 10 to 12.

7609. You would expect the scholars to have acquired a knowledge of reading, writing, and arithmetic, before you endeavoured to teach these things, I suppose?—Yes. I think from 10 to 12 would be the proper age for commencing to give instructions or readings in science.

7610. Is your institution conducted by day classes or by evening classes?—The Watt Institution and School of Arts is conducted entirely by evening classes; we give a lecture of an hour each evening at half-past eight.

7611. You were saying that you received no Government grant, but that you conducted your institution independently of such grants, yet I observe in the balance-sheet of 1866-67, a deficiency on the receipts of 42 l 14 s.?—Yes.

7612. The institution is therefore not altogether self-supporting, at least you are forced to make an extra levy at certain times?—It is not altogether self-supporting as far as the students' fees are concerned, but these are supplemented by contributions from friends, and likewise by the rent which we receive from letting off part of the property. A little extra exertion and liberality on the part of the well-wishers of the institution will, it is hoped, clear off the deficiency which is apparent in the balance-sheet of 1866-67.

7613. But if you were able to obtain a grant from the Department of Science and Art, you would be somewhat more independent, would you not?—I believe the department would not give grants towards the buildings, or the rent; they only give grants to pupils who pass examinations, and to teachers.

7614. And you are prepared to accept those grants for both?—Yes.

7615. You being in communication with both the Society of Arts, the Science and Art Department, do you find any clashing between the two functions?—We have done very little with the Society of Arts hitherto; a few of the students have passed their examinations, but the lecturers have not paid much attention to those examinations, and although we have a gentleman who is the secretary in connection with these examinations, still very few of our students have ever taken advantage of them. We have always thought that the Science and Art Department was the body with which we should connect ourselves more immediately.

7616. I observe among the recommendations of your conference on technical education, that the mechanics institutions of the country should be re-organised, so that systematic instruction in elementary science may be placed within the reach of all artizans; have you formed any plan which you could recommend for the reorganization of

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those institutions?—I think the plan which was in the minds of those who framed those resolutions, would be this. At the present time the mechanics institutions distributed over the country cannot have systematic lectures on science, simply because the institutions are supported by the small sums which are paid for admittance by annual tickets, or for the evening lectures. At present those institutions have annually perhaps half-a-dozen lectures on science, and half-a-dozen on general subjects; and those half-dozen on general subjects will probably be delivered by clergymen, while those on science will be delivered by lecturers on science. The lectures must have a certain amount of popularity in them, and therefore they have not contributed much towards science teaching; the reason being, that those who take charge of those lectures, must to some extent introduce the popular element, or else they would not pay. I believe the mechanics institutions would be placed in a much better position if the Government would come forward, and say, for example, If you raise 50 l for scientific teaching in your locality, we will give you an equal sum; then, under such an arrangement scientific teaching would be placed on a much more solid and permanent footing, and I consider it likely that the systematic study of science might be begun and fostered by such a scheme, even in small towns.

7617. You would advocate the establishment of systematic science classes in connection with all those institutions?—Yes, in numerous instances, but many mechanics institutions are in districts where there is a very scanty population, and there I think we ought to devote ourselves simply to fostering the desire for the study of science.

7618. Is there any scientific teaching carried on now in connection with your mechanics institutions?—None in the mechanics institutions distributed over the country. The systematic instruction of artizans in science is restricted to the School of Arts in Edinburgh, the Andersonian Institution in Glasgow, and the Mechanics' Institute in Glasgow.

7619. There is no elementary scientific teaching carried on in connection with mechanics institutions in general?—There is no systematic instruction.

7620. Do you find a great advantage for scientific teaching in the fact that your population in Scotland is better educated than it is in England?—I would anticipate great advantage and benefit from that cause.

7621. You have junior and senior classes in mathematics, I presume the word junior applies not to the age at which students attend, but to the grade of what is taught them?—Yes; if a student wishes to attend the classes in junior mathematics, he may do so for three, or four years.

7622. You have two sessions; the attendance in the summer is very scanty; being only about 140, the attendance in the winter is very much larger; so that, in fact, your education is carried on chiefly in the winter session?—It is; the ordinary curriculum of study is entirely in the winter; we have merely extra classes in the summer, for we have found that, apart from the desire of most people to be in the open air in summer, the volunteer movement has affected us, and many of those who would be students are drilling at the time our classes are held.

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7623 *Chairman.*] You have referred to the chair of applied chemistry in Edinburgh, have you personally any doubt with regard to the tendency of technical courses in chemistry to improve our manufactures?—I have not the slightest doubt of it, and so much is that my opinion, that this year I organised, in connection with my classes, excursions to different public works, and introduced not only students of my own morning class, which is the more extended course, and is attended by the middle or professional and manufacturing classes, but I offered to the pupils of the School of Arts that any of them who could leave their work on the Saturday would be welcome, and from six to 12 of those artizan students accompanied me on each occasion, and probably 50 or 60 of the artizans availed themselves of one or other of these technical excursions.

7624. With regard to engineering, would you be of opinion that technical courses are also important in that department?—Undoubtedly.

7625. Mr. *M'Lagan*] What are the salaries of the teachers in the School of Arts?—The present salaries in the case of the lecturers upon chemistry and natural philosophy are 36*l.* 10*s.* per session of 25 lectures, ranging over the six winter months, and the lecturer on mathematics receives about 40*l.*, whilst the teachers of English and the extra branches receive the fees derived from their classes.

7626. *Chairman.*] Have you more than one session in chemistry in the course of the year?—One only during the winter.

7627. Will you hand in the balance-sheet of your institution?—Yes. (See *Appendix.*)

7628. Mr. *M'Lagan*] Are the professors of

your institution quite satisfied with their allowances?—We are not satisfied, but I believe the original sum given to the lecturers on chemistry and natural philosophy was 25 guineas; during the time of Professor George Wilson, the sum was raised to 30 guineas, and within the last two years there has been an additional 5*l.*

7629. *Chairman.*] If you had no other sources of income, it would be quite impossible that lecturers could be found for your school, I suppose?—Quite impossible; we look upon the School of Arts as contributing no substantial part of our income.

7630. Mr. *M'Lagan.*] The salaries are obtained from the fees and the subscriptions?—Yes, and the rent of the part of the building which is let off.

7631. Mr. *Powell*] Have you any field classes in which the pupils might gain a knowledge of botany?—No.

7632. *Chairman.*] Is there anything you wish to add to your evidence?—At the High School of Edinburgh elementary science is taught; the junior boys, or the first class, are taught botany; the second class, zoology; and the third and fourth classes natural philosophy; whilst the fifth and sixth being the rector's or higher classes, are taught chemistry; the boys in that school are found to appreciate highly the teaching of science, and the rector masters state that since the introduction of science, which took place rather more than two years ago, the pupils have advanced rather than fallen back in their other studies.

7633. Up to what age do they remain in the High School?—Till about 16 or 17 years of age on an average, entering the school at about 10 years of age.

Mr. JOHN MAYER, F.C.S., called in; and Examined.

Mr.
J. Mayer,
F.C.S.

7634. *Chairman.*] You are a Science Teacher in Glasgow?—Yes.

7635. And secretary of the Association of Science Teachers?—Yes.

7636. Will you kindly state how long you have been engaged in teaching science?—The school with which I am connected has given science instruction ever since it was founded, which is now upwards of 20 years ago. It is called a secular school, and was established by a number of gentlemen in Glasgow, to show that it was possible for a system of instruction to be established that should not founder on the rock of the religious difficulty. It is a secular school in which the Bible and Catechism are not introduced at all. The school is, in the ordinary sense of the word, an elementary school. The subject of science has taken a prominent position in that school; the teaching of elementary science only, of course, because the children are drafted almost exclusively from the industrial population, including among them small shopkeepers, managers and foremen in the large manufactories of various kinds, and artizans.

7637. At what age do the children generally come to your school?—In some cases as early as five years, and they attend the school up to 13 or 14 years of age. We begin with the merest elementary instruction; we give boys and girls a training, so far as we are able, in science as well as in ordinary elementary subjects. The school since 1859 has been directly connected with the Science and Art Department. I was the first

person from Scotland, and in the first year the only person who came to London to be examined in connection with the Science and Art Department. The class that was first established after I myself passed the examination was the class in inorganic chemistry. That was conducted apart from the ordinary school hours; but before that we had even taught systematically the elements of animal physiology, in connection with the principles of health, giving one or two every week during the whole 10 months of the session.

7638. What is the average number of years during which children remain in the school?—The boys and girls who get the benefit of the science instruction after they begin to receive it, attend in many cases for a period of three or four years.

7639. What is the entire number of pupils in your school?—We have had as high as 220 and as low as 160.

7640. How many of those are receiving instruction in science?—We have generally receiving scientific instruction about 60, and those vary in age from occasionally 10, but generally 11, up to 14 years of age.

7641. Are you paid on results in respect of those pupils?—Not on all; some are cut off on account of the position which their parents are supposed to occupy.

7642. What number may be cut off on account of the position which their parents occupy?—Of the 60 or so, the probability is that a dozen or 14 would be so cut off.

7643. What

7643. What have the results been in your time, say during the last two sessions?—The subject in which the greater number of pupils have been examined has always been animal physiology, and we may have from 30 to 35 out of the 60 who come up for examination. Some of those 60 have not been with us during the whole year, but if they have been for the whole session we generally expect they are able to go forward for the examination in May. In addition to the ordinary day classes we have had in the school evening classes during several seasons. I have myself conducted classes in chemistry and botany, including under chemistry the elements of metallurgy and working in iron and steel, and the extraction of metals generally.

7644. What have been the numbers attending those evening classes?—I have had from 12 to 20 attending those classes.

7645. Are those classes also in connection with the Science and Art Department?—Yes.

7646. Are the pupils chiefly apprentices or adults?—Both; they are very mixed.

7647. Are the adults generally of the working classes?—Almost exclusively; besides the purely evening classes and the purely day classes I have for five years now had a normal students' class, a class of young men, and for two or three years have had even young women who come from the normal schools in Glasgow.

7648. Have those pupils been numerous?—Yes; I have had as many as 18, and never less than 12. They are generally second year normal students who have learnt that we are willing to conduct a class for normal students in the subject of animal physiology. Under that head we generally give a certain amount of chemical information and zoological and botanical information. I have had a number of normal students also, who came to attend the botany class and the chemical class. They cannot get those subjects taught them in the normal schools. There is at present no provision in the Glasgow Normal Schools for giving systematic instruction in science except pure mathematics.

7649. Are you acquainted with the operations of the Andersonian Institute and the Mechanics' Institute in Glasgow?—Very intimately.

7650. What is done there with regard to teaching experimental science?—The Andersonian Institute was the first institution in which science lectures were given. When the science instruction was commenced there it was really systematic.

7651. What is being done there now in that respect?—Dr Birkbeck, Dr Ure, Professor Graham, and Dr Penny have systematically taught science since the foundation of the classes.

7652. Is that the same Professor Graham who is now the Master of the Mint?—Yes.

7653. Can you state the number of pupils in the Andersonian Institute?—In the chemistry class I believe they vary from 400 to 500 students, who attend courses of from 20 to 25 lectures. The lectures are given in the evening, and last from one hour to one hour and a half each lecture, they are lectures such as Dr Macadam has spoken of, they are generally on inorganic chemistry one year, and organic chemistry another year, but in both cases they are given with special reference to applications in the arts and manufactures.

7654. Who is the lecturer on chemistry at the Andersonian Institution?—Dr Penny.

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7655. What number of pupils generally attend his class?—About 400 or 500 attend his class alone.

7656. Is that institute in connection with the Science and Art Department?—Dr Penny has not himself a certificate from the department; he can obtain no direct aid, and he has never troubled himself to prepare pupils for those examinations.

7657. Do you know why he has not done so?—I understand that he applied a number of years ago for a certificate without examination, and at that time the granting of such certificates rested with the special examiner retained by the department. Dr Hofmann was examiner at the time, and I am told that he could not recommend Dr Penny because he did not know anything of him to justify him in giving the certificate.

7658. If Dr Penny had possessed a certificate are the pupils attending his lectures generally of the rank which would have entitled him to be paid on results?—A very large number of them are.

7659. What proportion of them?—I should expect that from his class not less than five-sixths, and perhaps even a larger number, would be strictly of the industrial class.

7660. Could you compare the scientific instruction received from those lectures with that which would qualify for payment on results in connection with the South Kensington School of Arts?—Taking the lectures simply, I feel quite satisfied that the students attending the course of 25 lectures would not be able to pass the examination. There must also be practical work in the laboratory.

7661. Is there that practical work in the laboratory in many instances?—Yes. There is a practical class in the laboratory held one evening per week, two hours each attendance, and this class is largely attended by young men who are themselves engaged in chemical establishments of various kinds, but there is a separate fee, and it is only those who are in tolerably good situations that can afford that payment.

7662. Do you know the amount of the laboratory fee?—One guinea for each course, a quarterly course of 12 nights.

7663. Does that include the use of apparatus and materials?—Yes, it includes the use of apparatus and materials.

7664. How are the professors of the Andersonian Institution paid?—The lecturers on chemistry, animal physiology, and natural philosophy are endowed. A Glasgow gentleman, Mr. Freeland, who has retired for many years now, and is living at Nice, gave 7,500 *l* eight or ten years ago, to endow those lectureships. The lecturers themselves receive for the 25 lectures, a sum of about 100 *l* each, with some abatement to assist in paying the expenses of conducting the classes. Then there are the payments derived from the fees; the fees paid by the students are very small; the fee for the course of 25 lectures, including the use of the very valuable library, is not more than 3 *s*.

7665. Is there any payment at all from the State or the municipality?—None whatever.

7666. What is the effect of this scientific instruction on the artisan class?—I believe it is of very great value indeed; a very large number of persons now in excellent positions in society, and others in responsible positions as servants, can trace their success in a very great measure to their

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their attendance at the classes of chemistry and natural philosophy in the Andersonian Institution.

7667 Are there any lectures on civil or mechanical engineering?—Not in the Andersonian Institution. The natural philosophy class in the Andersonian Institution is a class that goes very systematically to work. Mr Herschel, the son of Sir John Herschel, is the occupant of that lectureship; and since he undertook the work he himself became connected with the Science and Art Department, and he is now in such a position that he can receive the aid of that department, he is conducting the class not by lectures only, but by tutorial instruction and private examinations.

7668. And in that class payment is made on results, is it?—It will be henceforth made on results.

7669. Can you state what is the teaching in the Glasgow Mechanics' Institute?—In the Glasgow Mechanics' Institute, the natural philosophy and chemistry classes, the really fundamental classes, have not, for a number of years, been at all so successful as those in the Andersonian Institution, and the amount of apparatus, and the means of illustrating the lectures, are so very much greater in the Andersonian Institution, that a much larger number of students are drafted into it than go into the Mechanics' Institute; but the other classes are, some of them, largely attended in the Mechanics' Institute.

7670 You mean the science classes?—Yes, some of them.

7671. What are those classes?—There was a class for mathematics during the session 1867-8, and there was sold to those classes, junior and senior, 266 quarterly tickets.

7672. What is the cost of those tickets?—Six shillings a quarter, I think.

7673. Have you stated what is the fee for instruction in the Andersonian Institution apart from the laboratory?—Apart from the laboratory it is 3 s. per course. I think at one time it was 2 s. 6 d., and for several years it was 2 s.

7674. There being only one course in each year?—Only one course in each year.

7675. And that course occupies about six months?—About six months; for the last eight or 10 years, however, there has been a botany class in the Andersonian Institution during the summer months. At the Mechanics' Institution, besides the class for mathematics, there is also a class for botany, which was attended last summer by 21 students; the class for practical mechanics was last winter attended by 15 students; the class in geology was last summer attended by 93 students, and at the class for mechanical drawing there were 206 quarterly tickets sold. This is also a very popular class in the Mechanics' Institute, in fact, the most popular class apart from the mathematical class.

7676 Are those classes in connection with South Kensington?—The only one that is really connected with South Kensington is the one for practical mechanics; none of the others have taken any aid from the Department of Science and Art.

7677. Can you at all suggest why they have not done so?—There are various reasons; the Mechanics' Institution has had some little inclination in its past years to be regarded as a kind of parent institution, and having a little natural pride in that way, it did not trouble itself with the scheme, or make any inquiries.

7678. You mean the parent of the mechanics' institutes?—Yes, but, of course, the Andersonian Institution is the real parent. There is some indisposition in Scotland, generally, as far as I can learn, to take advantage of any Government aid in the teaching of science. I cannot say why; Mr. Buckmaster, the organizing master of the department, has been twice in Scotland, once last spring; and until now there has been no practical result from his first visit, any practical result which might now arise would be from his second visit, and from the conference spoken of by Dr. Macadam.

7679. But that indisposition has been so far conquered that the professor of natural philosophy at the Andersonian Institution has now consented to place himself in connection with the Science and Art Department?—Yes, I have some expectation that the chemistry class will be placed in connection with the Science and Art Department. I must correct myself by saying that the anatomy and physiology class has likewise taken the aid this Session for the first time.

7680. Then, at the University of Glasgow, have you anything to say of the teaching of science supplementary to the evidence of Dr. Macadam?—There has been in existence now for several years, perhaps not exceeding six years, an arrangement whereby an engineering diploma can be granted by that university. There are various classes gathered around Professor Rankine's class in civil engineering and mechanics. The engineering course embraces civil engineering and mechanics, geology, chemistry, natural philosophy, and mathematics. The student must attend all those classes, or he must produce a ticket of attendance at the classes for natural philosophy, chemistry and mathematics, in some other university.

7681. Do you mean that every student in the university must attend some of those classes?—No, only students of the applied science department.

7682. How long have those classes existed?—I should say, perhaps, not above six years in their present complete shape.

7683. Is the number of pupils very large?—In chemistry, natural philosophy, and mathematics, the attendance is very large, but I think about 30 is the maximum number of the students attending the engineering class.

7684. Many of the students in the other classes would be medical students?—They would be medical students almost universally.

7685. Are there many students in the chemistry class who would be proposing to devote themselves to manufactures?—Not a large percentage. I dare say we might say that in Glasgow in the University course of lectures on chemistry, there might possibly be five to eight per cent. of the students who would be proposing to devote themselves to manufactures, but I have no exact data from which to speak, and it is only from my own attendance at the class, and from my knowing something of the students that I am able to say that I think from five to eight per cent. of them would be students who would not be medical, or engineering students, but pupils studying chemistry as a science to connect with their own arts.

7686. What are the fees at the University of Glasgow?—£. 3. 3 s. for each course of lectures.

7687. Among those students, are there many of

of the working class?—In the University classes there are exceedingly few, in the engineering class there are a large number of students who are to be engineers, either civil or mechanical.

7688. Are there any evening lectures at the University of Glasgow?—None at the University.

7689. Are the students at the Andersonian University chiefly working men?—Almost exclusively.

7690. Are they generally apprentices, or are they adults?—A large number of them are adults.

7691. Is there any difficulty in imparting information to them from their want of previous elementary knowledge?—I feel quite satisfied that a number of persons who attend the chemistry class, and though not so frequently the natural philosophy class, and perhaps I might also say the botany and physiology classes, would not be able to pass the Society of Arts' examination, because they would be plucked on elementary subjects.

7692. Have you found that that constitutes a very serious hindrance to the progress of your scientific instruction?—The information which they will get would be to a very large extent *vis à voce*, in many cases I believe they would not be able to read with advantage books on systematic science.

7693. Does that apply to a large proportion of those students?—No, not to a large proportion.

7694. But comparing the students at your evening classes, and those at the Andersonian Institution, with men of the corresponding grade in England, would you say that the Scotch were better grounded in elementary subjects than Englishmen?—Most decidedly.

7695. How far do you think elementary teaching in science could be carried in elementary schools under the conditions and arrangements which now exist in Scotland?—I believe that in Scotland, as a rule, the pupils, even in the elementary schools, from 11 to 12 or 14 years of age, would be able to receive a very large amount of instruction in science, not only in the facts of science, but also in the methods of observation, and even in the principles of science. That I give as the result of my own experience, I do not believe that the pupils I have had are any better on the average than pupils generally are in other elementary schools taken from the same vein of society, and I find they can actually reproduce in writing the instruction given to them.

7696. Do you think you could say that of children instructed in English schools of the same grade?—I believe they could do almost equally as well as the pupils in Scotland.

7697. If they remained at school for the same length of time?—If they remained at school for the same length of time.

7698. Do they ordinarily remain at school in Scotland up to about 14 years of age?—In many cases, but not to a large extent, when their parents have an income of 50*l*, 70*l*, or 100*l* a year, children may remain at school perhaps up to 13, or 14, but otherwise they are frequently taken away at 10, or 11 years of age.

7699. Are you acquainted with the effect of the factory regulations on education in Glasgow?—No.

7700. What are the fees in the secular school?—The fees for the day classes are 7*s* 6*d*. per 0.72.

quarter; and for that sum the ordinary elements of education are given, and the science lessons also. We make no separate charge for the science lessons.

7701. Are you acquainted with the normal schools in Scotland?—I know those at Glasgow, more especially through the connection I have got with them by students coming to me from them during the last five years.

7702. They come to you because those subjects are not taught in the normal schools?—Exactly.

7703. Therefore any instruction which would enable them to impart scientific knowledge to their pupils has to be acquired elsewhere?—Yes.

7704. Mr Akroyd.] Are there many factories in Glasgow?—Yes, a very large number.

7705. Do you not find generally that the parents of the children who attend those factories take the children away from school at the age of 13?—Yes, frequently, but a few of the parents who are in receipt of upwards of 50*l* a year, if they are well-conducted and sober persons, will let their children remain at school longer.

7706. With regard to the endowments for the teachers and professors in the Andersonian University, do you think those endowments have had the effect of drawing to the institute rather, a higher class of teachers than you would otherwise expect to have?—There cannot be said to have been any change in the lectureships or teacherships, since the endowments were instituted; the gentleman occupying the chemical lectureship has been in it for 30 years or more, and the endowment is not 10 years old.

7707. Comparing your teacherships and professorships with those of the mechanics' institutes, have you precisely the same class of teachers, or a higher or better class of teacher at your school than at the mechanics' institutes?—Taking those in the Andersonian Institution, and comparing them with the teachers in the mechanics' institutes, they may be said to be rather of a higher level.

7708. Then have not the endowments conduced to that effect?—No, I think not; the persons who have the lectureships are just the same persons as those who occupied the posts when the endowments were first given, with the single exception of Mr. Herschel, and he came and took the post because there was a vacancy.

7709. Speaking broadly, however, you would admit that a fixed income would have attractions over an uncertain income?—Most certainly.

7710. In connexion with the Science and Art Department you have an annual inspection, I presume?—At the time of the annual examination held in May, for two or three years, or perhaps more, there has been a visit from one of the officers of the department.

7711. And you attach great importance to those annual visits and examinations?—Yes, I attach great importance to the examination, but practically no importance to the visit.

7712. Do you give prizes at your institute?—There are none given by the school itself, all the prizes are given by the department.

7713. There are none given independently?—None.

7714. Mr. M'Lagan.] Did I understand you to say, that the Andersonian Institution is a purely artizan college?—No, there is, in addition to the artizan department, a medical school.

7715. Taught by the same professors?—By

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two of the same professors, but there is no natural philosophy class for the medical students. That subject is not required by the College of Surgeons, or by the Glasgow Faculty of Physicians and Surgeons, but for an university degree in medicine it is required.

7716 Therefore the professors in the Andersonian Institution are in a much better position, and have much better salaries than the professors of the School of Arts in Edinburgh?—Certainly.

1717 They have endowments, and the fees from the medical students also?—Yes.

7718. What are the fees which the medical students pay?—The medical students pay for each class a fee of 2*l* 2*s*; in the University proper it is 3*l* 3*s*.

7719 Those certificates from the Andersonian Institution are taken by the Faculty, are they?—They are taken by the Faculty, and by all the examination boards throughout the country, in medicine.

7720. Mr. Powell.] Did you state, in a previous answer, that you gave instructions to the students at the normal college in science?—No; I stated that the students from the normal college in the second year had generally, to the extent of 12, 18, or 20, come and attended a class of mine.

7721. Whether you go to them or they come to you, the result is that science instruction is communicated by you to them?—Yes.

7722. Do you consider that the instruction so communicated is of such a nature as to impress upon the minds of those pupils the elements of the science of health as applied to ordinary domestic life?—Yes; as an illustration, I may say that a young lady who studied with me has been certified by the department, and is now teaching in a school belonging to Mr. Murray Dunlop, the Member for Greenock, and for the last four or five years that school has been receiving aid from the department.

7723. You think the instruction imparted, when communicated through the teachers whom you instruct, will induce the working classes, with whom in future years they will have intercourse, to attend to the ventilation of their homes, and to other circumstances which relate to their health?—I am quite satisfied of it.

7724. Would you apply the same remarks to the necessity of personal cleanliness?—Yes.

7725. And to the cooking of their food in a wholesome and nutritious way?—Yes.

7726 Lord Frederick Cavendish.] Are you acquainted with the system under which assistance is given by the Science and Art Department, have you any suggestions for any

improvement in that system?—One thing which I should most distinctly ask the department to do, and indeed I have done it through another channel already, is this, that the examination for teachers specially should be resumed; they have been dispensed with for the last two years, and I think they should be resuscitated; and I might perhaps venture to suggest how that should be done. I believe that the present local committees, wherever there are centres of examination, would undertake the duty corresponding to what they now do, if the department would send down printed papers.

7727. Do you wish that the teachers should pass a higher and more difficult examination, or is it for another reason?—I should wish the teachers to pass a higher examination, and I feel sure that it would carry far more weight in the estimation of the teachers as well as of the pupil. I have also to suggest that the difficulty which still exists as to the teaching of elementary science in schools, should be abolished by some arrangement between South Kensington and Whitehall, and that a teacher should be allowed to receive payment on results, whether he taught during the day or during the evening. Very many teachers are not able to do it, but whenever the teacher was both able and willing, I would allow him to teach science during the day, and the Whitehall department should not interfere with him.

7728. Are you satisfied generally with the system of payment on results?—Yes, it has been attended certainly by an amount of success to myself which enables me to speak of it. It may be, indeed I believe that it is not the correct thing with regard to the elementary department, but with regard to science as a rule, I think it would be attended with good to the teachers, and with good to the pupils, and with no ill effect to the State.

7729. Do you consider that the present amount of assistance is sufficient?—As I have had great latitude allowed me in my own school, I have been able to receive pretty fair sums in aid, but the system might not succeed quite so well in thousands of cases.

7730 Chairman.] Are you aware that it has been proposed to have a third grade of examination, namely, an examination for honours at the May examination; and do you think it would be sufficient for a person preparing to be a teacher, to pass in that higher grade of examination?—I think that would have no ill effect whatever, but I would suggest that the candidate for the teacher's certificate should not be examined in the same room as the pupil, or at the same time.

Mr. ROBERT GILL, called in; and Examined.

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7731 Chairman.] You are a Manufacturer, I believe, at Innerleithen, in Peeblesshire?—I am.

7732. You represent the South of Scotland Chamber of Commerce?—I do.

7733. I believe the South of Scotland Chamber of Commerce voted a sum of money for the purpose of conducting an inquiry into the state of the manufactures and the education of artizans, and the manufacturing class generally on the Continent?—They did.

7734. And you undertook to conduct that inquiry for the Chamber of Commerce?—I did.

7735. You have also formed opinions after reflection on the position of the industrial population with respect to scientific knowledge?—I have.

7736. Is it your deliberate opinion that there is a difficulty in this country in getting qualified foremen and managers?—That is a difficulty which we have had for a great many years almost constantly to contend with.

7737. To

7737. To what do you attribute that difficulty?—To their want of scientific instruction in their business. There are two branches of the woollen manufacture very much requiring scientific instruction, namely, weaving and dyeing, and the greatest deficiency which we find in them is especially in regard to dyeing.

7738. Your dyers have very great practical skill, no doubt?—They have practical skill up to a certain point, to which their limited knowledge has carried them, but they have no scientific knowledge; nothing but what has been acquired in their experience; they have no means of getting scientific teaching, there is no such thing as a school in Scotland in which the art of dyeing is taught.

7739. Do you think that dyeing would be better taught in a school than in a factory?—Yes, clearly so, in a school the rules of the science would be given; the theory would be taught as well as its application. In a factory you have only the compounding of the substances for bringing out the colour, and that often inaccurately, expensively, and very wastefully done, there being no scientific knowledge to guide the operation as yet.

7740. Perhaps you would say that if the principles of the art of dyeing were acquired in some school, and the practice of dyeing were obtained in such manufactories as we have in this country, the combination of those two would be as good teaching as could be obtained?—I am of that opinion; the principles of the art and their application being taught in the schools, as is the system on the Continent.

7741. By factory, of course, you mean a dye-house?—Yes; in all woollen factories throughout Scotland the dyer is needed, some few of them have not a dyer in their own factory, but they employ what is called a public dyer, but there the want of that scientific knowledge is felt, as it is in the factories.

7742. But notwithstanding the absence of that scientific knowledge, is it the case or not that our people are as good dyers as the continental dyers?—I am afraid that is not the case, it has been the case, but I think that on the Continent now they have gone ahead of us in that, and in some other things, in their factories.

7743. From your own personal experience, can you state any other things in which they have gone ahead of us?—In some of the machinery employed in our business, and in their mode of working it.

7744. Is it not rather in the mode of working than in the machinery itself?—No; I found some machinery in the carding business better, I think, than any we have in this country.

7745. Where did you find that?—I found it to have come from Chemnitz.

7746. In what factory did you meet with it?—I met with it in factories in Saxony and in Prussia.

7747. Did you meet with it in Belgium?—I am not able to say that I met with that Chemnitz carding machinery in Belgium, but there is very good carding machinery made in Belgium, quite equal to anything we have made in England.

7748. Did you visit any factories in Verviers?—Yes, I went over two of them.

7749. Were they spinning factories?—One of them was a spinning factory, and the other was a spinning, weaving, and complete establishment for making broadcloth.

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7750. Did you find in the spinning factory that there was any other department of the wool manufacture in which they were superior to us, besides the carding department?—I think, generally, their working men are under a higher system of training, and do their work a little more methodically, they sort the wool more carefully than is generally done in our factories, but on the whole there is not very much difference there.

7751. The Belgians produce a comparatively fine quality of yarn from a comparatively low quality of wool?—Yes; taking the wool in the bulk, it is of low quality, but out of each fleece they make six sorts, and sometimes a seventh, therefore they get a little very fine wool out of each fleece, and when they come to have a quantity they produce from it very fine yarn.

7752. Does that involve a greatly increased amount of labour?—It does.

7753. As between Belgium and England or Scotland, the question of wages will enter into the account?—Yes.

7754. Therefore, other things being the same, what would pay in Belgium might not pay in England?—Not in all branches of the business here, but in some it would pay.

7755. Is there a large importation of woollen yarns or fabrics into this country from the Continent?—That is not quite within my knowledge; I believe there is a large importation of yarns from Belgium and Saxony to Glasgow and Paisley.

7756. That is to say, a really important importation?—It is a very important trade: the factories in Belgium and Saxony are running 22 hours out of 24, making yarns, they are not altogether, perhaps, but some are chiefly employed in spinning for that trade.

7757. They are working double gangs?—Yes; relays of people.

7758. Did you see any of those factories at work?—I did.

7759. Did you see any of them working at night?—No.

7760. Are you aware whether the children are employed there during the night?—I had better not speak very positively on that point. I believe that children in Prussia from 14 years of age may be employed 11 hours during the 24; it may be part of the day and part of the night.

7761. Are you aware that both in Prussia and Saxony they cannot be employed at all under 12 years of age?—I am.

7762. Are you of opinion that the continental manufacturers are deriving any advantage from the superior instruction of their managers and foremen?—Yes; it is impossible to resist that impression, when you see the means of instruction provided for the work people, and the effect on the work people in the factories.

7763. In what way is that advantage derived?—In the first place, I may say the fact of the good elementary education which they receive, followed up by higher education, has made them a thoughtful and orderly body of working people. Then the scientific knowledge will certainly tend to give them great superiority over other countries which do not adopt that system.

7764. You mean that they get economic results which they would not get if they were less carefully instructed?—Yes.

7765. Would you say the same of the manufacturers themselves?—The manufacturers them-

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selves take advantage of those industrial schools; they go there and learn more of the business almost than they do in their own factories; they get through technical instruction in those schools to become manufacturers, and then they follow it out in practice within their establishments. The sons of manufacturers and the sons of any persons wishing to become manufacturers are taught to be so in those industrial schools.

7766. Can you describe the nature of those industrial schools?—In the first place the schools are very large establishments with many classrooms, and several large rooms in which are deposited specimens of every kind of industry which exists not only in their own neighbourhood and country but abroad; the place might almost be called a museum. The professors bring the specimens from the museum into their class rooms, and they lecture to the students with those specimens before them, and give them their instruction with those things in their hands. Then they have models of all kinds of machinery and all things which it is necessary they should have in the carrying on of their several classes. Where the machines are too large to be moved into the classroom, the class is taken into the museum and the lecture is delivered to them over the machine. All that constitutes a very excellent training. Besides all that, they have their weaving schools, where it is made quite a science, and everything connected with weaving is most carefully taught to them. They are taught to design patterns, to design from nature, and from any beautiful object, and to apply those designs to the goods of all kinds. All those lessons are given to them with as much care as lessons on arithmetic or anything taught in our ordinary schools would be.

7767. You have now spoken of purely technical instruction, but is there no theoretical instruction preceding that technical instruction?—They have to begin with their elementary schools, which we should very little understand indeed if we thought of them in connection with our own parish schools in Scotland. These are large buildings containing very many large class rooms; there are not permitted to be more than 45 pupils in one class room at a time, and only that number until there are as many fives above 40 as shall constitute another class, and then that 40, which is the standard number, get a room to themselves. They hold it to be essential to the success of the teacher that only one class should be in a room at a time. In our parish schools there is only one room for all the various branches which they teach, and that room, in most cases, is a small one. One elementary school which I went over contained no less than 54 class rooms, there were other two schools in the same place of nearly the same size, and there were in course of erection several district schools for the greater convenience of children, the town having increased considerably; that was at Chemnitz in Saxony.

7768. Are you now speaking of elementary schools?—Yes.

7769. But is there any theoretical instruction in science preparatory to the technical courses of which you have spoken?—Yes, there is theoretical instruction given in all those industrial schools; in natural philosophy, chemistry, mineralogy, and applied chemistry; to agriculture, for instance, and to such branches of industry as it is the handmaid. There is likewise taught architecture, mechanics, geometry, mathematics, &c. &c.

7770. Are you acquainted with anything in

England or Scotland analogous to the schools of which you have spoken?—We have not anything at all of the kind in Scotland, and I am afraid there is nothing in England. If I wished to send my son away to receive such instruction as I could very easily find for him on the Continent, I do not know where I could send him in this country; but on the Continent, in every place of large population, whatever the industry may be which employs the population, there is a technical school in the midst of them.

7771. There is a school in every centre of industry appropriate to the industry of the district?—Yes, and if it be a district partaking more of a rural character, they then have instruction given accordingly, namely agricultural instruction. The museum contains all the specimens of agriculture which can be collected.

7772. Did you inquire how those schools were supported?—In all cases the governments render great assistance, generally contributing one-third, then a third upon the land of the province, and the other third by the commune. I suppose that is including the population of the neighbourhood of the town.

7773. Generally the State does not contribute more than a third, and a large proportion of the cost is contributed by local taxation?—Yes, I understand that to be the case, but at Brunn, in Moravia, where I found a very fine establishment of the kind, erected in 1860, the government contributed half the expense of the building, and the other half was laid on the land. The government also gave a subsidy to furnish completely the museums, and to provide all the apparatus of every kind. Its support is derived, I think, very much in the same way.

7774. Did you visit the school at Barmen in Westphalia?—Yes.

7775. Is that one of those schools in which theoretical and applied sciences are taught?—Yes.

7776. I believe you have brought with you drawings of the buildings recently erected in Barmen?—I have.

7777. Are you aware what are the fees paid for instruction in that school?—The fees are very trifling indeed; in Prussia, Saxony, and Belgium merely nominal. I do not know exactly, but I believe they are not exceeding 3*l.* per annum, as in Brunn, (it is 90 dollars, 13*l.* 10*s.* for 12 months, in the Weaving school at Mulheim; that is the highest in any case of an industrial school); but if it is shown that the pupil is not able to pay the fees, the education is given quite free in all the schools.

7778. Then persons of all classes are taught in that school?—Yes.

7779. Is it your opinion that if we had a much more extended system of scientific instruction in this country, our manufacturers would be greatly benefited?—Yes, I have not any doubt about that. We must take into account that manufacturers on the Continent, having that instruction to aid them, will continue to make very great progress; we, not having it at all, shall stand very nearly still, where we are; we have worked up to the point of the information which we possess, but they are receiving fresh instruction every day.

7780. Their practical skill is now nearly as great as ours, and they have scientific knowledge in addition which we do not possess?—Yes.

7781. What

7781. What would be the cure which you would propose for that state of things in this country?—The only remedy is to provide some means of giving that instruction, to grapple with it in a comprehensive manner, and not to do it in small dribbles.

7782. Do you think the manufacturers of the south of Scotland are fully alive to that necessity?—Quite so.

7783. Do you think they are prepared to make sacrifices in order to provide that instruction for their sons, and their foremen and managers?—I think they would be very glad to have an opportunity of doing so.

7784. Do you think they are prepared to bear the whole cost?—No, I think they would not expect to bear the whole cost, the general feeling would be that the institutions themselves should be under Government control, and that Government should assist in the erection of them, and in the expenses attending them in every way.

7785. But would they desire the Government to take the initiative, or would they be satisfied if, on the locality making a decided effort, the Government were to supplement that by an endowment?—I think that they are looking to what is being done in Parliament at present, for a measure to follow upon the evidence now being taken, and they expect the initiative to proceed from Parliament.

7786. But how would the Government be able to select the localities unless they had some guide to show them where those schools are most required?—Where the population amounts to a certain figure there can be no difficulty, and where it is under that, if neighbouring places could avail themselves of an institution situated conveniently for them, there might be a way of serving those places; but the way to get the education properly taken advantage of is to place it at the doors of the persons who are to receive it; and if the town is not very large the institution need not be so large.

7787. You would propose that in every large manufacturing locality, and even in very moderate-sized manufacturing localities, a science school should be established by the Government, and the locality should contribute to it?—Yes.

7788. Would you compel the locality to contribute to it by law?—Yes, I think so.

7789. Do you think that the Scottish manufacturers are prepared to sanction a law providing for a system of that kind?—I think they are quite prepared to pay a rate to support a system of that kind.

7790. A science education rate?—Yes.

7791. Since your return from the Continent, have you consulted with your brother manufacturers on that subject?—I have with as many as I met at the Chamber of Commerce last Saturday in Hawick.

7792. Was the subject of an education rate discussed?—It was referred to, and they are all quite prepared to see a rate imposed. That is a subject with which the minds of the people have become familiar of late years. People grumble at all rates, but I think they are quite prepared for a rate for that purpose.

7793. With regard to the working population on the Continent, did you find that they possessed much scientific knowledge?—The system is only beginning on the Continent to show its effects on the young; it has not been long enough in operation in the perfect form in which we see it now to

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send many highly qualified persons into factories, but there is no question that what is going on among them is acting on the minds of all persons who have any charge given them, and greatly improving their usefulness.

7794. Do you speak of the workmen themselves?—Yes, I speak of the workmen, certainly, every workman is in charge of his machine and of the material, and it is very important that he should be careful over that charge.

7795. But how would the workmen who leave school, at all events, not later than 14 years of age, in Prussia and Saxony, acquire their scientific knowledge?—They attend the classes in the evenings. There are classes held in all those schools in the evenings to enable those young persons who are employed during the day to avail themselves of the instruction given. In that school at Verviers the whole instruction is given after six o'clock in the evening, except on one day, when certain classes are held at four o'clock in the afternoon.

7796. Are those classes attended by working men as well as foremen and managers?—They are attended by working men as well as foremen and managers, they are open, and the working men are invited and pressed to go to them at a very small charge.

7797. You visited some of the manufactories of machinery on the Continent, did you not?—Yes.

7798. Can you state what machine shops you saw?—I was in two machine shops in Chemnitz; one for making power looms, and the other for making carding machinery. I visited the workshop of Theodor Wiede, and there I saw machinery quite equal to anything we make in this country, applicable to our woollen business, and one kind better made than anything we have.

7799. Do you mean better in design or simply better in the finish?—Better in the finish, better in the material, and better in construction.

7800. Were there any novelties of construction in those machines?—The only novelty was in the material. The axles were all of steel, and what we call the cleading was made of gypsum, I think, and so attached that it formed, when finished, a thing like a perfect enamel; so that, whatever the state of the atmosphere may be, the machine is always true, and that is most essential.

7801. Do you consider their carding-engine superior in durability to the iron carding-engines made in Lancashire?—Yes, I consider it better in all respects.

7802. Was there anything in it differing in principle from the machines produced by the best factories in Lancashire?—A little, but not very much. I found the people doing quite as much work with this small machine as is being done in our factories with a machine more than three times the size and weight of it, at less expenditure of money, and a less expenditure of power.

7803. Are you acquainted with the newest machinery made at Oldham?—Yes.

7804. Mr. Akroyd.] Do you export any of your goods?—They are sold for exportation.

7805. To what market do you send them?—The merchants we deal with for foreign countries come and buy the goods. We make them to order, and they send them to America, and I believe to the Continent; in fact, they are largely exported.

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7806. Do

Mr
R. Gill
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Mr
R. Gill
2 July 1869.

7806. Do you find much difficulty in meeting the competition of the Saxon manufacturers in neutral markets, in America for instance?—We are constantly hearing of it; and perhaps our trade in that way does not extend so much as their trade is extending. We can only draw inferences, not being directly in the market ourselves.

7807. Have you lost the sale of any article of your manufacture in consequence of foreign competition?—I think not in consequence of foreign competition; but articles have changed, which is more owing to fashion than to foreign competition.

7808. So that notwithstanding all the advantages which the foreign manufacturer has in the improved scientific education of his people, we have been able, hitherto at all events, to hold our own?—We may perhaps say that, but we must say it with some hesitation. I believe there is always a turning point to everything when a change is taking place, and that we should very seriously consider at the present time whether we are not now on that turning point, and take every possible means to prevent the change.

7809. So that although hitherto we have been able to maintain our competition without that scientific knowledge, yet you think that for the future we might lose our relative position unless we took care to secure to the working population the same advantages as they have on the Continent?—Yes.

7810. You spoke of the importation of Saxon yarns to Glasgow; are those Merino yarns?—They are not all Merino yarns, but they are used for a manufacture which exists there, on a very large scale, the making of winceys is a very large business in Glasgow, the yarns come principally from Verriers.

7811. Is that yarn woollen or worsted?—Woollen, there is worsted yarn comes for hosiers, but the yarns I speak of are soft yarns, not combed.

7812. But there is a large quantity of Merino yarn imported for the manufacture of shawls, is there not?—That comes principally from France.

7813. And that is not what you refer to?—No.

7814. I think you said that you thought your manufacturers would be very willing to contribute towards the scientific education of their people, provided, I suppose, they received a grant in aid from the department?—Or from Government; we have not yet got to know much about the Science and Art Department.

7815. You would be unwilling to incur the whole expense unaided by the Government?—Certainly; we think the Government has a duty to discharge in this matter.

7816. Are any of the Yorkshire worsted yarns consumed in Glasgow?—Yes.

7817. It is a large market for the Bradford yarns, is it not?—Yes.

7818. Have the Leeds yarns been much displaced by foreign yarns?—The quantity of foreign yarns used is very large and increases, no doubt displacing to a corresponding extent the Yorkshire yarns.

7819. Do you import any yarns from Stroud, in Gloucestershire?—Not to my knowledge.

7820. The foreign yarns are cheaper than those produced in this country, you say?—Yes, and very well made, they are very level.

7821. Do you know much of the colours produced in Turkey carpets and Persian carpets?—No.

7822. But from what you have observed, those colours are very beautiful and brilliant, are they not?—They are very beautiful and brilliant indeed.

7823. The dyers in Turkey and Persia have not derived much advantage from scientific culture, I suppose?—There must be a great deal of science exerted in the production of those colours.

7824. But in those countries it would necessarily be traditional science?—No doubt.

Mr. WILLIAM BAIN, called in; and Examined.

Mr
W. Bain.

7825. *Chairman.*] I BELIEVE you are a Manufacturer of Iron Articles at Edinburgh?—I am.

7826. You were, I believe, originally an artisan, and a student of the Watt Institution at Edinburgh?—Yes.

7827. During how many sessions did you attend that institution?—Four.

7828. What classes did you attend?—All the classes taught at the school, chemistry, natural philosophy, junior and senior mathematics, English, French, drawing, and modelling.

7829. What had been your previous training?—My elementary education was derived partly in a country parish school, and partly in a school at Leith.

7830. At what age did you leave school?—I think I left school when I was about 16 years of age. I did not attend constantly up to that time and, indeed, I had been at work for three years previously.

7831. Had you received any scientific instruction at school?—I had not.

7832. Had you had no instruction whatever in science when you first attended the classes at the School of Arts at Edinburgh?—None whatever.

7833. Was the whole of the instruction in science which you have received from others imparted to you there?—It was commenced at the School of Arts, but the course I followed out afterwards was by study on my own part.

7834. The courses which you attended were then supplemented by self-instruction?—Yes.

7835. Were there many artizans attending the school at that time?—Yes, the school was constantly full, each class numbering from 150 to 200.

7836. What were they; were many of them artizans?—I should say the majority of them were artizans.

7837. I suppose many of them were acquaintances of your own?—Some of them were.

7838. Can you state to the Committee what has been the influence upon your own career of the instruction which you obtained there?—It has enabled me to turn my apprenticeship, my skilled labour, and the business by which I make my living, to much better account than if I had not obtained that instruction.

7839. Were you a simple artisan, or were you a foreman or manager when you joined the classes?—When I joined I was simply an artisan, but before I left I was a manager.

7840. What

7840 What were the works in which you were manager?—Iron works, engaged in the construction of bridges, iron houses, greenhouses, and other articles made of iron

7841. They were the works of Messrs Young, who built the Chelsea bridge, were they not?—Yes.

7842 You were able to attend to your duties as foreman or manager, and at the same time to follow those classes?—Yes, and perhaps I may state that one of the most important arrangements about the School of Arts is, that the classes are held at late hours which enables artizans to attend, it enables parties who are occupied during the day to take advantage of the instruction offered there. At the university, where classes are only held during the day, the artizans could not take advantage of the instruction given there in consequence of their being employed during the day.

7843. You say that the advantage of your attendance at the lectures of the institution has been very great, are you acquainted with many similar instances of advantage derived by working men from the School of Arts?—Yes. I know a Mr. Ness, who is now an engineer, having the management of large works in this country, and I know several others. I have heard it stated that Mr. Nasmyth, the inventor of the steam hammer, was a student of the School of Arts in Edinburgh. If my memory does not deceive me, I believe he has been on several occasions referred to by public speakers at the school.

7844. In the works of which you are now the proprietor are there many artizans who attend the classes at the Edinburgh school?—I do not know that there are, perhaps there are three or four.

7845. How many workmen do you employ?—Fifty is about the average.

7846. Are those three or four men who attend the classes of the School of Arts foremen, or are they ordinary workmen?—Two of them are apprentices, and two of them are journeymen.

7847. Have they attended that school at your recommendation, or of their own mere motion?—Partly at my recommendation and partly from their own inclination.

7848. And being acquainted, as you probably are, with the feelings of the artizans of Edinburgh generally, are they favourable to this institution, and do they appreciate its value?—Very much, particularly because the course of instruction is systematic, lectures are not picked out and delivered, and taken for granted that they have been understood, but they begin at the beginning

as it were, and the course is made systematic, beginning with the simpler part, and the most intricate part is followed out afterwards

7849 In that respect the instruction differs very much from the ordinary courses of popular lectures, does it not?—Yes, it differs from the ordinary courses of popular lectures

7850 Are there any recommendations which you would wish to make to the Committee with regard to the courses of this kind?—I do not think I could add anything further to what Dr. Macadam has stated, than that the building should be enlarged, and, if possible, have given to it a higher tone of respectability, the Watt Institution and School of Arts is, in reality, a workman's college, and gives to artizans advantages which cannot be obtained at the universities

7851 In what way would you propose to give greater respectability to it?—I would recommend its endowment to a certain extent by a Government grant.

7852 You think that would give to it a certain amount of dignity?—I think it would

7853 Mr. *McLagan*.] You stated, I think, that the workmen of Edinburgh appreciate the value of this institution, are you aware whether any of the private subscriptions that are given for the support of the School of Arts are derived from working men?—I cannot say that, I think they are derived more from well-wishers to the school.

7854. Are they principally of the middle class?—They are principally of the middle class.

7855. Mr. *Arcyod*.] What science classes did you attend at the institute besides those on mechanics and mathematics?—Chemistry, and all the other classes taught at the School of Arts

7856 Did you find in subsequent experience in your occupation that knowledge of mechanics of the most essential use?—I thought so at the time, but experience has shown me that chemistry has been of as much consequence, and even more than natural philosophy.

7857. In your works you find the knowledge of chemistry quite as useful as that of mechanics and mathematics?—Yes, and perhaps more so

7858 At what hours did you attend the courses at the institute in the evening?—From half-past eight to half-past nine, and sometimes a few minutes longer.

7859. I suppose those are the most convenient hours for the working class?—Yes, because it allows those who work up to eight o'clock an opportunity of attending the lectures.

Mr
W Bam
2 July 1861

Friday, 3rd July 1868.

MEMBERS PRESENT:

Mr Acland.
Mr. Akroyd.
Mr. Bazley.
Lord Frederick Cavendish.
Mr. Dixon.
Mr M'Lagan.

Mr Wm Lowther.
Lord Robert Montagu.
Mr. Edmund Potter.
Mr Powell.
Mr Samuelson

BERNHARD SAMUELSON, Esq, IN THE CHAIR.

Captain DONNELLY, re-called; and further Examined.

Captain
Donnelly.
July 1868.

7860 Lord Robert Montagu] I BELIEVE you wish to put in the memorandum written by Mr. Cole?—Yes, he has written it at the request of the Chairman of the Committee “Memorandum on combining the Royal School of Mines, the Royal College of Chemistry, and the Royal School of Naval Architecture into a Metropolitan College of Science, prepared at the request of Mr. Samuelson, Chairman of the Select Committee on Technical Instruction

“1. Attached both to the Royal School of Mines, the College of Chemistry, and the School of Naval Architecture, there are already most of the professors who would be required in a college of science applicable to productive industry, and an improved organisation only is necessary greatly to increase the value of their present services. Some few additional professorships would have to be created. Wherever the college may be placed, ample space should be provided, in the first instance, for its future development, and it would appear desirable that it should be connected with, or conveniently situated with regard to, a museum illustrating the progress of science applied to industry, somewhat after the manner of the *Conservatoire des Arts et Métiers* at Paris. Moreover, it is most desirable that the locality of the college should afford facilities for provincial students being boarded either by the professors or in inspected lodgings.

“2 I consider that the arrangements for the Royal College of Science in Dublin furnish an excellent model for a similar establishment in London, with some slight modifications as to details. The whole report of Lord Rosse's Commission appears to be quite sound. The subjects taught are the following: 1st, applied mathematics; 2nd, descriptive geometry and mechanical drawing; 3rd, mechanism; 4th, physics; 5th, chemistry; 6th, botany; 7th, zoology; 8th, geology; 9th, mineralogy; 10th, agricultural science; 11th, mining; 12th, metallurgy; 13th, machinery; 14th, surveying. The course of instruction extends over three years. During the first two years it is general, and during the last year it is specialised under either mining, agriculture, engineering, or manufactures. The scheme is as follows—First year, 1st term, applied mathematics, physics, descriptive geometry, geometrical drawing; 2nd term, applied mathematics, physics, botany, descriptive geometry, geometrical drawing. Second year, 1st term, applied mathematics, chemistry, laboratory practice, mechanical drawing; 2nd term, applied mathematics, chemistry, laboratory practice, zoology, mechanical drawing. Third year, Division A., Mining: geology, with demonstrations

in palaeontology, mineralogy, mining and assaying. Division B., Agriculture geology, agricultural science and land surveying. Division C., Engineering mechanism, machinery, mechanical drawing and surveying. Division D., Manufactures. mechanism, applied mechanics and physics, and applied chemistry.

“3 If a college of science be established in London it is indispensable to its success that proper arrangements should be made to conduct its administration, which ought to be the sole duty of those entrusted with it, and should on no account be made a secondary work to any other occupation

“4. I believe a dean of faculty, elected for two or three years, would be the best kind of presiding officer for such a college.

“5 The whole time of most, if not all, of the professors should be engaged by Government, and for this they should be sufficiently remunerated, so that their minds may not be distracted with other and less important work, but which is necessary to enable them to maintain their social position. I consider such professors ought to be guaranteed an income of not less than 800 *l.* a year, with the probability of receiving more, proportioned to success. Such an income is below that of a second-rate prosperous tradesman, and among professional incomes would be considered very moderate

“7. Chemistry would be largely taught in the college itself, and it is doubtful whether the existing College of Chemistry should be also maintained. If it were found advisable to do so, it might be retained as a separate self-supporting institution for that special science in its application to manufactures, for which there is an increasing demand. This, however, is a matter for future consideration.

(signed) “Henry Cole.”

7861 I believe the subject of a central college was very much considered by the Board during last winter?—Yes, it has been before the Board in various forms.

7862 And a minute was prepared?—Yes, a draft minute was prepared.

7863. The minute was not passed because it was considered that it was a very bad year for commencing a system of increased expenditure?—Yes; and because it was known the whole subject was going to be taken into consideration by this Committee.

7864. This draft minute contains the conclusions at which we arrived after a great number of discussions?—Yes

7865. With regard to our intention as contained in that minute, we were desirous of supporting

supporting existing action, and rendering existing institutions available rather than of creating new ones?—Yes

7866. There are also a number of institutions in which scientific instruction is given, such as Oxford, Cambridge, Edinburgh, Glasgow, Durham, Aberdeen, St. Andrew's, Owens' College (Manchester), King's College (London), and University College (London)?—Yes, in all of those, more or less, a complete staff for scientific instruction already exists.

7867. But there the scientific instruction forms part of a general course?—Yes

7868. A person who wishes to go into scientific instruction must also matriculate in those universities in Latin and other subjects?—Yes. I may take this opportunity to correct a mistake made by Dr Carpenter with regard to that subject, and the question of degrees in mining in the University of London. In the year 1862 Lord Granville, Sir Charles Trevelyan, and Mr Lowe, made a Report upon the Royal School of Mines; and that report says that it would be very desirable to have a degree in mining, but it goes on thus "It is obvious that a universal diploma could not be granted by any one school in London, however eminent. Any diploma must be granted by an independent and impartial agency. The University of London seems to fulfil all the necessary conditions, having already by its charter the requisite powers. But it has been found that no arrangements can be made with the University of London, as classical knowledge is considered indispensable in the matriculation examination. We do not consider it expedient at present to recommend that a new body should be incorporated by charter for the special purpose of conferring degrees in Mining Science." Dr Carpenter, when he was examined, having forgotten, I suppose, the exact circumstances, said the request was refused, because the senate "considered it was not their function to give certificates of technical knowledge, without, what they held to be, a proper scientific basis." It will be seen, however, from the report, that it was intended to found the degree on a thoroughly scientific basis or course of study, and not to give it for mere technical knowledge. The classical matriculation was the real stumbling block.

7869. *Chairman*] Dr. Carpenter, I think, modified that answer in a subsequent part of his examination, did he not?—No, I think the same misapprehension runs throughout his evidence.

7870. *Lord Robert Montagu*] We thought it would be necessary to require not only that science instruction should be made complete in itself, but also that it should be separable from the other courses given in the various colleges?—Yes.

7871. We intended, if the universities and colleges would form such special and complete courses of instruction in science, to consider a plan for giving them aid in carrying them out?—Yes, and of course to consider any plans they might themselves bring forward.

7872. We thought, also, that a few model institutions should be established, not only in the metropolis, but in the leading towns and centres of industry?—Yes, two or three.

7873. And that they should be formed on the model of the Royal College of Science in Dublin?—Yes.

7874. We thought that besides the one in London, there should be science colleges in

Yorkshire, the Midland Counties, the West of England, and also Owens' College in Manchester?—Yes. there was to be a grant for Owens' College

7875 And we proposed that the course of scientific training should last for three years, the first two years being general, and the last year having relation to the special branches of industry?—Yes, and that the School of Mines in Jermyn-street should be continued as a special mining school for the third-year course

7876 And that the school of naval architecture should be organised together with the central institution in London?—Yes.

7877 With regard to the places where these provincial science colleges should be put, we determined to choose those places which had a large population; a population above a certain number, where a site was given, together with funds towards the building, and the most liberal endowments for free scholarships?—Yes.

7878 *Mr. Dixon*] Was it the intention of the department to recommend that the Government grant should bear some proportion to what was subscribed in the different localities?—No, I think with regard to these central colleges, of which you could only have two or three, the idea was to take the towns which made the most liberal offer in the way of site and endowment, the Government providing the professorships

7879 *Lord Robert Montagu*] But would not all the grants in aid to the different institutions vary in amount, being more in one place than in another, what we would give towards the professorships or towards the scholarships was not to be a fixed sum?—No, there was not a fixed sum, it was to be a matter of negotiation between the State and the particular locality

7880. Was it not the fact that we had various discussions on the subject at the Board?—Yes, the subject was continually before the Board for several months.

7881. And we went very minutely into the whole question?—Yes.

7882 And our views were embodied in that draft minute?—Yes

7883. *Chairman*] Have you considered the memorandum which you put in on behalf of Mr Cole?—Yes.

7884 Does that also express your views?—Yes.

7885. *Mr. Acland*] Will you kindly point out in what respect the memorandum of Mr. Cole differs from the scheme which you have explained as having been adopted by the Board?—It differs in no way from the draft minute. But the draft minute entered both into the question of provincial colleges and a central college, while the *Chairman* of this Committee asked Mr. Cole to express his views upon the question of a central college alone. That memorandum gives Mr. Coles' view simply on that one portion of the draft minute, so that he goes more into detail upon the question of a central college than is done in the draft minute.

7886 May we understand from you that in this memorandum of Mr Cole's, the central institution referred to is the same as that referred to in the draft minute?—Yes, but Mr Cole's memorandum is his own private memorandum, the Vice President has never seen it, and the Lord President has never seen it Mr Cole is away in the country, and he was asked to prepare that minute, and I now hand it in simply as his own and my private opinions, but it relates to the

*Captain
Donnelly.*

3 July 1869.

Captain
Donnelly.

3 July 1868.

same thing as the central college in the draft minute.

7887. Lord Robert Montagu.] The intention was to let students from those provincial colleges, or even students from grammar schools, come up to this central college?—Yes, and from the science schools of the country generally

7888. The central college was to be open to all?—Yes.

7889 Mr Potter.] Mr. Cole's memorandum then is practically an extract from the minutes which were discussed before?—It is an enlargement on the same idea.

7890 To any great extent?—I think not.

7891. *Chairmen*.] But assuming that there should be no affiliation of any of these provincial colleges to this central college, would you still consider it desirable that a fusion should take place of the three institutions which are spoken of in that minute?—Certainly, and the two questions of a central college and provincial college are entirely independent, you may have the one without having the other.

7892. You put in the other day a minute with respect to the building grants of the council?—Yes, it had before been referred to in the evidence.

7893 You stated that a grant would be given on condition that the school should be built under the Public Libraries Act, or be established in connection with a school of art, aided by a department building grant, and that the terms of the minute of the 18th December relating to building grants, as far as applicable to schools of science should be complied with?—Yes.

7894 Compliance with those minutes would only be exacted in the event of the school being connected with a school of art, is that so?—No; those minutes go into full details with regard to the trust deeds, and all the conditions with respect to the land, giving a lien on the property to the department, and so on

7895 Is there anything in those minutes which would necessarily fix the proportional amount which would have to be given by the locality in order to entitle it to a building grant?—The amount of the aid that the department gives is not necessarily 2s 6d a-foot, it may be taken at any lower sum, 2s 6d is the maximum. Therefore, supposing the building were made very cheaply, and that the place itself did not pay 2s 6d a-foot for the building, the departmental aid would not amount to 2s 6d a-foot.

7896 But would it be the case that in the event of the school being built under the Public Libraries Act, a definite proportional contribution would be exacted from the locality?—Yes, certainly

7897 What would the contribution be?—The contribution by the department would never amount to more than the contribution by the locality.

7898 Mr. Akroyd.] I presume that letter of Mr. Cole is not intended to be complete in all details, but rather as a general outline of the plan recommended by the Committee of Council?—Yes, quite so; the minute has not been officially sanctioned by the Board, or submitted to the Treasury. The letter of Mr. Cole's is simply carrying out what was spoken of as a central college in the draft minute; he goes into certain details which are not contained in the draft minute; for instance, as to the payment of the professors, and that point has not been considered by the Board.

7899 Neither the memorandum nor the minute is to be considered as intended to be complete in all its details?—No; Mr. Cole's memorandum is simply his own view of carrying out what is found still more in outline in the draft minute.

7900. Mr. Potter.] In fact, your evidence now is simply recollections of a discussion?—Assisted by a printed paper.

7901. *Chairman*.] Your evidence with regard to the memorandum put in by Mr. Cole is confirmatory of that memorandum, as far as your own views on the subject go?—Yes, it was really prepared by us together.

7902. That memorandum represents your own views as well as Mr. Cole's?—Yes.

7903. And you look upon it as an outline, and not as a settled scheme?—Yes.

7904. Mr. Baxley.] Probably you regard that memorandum as suggestive only?—I think it is very good as far as it goes.

7905. But it is not a scheme which is recommended to this Committee?—I should certainly recommend it for adoption; but there are a great many details which would have to be filled in; though if the principles of the memorandum were admitted, the details might very easily be added.

7906. Mr. Acland.] I understand the view of the department, as represented in your former evidence, and that of Mr. Cole, to be that the action of Parliament for the promotion of science, should not be a substitute for local exertion, but should encourage and guide it?—Yes, certainly, except so far as central metropolitan institutions are concerned, which must be done by the State itself, there is no local feeling or sentiment that you can stimulate in such things.

7907. But what is your reason for thinking it necessary that the locality should exert itself concurrently with the Government outlay?—It is really the only way in which you can decide where your schools or colleges are to be placed.

7908 Is it not also true, that in order to make your institution a reality, it must not be, so to speak, sent down into the locality, but must rather be a felt want in the place?—Yes, the whole local interest must be exerted in its favour.

7909 Is it not an essential condition of the success of such local institutions that they should be locally appreciated and locally used?—Yes

7910. Then will you point out the distinction in principle between a local and a central institution as far as regards the probability of a central institution being a reality and being practically used, is it not necessary to have the same indications of a real want for a central institution before it is established as in the case of a local institution before it is established?—I think the two things stand on a different footing. A metropolitan institution is for the whole country; it does not appertain to London, but to the whole kingdom, while a local institution is meant for the use of the particular town alone; and, as a matter of fact, it has been the State policy for generations to have metropolitan institutions supported entirely by the State; for example, the British Museum, the South Kensington Museum, the School of Mines in Jermyn-street, and the Royal College of Chemistry in Oxford-street.

7911. Are you prepared to say that the mining interest of England has shown such an appreciation of the Jermyn-street Institution as to justify any very great outlay in that direction for teaching purposes, as distinct from the public profession of science?—I believe that the mining interest

terest of England has not shown a due appreciation of the advantages of the Jermyn-street institution, and one of the principal aims of this scheme is, that the existing professorships which are now, owing to the name of the institution and various other reasons, confined entirely to the School of Mines, should be made generally useful for other branches of science.

7912. Is it not the fact that the Jermyn-street institution practically resolves itself into this, that it is a platform on which the most eminent and distinguished men have suitable occasions for bringing out lectures on science of the very highest quality, which may be of great advantage to the nation when published, rather than anything in the nature of a college or school for teaching pupils?—At Jermyn-street there are some of the most eminent men in the kingdom who give courses of lectures, and if these courses of lectures were given in a college of general science instead of in a school of mines, I believe they would be as useful for the purposes of a school of mines, but that they would appeal to attract a far greater number of students, and would therefore be of much more use.

7913. In fact, the Jermyn-street institution does not now attract to London the *élite* of the students in science for practical purposes, or at least not to any great extent?—No, just because it is a school of mines.

7914. There is no preparatory course of instruction which the pupils have to go through,

but they are allowed to enter for all the courses of lectures at Jermyn-street, without any matriculation examination?—Yes, they are.

7915. But, does not Mr. Cole's memorandum presume, that before a person learnt anything about agriculture, mining, or engineering, he should have gone through two years course of mathematical and scientific teaching?—Yes.

7916. Taking agriculture then, will you kindly state on what ground you think it likely that students in agriculture would come up to the college and go through two years of severe training in science, and then attend the professors in London for the purpose of learning agricultural science; have you ever seen any indication of such a disposition?—No; I do not know that they would do so, but they would be better for the two years scientific teaching, even if there were no agricultural professorships in London.

7917. Have you any opportunity yourself of studying the conditions of proficiency in agriculture, or do you know at all what is the training which an intelligent farmer is now supposed to go through before he practices his art?—No; that which relates to agricultural instruction was simply taken from the Report of Lord Rosse's Commission, whether it would be advisable to have a chair of agriculture in London, is, I think, more than doubtful, as there is already an agricultural college established in the country.

Captain
Donnelly.

3 July 1868.

The Right Hon. LORD ROBERT MONTAGU, a Member of the House, Examined.

7918. *Chairman*] You are the Vice President of the Committee of Council for Education?—Yes.

7919. You have heard the answers of Captain Donnelly to certain questions which have been put to him as to the views of the department upon the extension of the higher scientific instruction?—Yes.

7920. Will you generally state whether those views are the present views of the department on the subject?—Those are the views which we came to after careful consideration of the whole subject and numerous meetings, those views were embodied in a draft minute which was not passed, because it was not considered that this was a good year in which to commence a greatly increased expenditure, but the draft minute contained the conclusions to which the heads of the department arrived, including the Duke of Marlborough and myself.

7921. *Mr. Acland*] When you say that these are the views of the department, are they the views of the department entirely apart from their practicability in a financial point of view?—Those are the views which we held, supposing they could be carried out.

7922. They are not the views of the Government under all the circumstances of the case, but they are in fact the theory?—No, they are not a theory, I call them practical.

7923. They are the objects which you wish to carry out if on consultation with other members of the Government they were found practicable?—That which we think should be carried out, if circumstances permitted, is stated in this draft minute.

entailed by the carrying out of this minute?—That would depend very much on the negotiations which might take place with particular towns; for example, Owens' College might subscribe; Birmingham might subscribe, and there might be a number of other towns which might be willing to enter into the system, this would make a difference in the annual charge.

7925. Should you say that the sum of 25,000 *l.* a-year for 10 years, or the sum of 50,000 *l.* a-year for five years in addition to the present estimates, would enable you to carry out those views?—I cannot say what the exact figures would be, the College of Science in Dublin costs 7,000 *l.* a-year; but if I recollect rightly, the whole of this system, supposing we established six colleges (which was the number contemplated), would cost about 25,000 *l.* a-year for 10 years.

7926. *Mr. Potter*] Does that include Mr. Cole's idea of a large central university?—It includes the central college contained in the draft minute.

7927. I mean the one referred to in the letter from Mr. Cole which has been laid before the Committee?—I have not read that letter, but the scheme embodied in the draft minute comprehended a central university in London.

7928. In that scheme you could not contemplate any such allowance as is made to the Glasgow University at present, I suppose?—Not as much as that, certainly.

7929. You had no idea of making any such addition to, for example, the funds of Owens' College?—That would depend very much on the locality itself, it was to be a matter of negotiation with the locality.

Lord
R. Montagu,
M.P.

Lord
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M.P.
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Explanation to add another 100,000?—I have already stated that it was to be a matter of negotiation with the localities, we had not determined to give equal sums, at one time we thought we should do so, but finally that was not determined.

7931 Is it your Lordship's opinion that 25,000 *l* a-year for 10 years would be an effective amount?—The estimate was made by Mr. Cole, and put in print. I have not looked at it for some months now, not, I think, since the opening of Parliament, and I cannot remember the figures, but to the best of my memory it amounted to 25,000 *l* a-year for 10 years.

7932 Mr. Acland.] I understand that your plan is to have a central university for science only?—For scientific instruction.

7933 Do you propose to endow the professors?—We propose to have professors and to pay them

7934 Not by endowment?—No.

7935 Then how are they to be paid?—They might be paid out of the estimates

7936 Do you propose to endow scholarships or exhibitions?—Very possibly.

7937 You would have a head, or director, or dean of faculty of some kind for this university, I suppose?—A dean of faculty.

7938 Was it to be a chartered body?—I do not know that it need to be chartered.

7939 Has there been any communication with the other universities on the subject?—We had had no communication with other universities before we came to these conclusions, we had received deputations, and we ascertained the views of various persons without putting before them our own views

7940 Have you any reason to suppose that the London University are aware of these plans?—I do not know that they are

7941 Do I understand that one reason for this plan is, that the existing universities require other elements of knowledge besides those which you include in your plan, and on that ground you think it desirable to found a new university?—I understand that the London University at all events requires other courses of study

7942 Is it proposed that these colleges of science are all to be incorporated in the Central University; are they to be affiliated to it?—No; it was no intention of ours to affiliate them

7943 Would they be entirely governed by the department?—No; not necessarily governed by the department. I should say they would be governed, in part at all events, by the locality; but that was to be a matter of negotiation.

7944. Chairman.] Was it decided that the central institution should be a university or a college, because I observe the word "college" is made use of in Mr. Cole's memorandum?—We contemplated a university.

7945. But that is not what is contemplated by Mr. Cole's memorandum is it?—I have not read that memorandum of Mr. Cole.

7946 Mr. Acland.] Representing the views of the department, may I ask you if it is the view of the department that the highest degrees in science should be given without any reference to liberal culture of other kinds besides natural science?—The university and the provincial col-

leges were to be for the sake of giving scientific instruction alone, and if any degrees were to be given by them (though that was a point which was not finally determined upon) they would depend upon the scientific culture of the person examined.

7947. But is it intended that these colleges are to give degrees as well as the university?—That is a point we have not determined upon, as will be seen from the draft minute which embodies our views, there was nothing said about degrees in that minute or in any other document that I know of

7948. Was it intended to work this institution in any relation with the medical faculty, or have the medical faculty been consulted upon the subject?—I do not know to what kind of relation with the medical faculty the question alludes.

6949. Has any communication whatever been taken with the governing body of the profession of medicine?—Not that I am aware of.

7950. Then do I understand you to state that it is intended to create a large university with a great many colleges for general science, and that one of the most scientific professions in the world will have no access whatever to that school of science?—I am not sure that I quite understand the question.

7951. Chairman.] Are you now speaking of a university in the sense of the older universities, or are you speaking of a polytechnic institution, such as those which exist on the Continent?—That depends on the meanings of the words "University," and "Polytechnic Institution." What we contemplated was this: that any person who had been educated at one of those colleges, or at any science school, and had attained great proficiency, should be able to come up to the central college in London, and continue his studies. Whether that central college should be called a university, on the ground of its being open to all the provincial colleges, or what else is meant by the word university, as distinguished from an institution for local or partial advantage, is another question.

7952. Mr. Acland.] Is it the view of the department that it is desirable to separate the study of science from the general secondary education of the country, is it your view that, instead of improving the secondary education of the country by the introduction of science into the education of grammar, or secondary schools, it is better to create separate colleges for the purpose?—On the contrary, we contemplated that the grammar schools should include scientific instruction, and that the inducements held out by these colleges would tend to produce that better scientific instruction in grammar schools; because the boys at those grammar schools would be led to hope that, if they prosecuted their studies in science they might go up to these colleges, and obtain scholarships, and, perhaps, even attain a still higher standing by means of the central college in London.

7953. This college, in fact, would be for the older boys leaving secondary schools, or rather for young men?—Possibly, but the view of the department had no limit with respect to age, it had regard to proficiency.

Professor THOMAS H. HUXLEY, LL D., F R S, called in, and Examined.

7954. *Chairman.*] You are one of the Examiners in Science, in connection with the Department of Science and Art?—Yes.

7955 You are also one of the Professors at the Royal School of Mines, in Jermyn-street?—I am

7956 Have you formed any opinion with regard to the organisation of that school?—I have been professor there for a number of years, and of course I am intimately acquainted with the organisation of the school. I presume the point to which the question particularly refers is its organisation for teaching purposes. For that purpose we require all the students who go through the whole of our curriculum to study during the first year physics and chemistry, they give almost their entire attention to those two branches of science during the first year, because it was the impression of the persons who drew up the present curriculum, of whom I was one, that those branches of science lie at the foundation of all others, that no one can acquire a real knowledge of physical science unless he is first acquainted with the elementary principles of physics and chemistry. I need not trouble the Committee with the details of the scheme as its general features are probably known to the Committee, but the principle of it is, that after instruction in those two branches of science is communicated, the student takes up those sciences, viz, mineralogy and geology, which supply the theory of mining, and finally devotes himself to geology, or metallurgy, or mining. He passes out in one of those branches, and takes what is practically a degree, namely, the associateship of the School of Mines.

7957 It has been stated that not many persons pass through such a course and take that degree; can you account for the paucity of persons who avail themselves of the full curriculum of the School of Mines?—There are several conditions which contribute to that result. In the first place, there are defects in the school itself, the first of those is, I think, the absence of any mathematical training, there is no chair of mathematics in connection with the school, and that I hold to be a very fundamental defect. I need not go into the reasons which caused that chair to be left out; there were several reasons, some reasons of convenience, and some reasons of policy, but I repeat that I think that a very important defect. A minor defect is the absence of any chair of botany, but that I consider a secondary matter. The second important defect in the School of Mines, as an educational body, is, that in the great majority of cases, the entire business of teaching is thrown upon the professors. Lectures are given, but in the majority of cases those lectures are not supplemented by the action of any persons corresponding to what the French call *Répétiteurs*; that is to say, we have not the tutorial system as well as the professorial system, though both of these systems ought to be combined in any completely organised course of instruction. That defect does not exist so far as the chemical and metallurgical chairs are concerned, but in my own class, and in the geological, mineralogical, and physical classes we have nothing corresponding to *Répétiteurs*. So far as my own class is concerned, I may say that the consequence is, that the teaching is by no means up to the ideal standard.

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7958 With regard to the Chemical and Metallurgical Departments, is it not the case that where that tutorial teaching takes place in the laboratory, the cost of the instruction is very much increased?—I would rather refer that question to the professor of chemistry, but with regard to my own branch of science, I find it a very great impediment that I neither have any *Répétiteurs*, nor have I anything corresponding to the laboratory of the chemist. I cannot teach my own branch of science properly, because I have nothing answering to a dissecting-room, or biological laboratory. The young men who are pursuing my branch of science should have studied the facts for themselves at all events, to a certain extent; but there is not even a room provided for such purposes. These which I have mentioned appear to me to be the principal defects in the school, and they interfere more or less with the efficiency of our teaching. Such defects are not perhaps apparent to persons who have not studied the subject of teaching carefully, but they very seriously affect the efficiency of a school, and must be regarded as causes tending to diminish its success. These and other causes account for the absence of any large success, but I must take leave to deny that the School of Mines has been a failure. It is very true that the number of students who have been turned out of that school is comparatively small, especially if it is looked at as a mere matter of arithmetic in relation to expenditure; but those persons who have taken the associateship of the School of Mines are instructed men, most of them have filled and are filling important positions, and act as centres for the diffusion of science throughout this country and the Colonies, and more than that, they have been of great value as leading people everywhere, though slowly, to admit the importance of professional training. So that, although we may not have turned out more than a few associates every year, the School of Mines is not a failure, on the contrary, I think that even if it had done nothing more than show the value of scientific training, the school has been a considerable success. But if the fact of the comparatively small number of students is to be regarded as so far evidence of want of success (and I admit that it is), I should throw the responsibility for that imperfect success entirely upon the ignorance and apathy of the manufacturing classes. That ignorance and apathy of the manufacturing classes acts on the School of Mines, or on any corresponding body, in two ways. In the first place, having no conception of the importance of scientific training, the manufacturers of the country do not send their own children or their leading men to take advantage of the school, and that diminishes the number of the students who might reasonably be expected to come to the School of Mines. In the second place, persons who have taken the associateship, distinguished themselves in their studies, and became thoroughly competent, may have an uncertainty about their future career. If a young man proceeds to a medical school, and goes through three years' training there, he is pretty certain of being able to get a living by his profession afterwards, although it may be a poor living; he is tolerably certain that he need not absolutely starve in the next succeeding two or three years, for he can go as an assistant, even if he can do nothing else.

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Professor
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3 July 1868

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3 July 1868.

On the one hand, though a student, who has gone through the course at the School of Mines, may, and often does, at once get a very valuable appointment, as our prospectus will show the Committee; yet, on the other hand, he may have to wait two or three years before he gets an appointment, and that acts as a very considerable discouragement when any parent of the middle classes thinks of sending his son to our institution. Such a man very naturally says, "What career is open to my boy when he has left your school?" And the only answer is, that the men who do well with us eventually get very good appointments, but they may have to wait two or three years for them. Those which I have now mentioned are, I think, the real causes of what may be called the numerical want of success of the School of Mines, for I guard myself very carefully in using the term "failure."

7959. Lord Robert Montagu] Do you mean that the student has raised himself above the work his father follows, and that then he has no career open to him?—No, I was speaking quite without reference to the status of the pupils or parents, he has no certain career open to him at the end of his course of study; he has to take his chance, though that chance is a fair one.

7960. But how does the course of study which he has received at your school spoil any chance which the student otherwise might have?—It does not spoil his chance.

7961. He is better off for it?—Far better off for it. The list of associates in our prospectus will show how our associates are, for the most part, occupying themselves, and the posts they fill are exceedingly good, considering the youth of many of them.

7962. Charman] But the student who has completed his course of study in the School of Mines is not immediately better off in a material sense?—Not, certainly.

7963. In reply to a question which I asked you before, you referred me to the professor of chemistry, but is it not the case that the cost of instruction is very much enhanced by the tutorial system, and in those cases would not the increased cost be in some measure a deterrent to persons addressing themselves to that institution for education?—So far as it is an extra expense, no doubt it would; but that difficulty would be very much qualified by the proportional advantage.

7964. Then what remedy, if any, would you suggest for this state of things in the School of Mines?—The principal and chief remedy which I should suggest is one which is not very easy to apply; but it is the real remedy, and that is an increase of intelligence on the part of the manufacturing classes. Let them once know what is the real value of scientific training, and I cannot have a moment's doubt that they will take it up as eagerly as they will take up any other means of improving their own business, and increasing its results.

7965. But you have stated certain defects in the constitution of the School of Mines, and I suppose that if those defects were remedied, you would expect some accession to the number of students?—Yes, in the long run.

7966. Then how would you remedy those defects?—I would say, give us a mathematical chair and a botanical chair (but I do not think the botanical chair is of so great importance as the mathematical), give us a staff of *répétiteurs*,

and give us the buildings requisite for efficient teaching.

7967. You know that there is a school of naval architecture at South Kensington?—Yes.

7968. Are you aware what is the course of instruction there?—No, I have no particular knowledge of it.

7969. Are you not aware that mathematical instruction is given, and efficiently given, in that school?—I understand so.

7970. Do you think it would be any advantage to the School of Mines, and to the pupils of that school, if they could avail themselves of that mathematical instruction given in the school of naval architecture at South Kensington?—Certainly; supposing it to be of the kind they required.

7971. So far, then, you would think that a fusion of the two institutions might be an advantage?—Certainly.

7972. In considering the causes which have led to the comparative failure of the mining college, have you considered whether the very name of the College of Mines may not somewhat have contributed to the result, as misrepresenting in some degree the subjects of study pursued in the college?—We have been in a very difficult position about that name. In the first place, I may explain that the School of Mines grew out of the geological survey. It was originally termed the "Government School of Mines and of Science applied to the Arts", but in the year 1853 an attempt was made to convert it into a general school of science; and its name was changed to the "Metropolitan School of Science applied to Mining and the Arts." In 1858, however, it was thought expedient, partly because we desired to avoid the appearance of drifting away from our original object, and partly because it was desirable to remove grounds of jealousy on the part of other scientific bodies, that we should return to our original designation; that is the sole reason why we remain as we are.

7973. I would ask you whether there may not also be some disadvantage arising from the absence of a central authority charged solely with the direction of the school as distinguished from another department?—The direction of the school is actually under such an authority, namely, that of the body of the professors who are the real governors of the school, the director general representing them; the affairs of the school are managed practically by the council of professors.

7974. Do you consider that mode of management is a satisfactory one, or would you prefer that there should be a governing head of the college?—No; I am not aware that there would be any utility in having a governing authority at the college, important educational bodies are managed by a council of professors, represented by a dean of faculty, and I think there is no need for anybody else.

7975. Then, having reference to the memorandum of Mr. Cole, which I believe you heard read, in which he suggests that a dean should be elected for two or three years, you would look upon such a dean rather as a constitutional ruler than as an autocrat, or as anything approaching to an autocrat?—Certainly; the mere fact that you have a body of professors, implies that they are competent to judge of their own affairs, and I think the direction of the studies is much better managed by such a body than it could be by any single person.

7976. I think

7976. I think you stated that it was in a great measure from the apprehension of jealousies on the part of other teaching bodies that you were prevented from making any change in the name of the institution, will you kindly state whether you would consider that such jealousies would have been well founded?—It was thought very desirable for a young institution to avoid such difficulties, though we were guided rather by the expectation of what might happen than by any actual demonstration.

7977. Then, suppose any jealousy or opposition had arisen, would you have considered that jealousy or opposition to be well founded?—I think it would have been well founded so far as those bodies would naturally expect that our competition might possibly interfere with them, but if you mean well founded in the sense that privately endowed bodies have a right, because they are privately endowed, to demand that the State shall not interfere with them, I think that such jealousy is certainly not well founded. Perhaps I may say that one class of privately endowed bodies appears to me to be at once put out of court; that is to say, all privately endowed bodies which have sectarian foundations. If any teaching body thinks fit to say that only certain persons shall come to receive instruction, those certain persons being bound to hold specified opinions, I think that body has no right whatever to cry out at any provision the State may make for the instruction of the people in general. But there are some privately-endowed teaching bodies which are non-sectarian, and my notion is, that while they may complain of undue competition on the part of the State, such competition as would crush them, they have no right to say that there shall be no competition at all on the part of the State. I do not think that a privately-endowed body is one whit better, because it is privately endowed than a State-endowed educational body, or has any right to make an outcry if the State competes with it within fair limits. On the contrary such competition may be of great use to the public, by tending to keep up the efficiency of both the private and the State schools. Still I think that in the case of those non-sectarian colleges, the students ought to have a fair share of all the rewards which are offered by the State to persons who are properly educated. I am not prepared to say that it might not be wise of the State to subsidise such bodies to a certain extent, and in proportion to what they have already done; it is, I am inclined to think, a case in which the principle of helping those who help themselves should be recognised. I should deal very tenderly with such bodies, but I think they have not the slightest claim to say, "You must not interfere with us, because we are privately endowed."

7978. On the whole should you consider that if great extension were given to the Government teaching in Jernyn-street or South Kensington, or to a fusion of both, that very fact would serve as a discouragement to voluntary effort for providing scientific instruction of the same grade, namely, of the highest grade of teaching applied to science?—I think it would, unless the State were prepared to offer a fair proportion of its scholarships and other rewards to those non-sectarian bodies, which are supported by private endowments. There is in London a very valuable body, namely, University College, which is entirely non-sectarian; and I think that if the State, not merely endowed a college to compete with that in

teaching, but also set up scholarships and rewards of various kinds, and said that no one should have those rewards except persons who went to the State school, that would be an unfair and crushing competition. But if the State says to privately endowed schools, "We shall give our schools so many of those scholarships and your schools so many of those scholarships, and perhaps you shall have a subsidy into the bargain," I think that is a very fair and wholesome competition.

7979. And a competition from which you would expect that no harm would arise to University College?—Not with the proviso that the State offered a fair share of its rewards to the students of that college as well as to its own college.

7980. Lord Robert Montagu] You would say that the competition should be open and not exclusive?—It would be very difficult to have open competition, because there would be such different classes of students.

7981. But do you mean to say that if there were scholarships, University College should have five, and the other college should have five?—I would leave the question of the precise proportion open so long as there was perfect fairness in the competition.

7982. Chairman] You are not speaking solely of scholarships, but of Government appointments, to be attainable by persons who had been trained in both institutions?—Yes.

7983. I think you heard read the memorandum by Mr Cole upon the establishment of a central college of science in London?—Yes.

7984. What is your opinion with regard to the proposition contained in that memorandum?—As far as I could judge, the suggestions were most of them extremely sound; I should be disposed to agree generally with them.

7985. Would you consider that by a fusion of the three institutions now receiving Government aid into one central institution, the advantages gained relatively to the cost would be very much increased?—I should say so.

7986. So far as you are acquainted with those institutions, would you consider a fusion of the Mining School, the Royal College of Chemistry, and the School of Naval Architecture to be desirable?—I can hardly speak of the School of Naval Architecture, as I know very little about it, but as far as the Royal College of Chemistry and the School of Mines are concerned, I must say I think the partial independence of the two at the present time is a lamentable circumstance, because in the School of Mines there is no chemical teaching, except that which is afforded by the Royal College of Chemistry.

7987. Assuming the School of Naval Architecture to be chiefly a school of theoretical and applied mathematics, and a good school of that description, would you consider that the addition of that school to the two others would be decidedly advantageous?—So far as they all of them teach certain branches of general science. I do not venture to give any opinion as to whether it might be desirable to have a special place for teaching naval architecture after the students have got their general science. But undoubtedly the only sound method of carrying out technical education is to take care that there shall be a general basis of scientific instruction for all classes of students. I hold that it is absurd to pretend to teach particular branches of science to

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people who have not previously acquired that general foundation. There are certain portions of science which, whether a man is destined for a naval architect, or an engineer, or a medical man, it is absolutely necessary that he should know if he is to deal scientifically with his own art. It is very desirable that all these fundamental principles of science should be acquired in some central institution, otherwise there must be a great waste of power.

7988. You give that answer irrespective of any existing institution, and merely as conveying a general principle?—Yes, I have a very strong impression upon that subject, I think that there is a certain amount of preliminary scientific training which should underlie every description of technical education, if that technical education is to be anything better than mere rule of thumb. If I may enumerate the branches of science which, I think, should be taught as a common foundation for all other scientific teaching, I should divide them into two groups. First come those branches of knowledge which are not only valuable as information, and as the groundwork of all science, but which are also the best instruments of mental discipline; and, secondly, those which should be taught as matters of information. Under the first head I should place elementary mathematics, elementary physics, with incidental chemistry, and botany, as the basis of all scientific education. Then coming, in the second place, to matters of science which should be taught as information, I should give the elements of what we call physical geology (though it is a very bad name), the elements of physiology, and the elements of what is called social science. On this last point I should like to insist particularly, because it is almost always left out in every scheme of scientific education; and yet really, for practical purposes, and more particularly for the classes who are to be benefited by technical education, some sound instruction in social science is of prime importance. I mean by social science what may be called the natural laws of conduct, or the laws which govern the organisation of society. I would refer the Committee for an illustration of what I mean, to the books of Mr William Ellis, the founder of the *Erkbeck schools*, who is not a theorist on these matters, but who has successfully taught these subjects to boys of 12 and 13 years of age for many years. In fact, instruction in social science means teaching a boy his relations to society; the conditions of stable social organisation, the natural basis of morality. I would make the subjects I have mentioned the foundation of all special or technical training.

7989. What do you think should be the relation of the technical training of the school, speaking generally, to the technical training of the workshops?—I presume, starting with general knowledge of the kind which I have just defined, the technical training would follow, that is to say, suppose a boy has to be trained to be a manufacturing chemist, I would give him an acquaintance with those branches of knowledge as an essential preliminary to beginning the study of chemistry as a speciality. Those branches of knowledge would stand in the same relation to his special technical studies as our first year's course in Jermyn-street does to the special courses of subsequent years. The only technical study with which I am practically acquainted is the study of medicine, and I will, with the permission

of the Committee, make that my illustration. I am of opinion that medical education at present is in a state of chaos, but if I had the modelling of it my own way I should make every medical student pass, first, through such a course as I have described. When he had got that, I should take him through the branches of science which supply the theory of his own art, namely, human anatomy, physiology, and what we call therapeutics, that is to say, the action of surrounding conditions, of which medicines constitute a portion, on the human body. Those are the studies which form the theory of the medical art, and after the student had acquired a sufficient knowledge of them, I should put him to the study of the art itself; that is to say, I should make him take up surgery, medicine, and obstetrics.

7990. Anatomy would hold the same relation to any operation on a patient as (so to speak) the dissection of the steam engine would hold to the construction of the steam engine?—Quite so.

7991. Mr. *Acland*] Do you think that the preliminary scientific training, and a complete knowledge of the theory of science as applied to the art, should precede any acquaintance with the facts of the art?—Not a complete knowledge, but that the principles of the sciences as applied to the art should be understood before the applications are studied. I think that is the obvious and natural order of things.

7992. You would not think it desirable that much acquaintance with the art of medicine should precede any of the sciences which you have named?—Certainly not.

7993. Lord *Robert Montagu*] You mean that the teaching in your schools should be directed to the education of the mind, and not to manual facility?—Manual facility would come at the ultimate stage. A young man who is studying for the profession of medicine, after he has obtained some knowledge of the medical sciences; and so much insight into the art of surgery as is to be derived from listening to lectures and looking on, may become what is called a dresser; that is to say, he goes to the workshop of the hospital, and, under proper guidance, he learns to draw teeth and dress wounds, and do all that a surgeon has to do.

7994. In your school, would you suggest that manual facility should form any part of the teaching?—Certainly.

7995. Would you apply that to every pursuit?—Yes, to all cases in which it is practicable to give such instruction. No man can be said to be completely technically educated until he has some knowledge of the actual practice of his calling.

7996. Would you, for instance, teach a carpenter how to make a table?—I would teach him the use of tools.

7997. Mr. *Acland*] Is it your opinion that, not only in medicine but in the arts generally, it is safe to postpone the acquirement of all manual dexterity to such an age as should admit of the pupil obtaining a tolerably complete knowledge of the scientific theory of his pursuit?—I would not apply that to all the arts by any means.

7998. Would you apply that to the case of an ordinary practitioner in medicine, who could never look forward to the receipt of a large income?—Certainly; I think no man should be allowed to try his hand on suffering humanity until he has had scientific training; but the case

is different with regard to some trades, for there may be some trades in which it would be requisite to communicate very early some dexterity of hand

7999 But in many trades there are other matters besides manual dexterity?—Yes, I would substitute the phrase “practical tact” for “manual dexterity,” and in many cases it may undoubtedly be desirable that a boy should acquire that practical tact very early

8000 *Chairman*] Will you be kind enough now to give us your opinion, generally, of the science schools in connection with the Science and Art Department?—From the commencement of the present system of examinations I have been the examiner in physiology and zoology, so that the results of the teaching in the science schools in those two departments have passed through my hands. There has been a vast increase in the number of students since the commencement of the system. It began with 100 or 200, and last year I had as many as between 1,400 and 1,500 sets of examination papers, so that the system is rapidly increasing in magnitude. With respect to its success, I confess I think that it is one of the greatest steps ever made in this country towards spreading a knowledge of science among the people. I have long looked upon any spreading of science from above downward as utterly hopeless, and it appears to me that this department has set on foot a system for spreading science from below upwards. Along with this increase in number of the students, I have noticed, in my own branch, a decided improvement in the answers, within the last two or three years particularly, there has been a very distinct improvement. I may say that there is now a very considerable amount of sound physiological knowledge displayed by the people who send up their answers at those examinations. I believe that that is a very great step, but it would be a great pity that we should remain satisfied with this commencement, for I conceive that there is a great and almost unlimited improvement possible in science teaching, and that with regard to both the objects which I have mentioned as being the great objects of science teaching, that is to say, science on the one hand as knowledge, and on the other hand as educational discipline. The chief condition of that improvement is the development of the teaching power of the instructors. A great majority of the teachers now teach very much from books, because they do not understand that getting up books is by no means a good method of bringing about a knowledge of science. The consequence is, that even the best of the teaching shows more or fewer of the defects of book teaching. One of the most important steps that could be taken towards improving the results of the examinations in science, would be to teach the teachers how to give instruction in science. Teaching in England is pretty much a matter of chance, and the mass of the people are ignorant of the fact that there is such a thing as a scientific method in teaching. I believe that an enormous advantage might be gained in my own science; for example, if the teachers could be brought to London and taught how, by the common materials which are accessible in every village, they could give their boys and girls an actual knowledge of the most important facts of physiological anatomy. Then, again, there is the defect, to which I have already indirectly alluded, in the whole scheme of the Department of Science and Art, namely, an

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entire omission of social science. I have a strong opinion, that this is one of the most important things which can be taught in this country, especially if you are going to address yourselves to the great operative classes of the country. I think that our science teaching will be imperfect until what I have just now spoken of under the name of social science, is made one of the great topics of instruction in the country, on the same system as is now pursued for other branches of science. And, let me repeat, there is now no question as to the possibility of teaching social science to young people, for Mr Ellis has for a number of years been in the habit of teaching it very successfully, and those schools which he has established supply numerous examples of pupils who have a very intelligent knowledge of what are the conditions of social life, and what I just now called the natural laws of conduct.

8001. You have said that it would be desirable to prepare the teachers for the work of teaching science?—Yes, certainly

8002. Would you desire that special establishments should be provided for that teaching of the teachers, or would you be of opinion that the teachers might be taught in the higher colleges of science, wherever such colleges may exist or may hereafter be established?—I think the teachers might certainly be taught in those higher colleges, or whatever the establishment might be called, but the training would have to be special, that is to say, it would not do to bring the teachers up merely to hear the lectures which are given in a course of general science. A teaching which would suit students is not precisely what one would require for the teachers

8003. You would have tutorial training for the teachers, which would be different from the teaching for persons who did not intend to become teachers?—Not tutorial teaching, but I should give a special course of a dozen or twenty lectures for the express use of teachers, showing them how to teach.

8004. But, apart from that, would you consider that they should receive their instruction in an ordinary science college?—Certainly.

8005. You would not desire that there should be any separate institution specially devoted to the teaching of teachers of science?—Certainly not. It is to be hoped that, in the long run, all teachers would go through the same course of science training as I have mentioned, and then this teaching of the teachers would be far less necessary, but I speak now entirely of the present condition of affairs

8006. That is to say, that if the science of teaching abstractedly were better understood, you think that it would not then be necessary for the science colleges to pay so much attention to that department?—I think that it would become of far less moment than it is now. I think the teachers who are once taught how to teach will teach others in their turn.

8007. You think they would be able to apply the knowledge of teaching once acquired to any department in which they would have to exercise it?—I should think so

8008. *Mr. Akroyd*] I understand you to attribute the scanty attendance at the mining school in Jermyn-street to the ignorance and apathy of manufacturers, or at least to some extent?—Yes.

8009. Supposing that a manufacturer sent his

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son to Oxford or to Cambridge, it is presumed that he would acquire some amount of scientific knowledge there, and you would hardly expect that manufacturer's son, after taking his degree at Oxford or Cambridge, to spend three years more at the mining college, would you?—I think if the manufacturer who sent his son to Oxford or to Cambridge to take an ordinary degree expected that he would thereby secure the smallest atom or scintilla of scientific knowledge, he would be mistaken. Some time ago I was at a dinner party, where there were a number of very distinguished university men, several of them fellows of colleges, and as we were discussing this very topic, I asked whether it would be a fair thing to say that any one might have taken the highest honours at the university, and yet might never have heard that the earth went round the sun? and all the gentlemen present with one consent said, "Yes." That gives some notion of how far science forms a necessary part of the training at the universities.

8010. Are you speaking of what was the state of things at the university some years ago, or of what is the state of things now?—Matters are so far improved now, that if a young man desires to do so he can get extremely good instruction in physical science at the university, but he may take his degree without hearing anything about it.

8011 Mr. Acland.] Would you say that of Cambridge?—Yes, so far as the experimental and observational sciences are concerned.

1012. Mr. Akroyd.] But assume the case of the son of a manufacturer, who has gone through the usual course at one of the older universities, you would hardly expect him after that to go and spend three years in a mining college in London?—That is for himself to consider. If he wants to acquire the knowledge applicable to his special pursuit, I imagine he must either do so, or spend at least as much time at the university after taking his degree.

8013. But would it not, instead of that plan, be far better to combine science teaching with the university curriculum?—I confess that I do not think so. I think that the spirit of the teaching at our older universities is entirely opposed to the spirit of scientific thought. At present they are hardly to be trusted with scientific education.

8014. But if a young man were intended for business, it would hardly be possible to devote six years of the best period of his life to complete his education in that way, would it, three years at the university and three years at the mining school?—But I do not see the necessity of sending him to the university.

8015 You would say that instead of his going to Oxford or to Cambridge, he should spend three years at the mining college?—If I intended my own son for any branch of manufacture, I should not dream of sending him to the university. I should send him to a good school, and then make him matriculate at the London University, and then I should devote him entirely to scientific pursuits.

8016. Would you not give him a knowledge of Latin and Greek?—I would certainly give him as much knowledge of those languages as is requisite for general culture; but a boy who goes to a good school, and is properly taught up to the age of 17 or 18, will probably know much more of

the dead languages than a young man who has taken the ordinary poll degree at one of the older universities.

8017 But surely, instead of shutting up the universities and completing the education of a young man at your scientific school, you would rather reform the system of education at the universities, and add science to what is taught there?—I am afraid that my ideas on that subject are so revolutionary, that I should almost startle the Committee if I were to state them fully; but I may venture to say that my conception is that our present system of education should be turned upside down. At present the universities make literature and grammar the basis of education; and they actually plume themselves upon their liberality when they stick a few bits of science on the outside of the fabric. Now that, in my apprehension, is not real culture, nor is it what I understand by a liberal education. The thing you really have to do is, in my opinion, to invert the whole edifice, and to make the foundation science, and literature the superstructure and final covering.

8018 Agreeing as I do with you entirely, in the importance which you attach to social science, which is, in fact, a milder name for political economy, do you not think that if full information were conveyed on that subject in our elementary schools throughout the country, and in our working men's colleges, it would tend to promote a much better understanding between employers and employed, and obviate that ignorance which tends to strikes?—I think that to communicate a knowledge of social science to all classes is the only chance for society. I think society will go to pieces unless men are made to understand the true conditions of human welfare; until that is done, you will never have society in a state of stable equilibrium. It is sheer insanity that people should go on as they are now doing, bringing children into the world, and there letting them grow up without the slightest knowledge of the laws which they must obey if they are to live for any purpose worth living for.

8019. And you would attribute those strikes which tend so much to widen the gap between the two classes of society very much to ignorance of political economy and social science?—If I say yes, to that question, I should like to be understood to mean strikes on both sides; strikes of the masters as well as strikes of the men; I wish to be quite impartial upon that point.

8020. You have been speaking also of the importance of physiology?—Yes.

8021 Do you not think that if sanitary science were also made part of the general system of instruction in our elementary and secondary schools, the effect would be to raise the standard of health of the working classes in populous towns?—I think that sanitary science is now in a transitional state; but what I should hope would be the result of the teaching of physiology properly would be to root in every mind a knowledge that health is enjoyed under conditions. No boy can learn the outlines of physiology without becoming aware that his bodily well being depends upon many very nicely-adjusted conditions, and when he has learnt that he will listen to those who can tell him what those conditions are. At present, a boy is brought up without knowing that his body is a machine, and consequently he is just as open to the quack or the superstitious man as he is

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to a person who is capable of telling him what are the conditions of the proper working of that machine. The thing is to give him a knowledge which shall lead him to judge rationally upon such points

8022. Mr *Potter*] Are you aware of the curriculum pursued at Owens' College?—Not precisely.

8023. Could not the course of education which you have suggested be acquired there?—I have no such knowledge of Owens' College as would enable me to answer.

8024. Mr *Acland*.] I think I understand you to say that if a manufacturer wished to send his son to the University of Oxford or of Cambridge, that son must go elsewhere to get a training in science?—I think that my answer was to the effect that his son might take his degree without obtaining any tincture of experimental science, but also that he might get a knowledge of science at the older universities if he went out of his way to procure it. I am well aware of the ability of the professors of science at the universities, and if a member of the university chose to go out of his way to get instruction from them he could do it. All I meant was, that sending a young man to the university to take his degree did not secure his having any knowledge of science.

8025. You are aware that the subjects you have just indicated as the foundation of mental discipline, namely, physics, chemistry, and physiology (speaking generally), are recognised at Oxford as the foundation of honours in science?—Yes.

8026. And so far as people make use of those advantages, you do not object to the course taken by Oxford beyond this, that they require too much Latin and Greek to precede or accompany the study of science?—I should not say too much Latin and Greek; but I should say that Oxford and Cambridge put physical (in the sense of experimental and observational) science outside

and underneath, which I conceive to be wrong; I am of opinion that physical science ought to be the primary instrument and subject matter of education, and literary culture secondary.

8027. But the older universities are giving opportunities for scientific instruction?—Yes, undoubtedly; if a man does not want any of the higher rewards of the universities, and chooses to go out of his way, he can get competent scientific teaching in the universities

8028. You are probably aware that there are a very large number of influential men at Oxford, for instance, who desire that the general examination in literature should, if possible, be passed immediately on the entrance of the student into the University, and that the fellowships should be thrown open to those who have achieved distinction in science?—Yes

8029. And if those views were carried out, would they not, to a great extent, mitigate what you think are the shortcomings of the older universities?—Yes, but still there would remain an immense deal to be done

8030. The question would then resolve itself into what ought to be a good secondary education in the schools?—Yes

8031. *Chairman*] Is it not the case that many of our manufacturers require that those who intend to devote themselves to manufactures should go to work at an earlier age than is compatible with their receiving the education which is now given in the universities. I speak not simply of those who are to work all their lives, but of those who must have a certain practical knowledge of work in order that they may conduct the operations of large establishments?—I have no doubt of that. I understand that men of business like their boys to go to business at 17 or 18 years of age

8032. Would not that necessitate the establishment of provincial polytechnic schools as distinguished from the universities?—I think so.

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DR. EDWARD FRANKLAND, F.R.S., called in, and Examined:

8033. *Chairman*] I BELIEVE you are Professor of Chemistry at the Royal College of Chemistry in Oxford-street?—I am.

8034. And as such you have necessarily given considerable attention to the question of technical education?—I have; inasmuch as the great majority of the students who pass through my hands are intended for some technical profession afterwards.

8035. By technical education you understand that portion of technical instruction which is given in the school as distinguished from the workshop?—Quite so. In fact we pass all the men, whatever their intended occupation may be, through one and the same course up to a certain point, and then allow them to diverge to those specialities of science which have a direct bearing on their future pursuits, if the latter have been determined on.

8036. That is the course which you pursue in Oxford-street, and which you consider a desirable one?—It is.

8037. At what age do you admit your pupils to the laboratory of the Royal College of Chemistry?—We have no particular age of exclusion, but, as a rule, we have none under 14, and rarely any under 16 years of age applying for admission.

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8038. Do you consider it desirable that youths so young as 14 should come to you?—I think it is undesirable that any so young as 14 years of age should come to us, but I do not consider it undesirable that they should be acquiring some knowledge of chemistry at that age elsewhere.

8039. What is the earliest age at which you think elementary chemistry might be taught in ordinary schools?—For those boys who exhibit an aptitude for knowledge of that kind, I do not think 10 years is too early an age. I speak of this from experience, having formerly had classes of boys in Queenwood College, where Professor Tyndall and myself were teachers of classes of boys of that age. I was astonished at the number of facts in science which boys of that age can accumulate without, however, being able in the least to generalise the knowledge, or make much use of it at the time.

8040. At what age do you consider an average boy would be able to commence with generalisation, which you say is impossible to boys of 10 years of age?—Not under 16.

8041. You think that up to the age of 16 any teaching of natural sciences had better consist in imparting a knowledge of facts rather than in any scientific generalisation?—I do.

8042. Was it your experience at Queenwood College,

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College, that the teaching of science by no means diminished the progress which was made in literary studies by the boys?—As far as my recollection serves me, there was nothing of that kind remarked, of course a certain amount of the time of each boy had to be devoted to those scientific studies, and it may be said, if he had devoted all his time to the literary department of the school, he might have made better progress in languages.

8043. Is that your opinion?—I very much doubt it; the two subjects were so different that the one acted as a kind of recreation to the other.

8044. Then you prefer to receive your pupils at about the age of 16?—I do.

8045. What is the course of instruction then?—The course of instruction consists, in the first place, of a course of 40 lectures on inorganic chemistry, followed by a course of 30 lectures on organic chemistry. Simultaneously with attendance on these lectures, the student works in the laboratory, and practically makes himself acquainted with manipulation and qualitative and quantitative analysis, spending in that study the time from 10 in the morning to five in the afternoon; there is about an hour taken from that for one lecture each day, or, at all events, four days in the week for about six months in the year.

8046. Is that lecture given in Oxford-street?—It is.

8047. What number of students will your lecture theatre accommodate?—It would accommodate 70 or 80 very well.

8048. Have you generally an audience of that number?—Only about 40 or 50 usually attend the lectures.

8049. What is the number of students who work in the laboratory?—The laboratory is almost invariably full; the maximum that we can accommodate is 40, and they are then very much in want of space. At the present moment we have 38 working in the laboratory. I have prepared a list of our students, which, I thought, perhaps, would be of use to the Committee, as showing their destinations, giving the number of students, the age, the time of entrance, and the destination, as far as I have been able to ascertain it. I have added a short analysis with regard to the destination of the students: Chemical manufactures, 9; brewing, 6; undetermined, 7; mining, 4; professional chemistry, 3; engineering, 1; science teaching, 1; sugar refining, 1; Church, 2, law, 1, and medicine, 1.

8050. Do nearly all these laboratory students attend your lectures?—All of them, almost without exception.

8051. In fact the same men are in the laboratory and in the lecture-room?—Practically it is so. In addition, however, I have a small class of students there who come from the Inland Revenue Office, men who are destined to be excisemen and collectors of customs and so on, who are selected from a large number throughout the country, and are sent up to London as a kind of prize to study chemistry for a couple of years. I have six of those men every year; they attend the lectures, but not the laboratory, inasmuch as the Inland Revenue have a laboratory of their own in Somerset House, where they instruct them.

8052. But do you insist on all those that attend the laboratory course being present at your lectures?—No, certainly not; it is left entirely to their own free will.

8053. You would not exclude any one from

the laboratory because he did not attend your lectures, would you?—No, certainly not.

8054. Is there a separate payment for the laboratory instruction?—Yes, and for each course of lectures.

8055. Are not the matriculated pupils of the School of Mines in Jermyn-street free of your lectures?—Yes, the matriculated students pay a general fee, which includes my fee for the lectures.

8056. But not the fees for laboratory instruction, and the other expenses attending that instruction?—No; they must pay separately for that.

8057. Will you kindly state to the Committee what is the expense of the course of instruction in the laboratory for a year?—£. 36, dividing the year into three terms of 12l. each term.

8058. Does that cover the expense of materials?—Practically it does; there are a few exceptions made of some very expensive reagents, which might be wasted by the students if they had them gratis; they only cost a few shillings a-year.

8059. What is the fee for a course of lectures to the students who are not matriculated students of the Mining College?—It is the same; there is no difference in the charge to matriculated students and the occasional students at the laboratory.

8060. The fee for your lectures is, in fact, the general fee of the Mining College, is it not?—It is included in the general fee. For the course of lectures on inorganic chemistry it is 4l., every 10 lectures cost 1l. I ought to have mentioned, in connection with that fee of 36l., that it covers the expense of materials, but it does not cover the expense of apparatus; the student has to find his own apparatus, except large and expensive instruments, which are lent to him.

8061. But is it not the case that a matriculated student at the Mining College paying 30l. per annum would have no additional payment to make for your lectures?—That is the case.

8062. Supposing a man attended your lectures only, would it cost him as much as if he attended the entire course of lectures at the Mining College?—No, certainly not.

8063. Mr. Acland.] The entire course for one year of the laboratory practice and the lectures would amount to 42l., would it not?—Yes.

8064. Chairman.] And the cost of attending your lectures during three years would be 18l.?—Yes; but no one would attend them during three years, because they are complete in one year.

8065. Mr. Acland.] Would one year carry a man through a tolerably complete course of laboratory practice, or would he require two years?—He would require two years for chemistry, if that was to be his speciality.

8066. Would one year of general chemistry and one year for speciality cover the ground?—Yes.

8067. Chairman.] What is the ordinary period during which young men remain with you if they desire to become thoroughly trained chemists?—It varies from one year to three years, formerly the time that it was considered necessary to devote to the study of chemistry alone was three years, but that has been reduced to two years. By more systematic study we are able greatly to shorten the time.

8068. For general purposes you consider a two years' course sufficient?—Yes.

8069. Although

8069. Although you do not insist upon the attendance of students at your lectures, you still have a prescribed course which is compulsory, in order to take a diploma of proficiency?—Yes.

8070. Does that course include attendance at lectures and practice in the laboratory?—That would necessarily include both.

8071. Would it include them for any definite time, or would the student, if otherwise qualified, get the diploma at any time?—If he had passed satisfactory examinations in all the departments, that is to say, in the lecture department and the laboratory practice, he would be entitled to his diploma on passing the examination.

8072. Any person partially prepared elsewhere could complete his education with you and get a diploma?—He could.

8073. You have also occasional students?—Yes, most of my students are occasional students.

8074. Then, what proportion of those receive a diploma annually?—I should say fully one-half would receive a diploma, but I speak only from memory.

8075. Rather under half would receive a diploma annually, and the remainder would be occasional students, is that so?—The occasional students may receive a diploma for chemistry alone, the proportion receiving the diploma as Associates of the School of Mines would be much less than that, not more than one-fourth or one-fifth.

8076. You have a separate diploma granted for chemistry alone, have you not?—Yes, that is given by the College of Chemistry, and not by the School of Mines. It is rather a testimonial of proficiency than a diploma.

8077. It was stated in evidence by Dr. Percy that he had students attending his laboratory for such short periods as one, two, or three months only. Is that the case also in your laboratory?—It is occasionally, but there are few students who remain less than one entire year, that is to say, nine months of actual work.

8078. And those, if not also students in the School of Mines, you would call occasional students?—Yes.

8079. You are aware that, apart from the Royal College of Chemistry, instruction in chemistry is also given at King's College, and at University College, London?—I am.

8080. Do you consider that, so far as the metropolis is concerned, those three institutions fully cover the ground?—I think they are not all full of students, and in that sense may be said to cover the ground.

8081. Then, in other portions of the kingdom, there is a laboratory and a course of instruction in chemistry at Edinburgh and Glasgow?—Yes.

8082. And also at Manchester?—Yes.

8083. And also now in Dublin?—Yes.

8084. And I believe at some of the Queen's Colleges in Ireland?—At all three of the Queen's Colleges.

8085. Do you consider that that provision being made there, is any occasion for the establishment of schools of chemistry in other parts of the United Kingdom, I am speaking now of the higher study of chemistry?—I think, for the present, those schools now existing are quite sufficient to meet the demands of the students. As the demand for this kind of education increases no doubt other centres of study would be desirable, but at present I believe those now established will be amply sufficient, and could be 0.72.

considerably amplified with regard to their power of accommodating students.

8086. Do you not think that in the great centres of our metallurgical manufactures, for instance, it would be desirable that advanced courses on the chemistry of metals should be given?—That would, in fact, necessitate an establishment in Birmingham, or some such position. Birmingham, I consider, is within very easy reach both of London and Manchester, and I think, for the present, the students in Birmingham might well be accommodated in one or other of those places without a separate establishment in Birmingham.

8087. Would you say the same of South Wales, and the great mining and metallurgical districts in the north of England?—Yes, I think so for the present, I believe for some years to come there will be so little demand for such education in those districts that that demand will be amply supplied by the existing institutions.

8088. The existing institutions in the metropolis, Edinburgh, Manchester, Glasgow, and Dublin?—Yes.

8089. Are you not of opinion that the existence of such institutions in the great manufacturing centres would have a tendency to stimulate the demand for chemical instruction?—I think it would, on the whole, increase the number of students, if we had more institutions of this kind, but I should deplore the establishment of a great number of such centres of education each badly supplied, and with an incomplete staff of professors, and it would be a great waste of power to have a complete staff of professors for the instruction of, say, 50 or 100 students. Owens' College has been established 16 or 17 years, and at the present moment they have less than 200 students, for the first six or seven years the students were generally below 100. I believe that Manchester presents probably a more favourable ground for a college of that kind than the other districts to which you allude, and yet that was the fate of that college, which was established in 1851.

8090. But at Manchester is it not the case that the attendance on the chemical laboratory is at least as large as that in Jernyn-street?—It is at present, in fact larger, if you take the entire number of students into account; but, perhaps, not so large if you take the maximum of the time devoted to study.

8091. The attendance at what, after all, is a mere provincial institution, is greater than that at a college which derives its pupils, not only from the provinces, but also from the very large population of the metropolis?—Yes, the number of students attending is certainly greater, but inasmuch as the laboratory there can only accommodate 40 students, I presume there is not a larger number of students actually working there at one and the same time than in the College of Chemistry here. The two laboratories have about the same capacity, and they are both full.

8092. Do you think it possible that such institutions as the Royal College of Chemistry, or in fact any polytechnic school, could be self-supporting?—You could not make such institutions self-supporting; you would require to have very high fees; now the very imposition of those high fees would exclude a large number of students, who would otherwise come; while attempting to raise the necessary revenue, you would cut off a number of students, and defeat your object to

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that extent. We can judge from the very successful schools of a similar kind on the continent; taking, for example, the Polytechnic School at Zurich, there the revenue in the year 1867, from students' fees, and in fact their revenue beyond endowments, was 38,500 francs, while the State and town subsidy was 269,500 francs, all of this being absorbed in the expenses of the year

8093. But the fees and expenses of the students at Zurich are exceptionally low, are they not?—Yes, they are much lower than our English scale of fees, but so are the endowments of professors, and all expenses.

8094. Are you acquainted with the *Ecole Centrale* in Paris?—I know very little of it, I have visited it once or twice, but I do not know it so well as the schools in Germany and Switzerland.

8095. Are you not aware that that institution in Paris, which you would describe as of a high character, is self-supporting?—I was not aware of that.

8096-7. What in your own case is the mode of remuneration?—It is partly from salaries, but chiefly from the fees of the students, certain expenses being paid by the Government, in the first place, the school is rent free; in the next place gas and fuel are found, the sum of 60*L*. a-year is allowed for lecture illustrations; 100*L*. a-year is allowed for a chemical assistant.

8098. Would you say that it would be possible in the case of a higher school of chemistry, to obtain competent teachers, if the payment to them were to consist solely of fees and payment on results?—In the case of chemistry, I think it might be so, but I question whether it would be so in almost any other branch of science.

8099. Would you think it desirable in the case of chemistry?—I should think it desirable in the case of any subject of instruction, to make the payment as far as possible dependent upon the fees of the students, and to supplement that by a salary which would bear the smallest possible proportion to the emoluments from fees, consistent with giving the professor a sufficient income altogether.

8100. But if the Government were prepared to contribute in some way to the emoluments of the professors, would you think that the services of a man of high attainments would be best secured by payment on results, or by a fixed contribution, I am speaking of chemistry more especially?—I should say the best mode of doing that would be by a fixed contribution or salary, and by giving him either the whole, or very nearly the whole, of the fees of the pupils, which would really be a payment on results, because pupils would not come if the professor were inefficient.

8101. The salary might be small?—The salary might be comparatively small.

8102. You have had the evidence of Professor Huxley, with regard to tutorial teaching?—Yes, I have.

8103. Would you consider that, in the case of the Royal College of Chemistry, any great advantage would be derived from an increase of your staff in that direction?—I think it would; there are now in the laboratory, constantly employed, two tutors of that description, and one in connection with the lectures, who does not attend in the laboratory, so that in the Royal College of Chemistry there are three tutors at present employed under my direction. I consider that for every 20 students in the laboratory there

ought to be one such tutor or assistant who should devote the whole of his time to their instruction during the day

8104. Then for the present the tutorial staff would be sufficient in your case?—Yes, for the 40 students; but I think that the staff, both of professors and tutors, not only in the School of Mines, but in most of the other educational institutions in this country, is lamentably deficient. When I compare this staff of professors and tutors with the staff of foreign colleges and polytechnic schools, for instance, I find, that the number here is very small indeed. The numbers of professors and teachers in the various polytechnic schools on the continent are as follow: in the Polytechnic School at Zurich, 60; at Karlsruhe, 47; at Stuttgart, 33; at Dresden, 23; at Berlin, 22; at Hanover, 24, and at Vienna, 57. In the school of Mines there are eight professors and four teachers. In Owens' College there are eight professors and nine teachers.

8105. Is that number for science alone in Owens' College?—No, it is the total staff for all the branches of instruction. In the Zurich Polytechnic School the 60 professors and teachers are divided in this way: 38 professors, 17 private tutors, and five other assistants, making up the 60.

8106. Are the young men who attend your college chiefly sons or relatives of manufacturers, and are they persons who propose to become managers or assistants in chemical works, apart from any investment of capital in those works?—My students are derived from various sources; but I should say that the majority certainly are either sons or relatives of manufacturers, who have a distinct object in sending for them chemical instruction in connection with different branches of manufacture. It is remarkable that brewers are distinguished by the large number of men that they send up to the College of Chemistry for scientific instruction. There is no other branch of chemical manufacture that will at all compare with brewing in this respect.

8107. Are those the relatives of London brewers?—They are Burton brewers, almost exclusively.

8108. But assuming a young man not to be the son or relative of a chemical manufacturer, has he a good chance of profitable employment in chemical works of any description, including brewing, on leaving your laboratory?—I think he has, if he can afford to wait, but it is a very uncertain future for him to look forward to. He may have to wait two or three years after finishing his studies.

8109. Even if he were prepared to enter at a small salary?—Even if he were prepared to enter at a small salary. But on the other hand, there are frequent openings, and several in succession presenting themselves for young men who have distinguished themselves in the study of chemistry and physics, with very fair emoluments. It is no uncommon thing for a student soon after leaving the College of Chemistry to obtain 200*L*. to 300*L*. a-year at once in some chemical manufactory or brewery, and to have his salary increased up to 500*L*.

8110. Have you had instances of young men refusing low salaries?—I have known cases of young men refusing 150*L*. a-year.

8111. Were they men of exceptional ability?—By no means.

8112. They thought that the law of supply and

and demand entitled them to more than 150*l.*, and that they would be sure to get it by waiting a little?—They think if they go into a chemical manufactory they ought to receive a good salary. A man who would be very well content to work in a laboratory to pursue his scientific studies further for a salary of 80*l.* or 100*l.*, thinks he ought not to receive less than 200*l.* a-year when his work benefits pecuniarily to a great extent his employer.

8113. Now when persons come to you, as I believe is the case in some instance, intending to become teachers, do you put them through any special course of training?—No, we have no special course of training at present, but I think it would be desirable to have such a course of training in connection with the School of Mines, or any institution where the higher education is given; any man passing through a regular course does get some instruction in teaching, because he sees the mode of instruction, and, if he is an observant man, he will benefit by it, but there might, with advantage, be a special course adapted to the requirements of those who intend to devote themselves to teaching afterwards.

8114. Would you consider it desirable that teachers should be attracted to such a college as the College of Chemistry?—I think it is very desirable. I found this opinion on what I have observed in the mass of the examination papers of the Science and Art Department which have just passed through my hands. I mean those papers that came from primary schools. I found that the papers went very much in groups with regard to merit. I am perfectly ignorant where they come from, but they had been placed in heaps, and consequently the papers of the pupils of one school must generally come together. I have noticed a very great discrepancy with regard to the knowledge of those groups of students. Thus I came sometimes upon a batch of papers where they were all bad; then, again, on 20 or 30 that were all good, with perhaps not more than two or three exceptions.

8115. Do you attribute that to the want of knowledge, or to the want of the power of imparting knowledge on the part of the teacher?—I attribute it to the one or the other, but in all probability it is partly owing to both. I also noticed a circumstance which has been already mentioned by Professor Huxley; that is to say, the great dependency which teachers seem to place on books in teaching. There are certain errors which may be called stock mistakes in chemical manuals, which are found everywhere in these papers, showing that the teachers have depended on books, and that is a mischievous thing.

8116. How would you attract teachers to the Mining School or the College of Chemistry?—I think a large number of exhibitions ought to be placed at the disposal of such men, and the present system of payment on results must in itself afford a powerful attraction to teachers to qualify themselves thoroughly for imparting instruction in science, especially if the standard at the examinations be gradually raised.

8117. Do you consider that the Minutes issued in December last, offering scholarships of 25*l.* supplementary to 25*l.* contributed from the different localities, would be likely to induce people to pursue a course of instruction in such institutions?—I think such a step is calculated to produce that effect.

8118. You think that that particular mode is

likely to prove successful?—I think it is as a supplement to subsequent payment on results of teaching, which perhaps after all ought to be made the main inducement for them.

8119. Now, with regard to that payment on results, you are aware, no doubt, that there is a great deficiency of teachers in science schools?—Yes, I believe so.

8120. And that in order to meet that deficiency, the Government now gives payment upon results to teachers who have not passed the teachers' examination, but have simply taken a first or second grade as pupils?—Yes.

8121. What is your opinion of that recommendation?—I should not like to express an adverse opinion, because it is obviously a matter of momentary convenience only, it would be very undesirable that this scientific instruction should be stopped for the want of teachers altogether, I would prefer rather that it should be carried on with comparatively inferior teachers.

8122. Would not you be afraid that the attempt to carry it on with inferior teachers would be liable to lead to discouragement on the part of those taught?—No doubt that would be one of the effects, but still, taking that evil into consideration, I think the advantage of awakening a desire for science teaching in the country would more than overbalance it.

8123. In what way would that quicken the desire for science teaching?—I think by bringing the boys and workmen into contact with scientific teaching at all, which has hitherto been quite exceptional, there would be a considerable gain.

8124. That there will now be a greater number of persons who would offer to teach than there would otherwise have been?—Yes.

8125. You have said that you consider the present schools sufficient, or about sufficient, for the supply of the actual demand for instruction in chemistry?—That is my impression, judging from the number attending those schools at the present time.

8126. Do you consider that that is at all a healthy state of things, the fact of the demand being so small?—No, that is the most melancholy part of the whole matter, you may contrive the best possible institutions for imparting instruction in science, but if nobody, or only a few come to avail themselves of it, your labour is in vain. I feel that the growth of this desire must be somewhat slow, and hence it is that I say the institutions now existing would probably be quite sufficient if they were amplified in the direction of technical and scientific instruction.

8127. If that desire could be quickened, and as a consequence greater efforts made also to impart instruction, do you think the country would be benefited in a material sense?—I do most undoubtedly. I cannot conceive that it would be possible for us to maintain our position as a manufacturing country unless something of the kind in a very marked degree takes place, and that before long.

8128. That is to say, that apart from any moral or general considerations, you think that in a mere economical point of view, instruction in your special branch should be more generally diffused?—Yes; we know that the two great chemical inventions of this country during the last 20 years have been made by men who have been specially trained in chemistry. I mean the invention of the manufacture of paraffin from coal made by Mr. Young, who was trained in the laboratory

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laboratory of Professor Graham, the present Master of the Mint; and secondly, the invention of the manufacture of the aniline colours from coal tar; this invention was made in the first place by Mr Perkin, who was a trained student in the College of Chemistry. Those are the only two great chemical inventions which have been made in this country during the past 20 years, and they have very greatly increased the manufacturing income of the country. They have started two most important branches of industry, which have already attained to colossal proportions. I have recently had occasion to go through a large number of chemical manufactories in Lancashire, which I had not visited for the past 11 years, and I was very much struck to find that the processes which were in use at that time were still employed, and in exactly the same form. That, in fact, those branches of manufacture had stood almost absolutely still, the only new invention that I found was beginning to be used was one for the recovery of sulphur from masses of alkali waste. This invention, which is important both in economic and sanitary respects, was made by a young German chemist, trained in the Polytechnic School of Cassel I believe, but at all events, having received a scientific training in Germany. Therefore, I think that science training imparted to those who are likely to become managers of chemical works, or proprietors of those chemical works, is of the very highest importance to the nation.

8129. If you were told that we, being a rich nation, can purchase the inventions of foreigners, what answer should you make to that?—I do not think that purchased inventions can, as a rule, be effectively carried out in a manufactory where the manager is not himself a well-trained man, capable of introducing a new branch of manufacture, and, consequently, that the mere buying of a patent right will not take the place effectively of the inventive spirit in proprietors or managers of chemical works.

8130. That is to say, a scientific invention must be scientifically applied?—A scientific invention must be scientifically applied, or else it will be almost certain to fail at all events, commercially. It is well known that one of the great obstacles to successful invention on the part of men of science who are outside manufactories, consists in the impossibility of getting their processes fairly carried out in the chemical manufactories. If they themselves turn manufacturers there is little difficulty; but, at present, there are no points of contact between the purely scientific man and the purely mechanical workman in the manufactory.

8131. Are there no attempts at invention in the chemical manufactories of this country?—There are many attempts, but they generally turn out failures; so much so, that if a new patent is taken out nobody believes in it; and with reason, because the probability is that it is worthless.

8132. Many of those attempts are prosecuted in the teeth of scientific principles, are they not?—There is a great waste of thought and a great waste of time in this country in that direction. Many people, who are not without ability, set themselves to solve a problem which is obviously impossible under the conditions.

8133. Do you insist upon the necessity of a general knowledge of the principles of chem-

istry preceding the application of those principles?—Yes, certainly.

8134. That general knowledge being granted, can you state how far you would carry their application in the laboratory as distinguished from the manufactory, taking, as an instance, brewing, or refining in the manufacture of sugar?—I should not attempt to teach the practice of any art or trade in either a laboratory or elsewhere, in connection with such a college, but I should give special courses of instruction upon those particular branches of science which bear upon the technical pursuits of students afterwards. In the case of brewers, for instance, it would be very desirable to develop, in the instruction of those men, what has been discovered with regard to fermentation, the conditions under which it takes place, and the modifications which it undergoes from various causes, things which would be almost useless to general students, or, at all events, would lead to too much detail in general instruction in science, but which would be invaluable to men who were going into that particular trade. Those are the directions in which applied science would be most valuable to technical students.

8135. And in the case of an institution affording instruction in engineering as well as chemistry and other departments of science, would you, to a person intending to become a brewer, give any general course in brewing, which should include both the mechanics and chemistry of brewing?—I should scarcely think that it would be desirable to go into the actual practice of the manufactory; that would be very much more quickly and efficiently learned in a brewery, to which I should presume the student would go on completing his instruction in the college.

8136. Supposing there were 10 or 12 different systems of machinery as applied to brewing, would you not consider it desirable that in the Polytechnic School the pupil should be made acquainted with those different systems?—Yes.

8137. And perhaps also with those systems which have turned out to be failures?—I should consider it highly desirable; in fact, any knowledge which can be imparted with greater effect in lecture rooms than in manufactories ought to be so imparted.

8138. Do the pupils who enter your college generally come well prepared?—The rule is quite the reverse; they come almost totally unprepared.

8139. That is to say they are unacquainted with the elements of science?—Yes, they are quite unacquainted with the elements of science, and with the modes of thought, I might almost say, which are necessary in beginning the study of science.

8140. But as a rule, coming to you at 16 or 17 years of age, has their general education been tolerably good?—Generally as to classics, and in a few cases mathematics, it is tolerable, but the cases where it is good are rare.

8141. You would describe it as barely tolerable, even in a literary point of view?—Yes; even in a literary point of view there is great room for improvement.

8142. Have you considered the question of the fusion of the various scientific schools in the metropolis which are supported by the Government?—Yes, I have; and I think such a fusion would be productive of very considerable advantage; it would

would not only give to the united institution a more complete staff of professors, but it would enable the students to pursue their studies with less loss of time, for the present students of the college of chemistry have to go about a mile to the Museum of Practical Geology in Jermyn-street to hear lectures on physics and on other branches of science; that is a considerable loss of time. It would be much better if their instruction could all be imparted in one building. But the other point, namely, the establishment of a more complete staff of professors would be the main advantage that would be gained by this fusion.

8143. With regard to the classes in connection with the Science and Art Department, you have pointed out some of their deficiencies, but would you say that on the whole those classes have exercised a decidedly beneficial influence on the scientific instruction of the country?—There cannot be a doubt about it; a large number of men have issued from the School of Mines, who have proceeded to different parts of the country, and who have formed centres around which a good deal of collateral science has subsequently been developed.

8144. I am speaking more especially of the provincial classes in connection with science?—Certainly, I think the evidence afforded in the examination which is now just passed, shows that a great deal of useful instruction is given in those provincial classes.

8145. Is it the case, that in addition to the number of pupils having increased, the answers given by those pupils in the mass show a gradual progress?—Unfortunately I cannot answer that question, inasmuch as I have only been examiner during the present year, but I may say that a very considerable number of the papers sent by those students in chemistry are very creditably worked indeed, and considering the amount of instruction that they can possibly have had, I confess they rather surprised me.

8146. That amount of instruction being necessarily small?—The amount of instruction must have been necessarily small.

8147. Mr Dixon] I understood you to say that you thought it would be inadvisable to establish any science college in Birmingham, on the ground that there is not sufficient demand yet for the teaching of such a college, and that until there is, the Birmingham people had better go either to London or Manchester?—Yes, that was the ground upon which I gave that opinion. I would not insist upon it strongly; but still it would very soon be seen whether there was likely to be such a demand in Birmingham as would require such an institution. At present I do not think there is such a demand for an institution of that kind, as would justify the expenditure of that amount of money which it would require to establish an efficient college there. There is a very good college in Manchester, and there are the various schools in London. I think those for the present would suffice for the wants of Birmingham. Birmingham is a most important centre for a future college, and sooner or later there must be one established there, but for the present, it is not absolutely necessary.

8148. You said, I think, that those colleges, even in London and Manchester, could not be expected to be self-supporting?—I think they could not.

8149. On the ground that the students there

were not in a position to be able to pay the whole expense of the teaching they required?—If in that expense is to be included the salaries of the officers necessarily attached to such an establishment, and the rent, and wear and tear of building, and apparatus, I do not think fees based on such requirements would be sufficiently low to attract students in sufficient quantity to give a revenue capable of meeting those expenses, because if you increase your fees you necessarily diminish the number of students.

8150. Then, admitting that such is the pecuniary position of those students, do you not think it is out of the question to expect that they would incur the additional expense of going from Birmingham either to Manchester or London to get the scientific education?—No doubt that would be a drawback, inasmuch as their living away from home would be an additional expense.

8151. Do you not think the mere fact that the Birmingham people do not come in large numbers either to London or Manchester, is no evidence of there being a deficiency of desire for this teaching?—I should not take that as conclusive evidence, although I may remark that we have many men coming up to London from greater distances than Birmingham, from Burton, for instance, and even out of Lancashire, and they come to London from places still further than that.

8152. And some have also come from Birmingham?—Probably

8153. Have you noticed any deficiency with regard to Birmingham in that respect?—I should say that I have. I can only call to mind one student of mine who came from Birmingham or the immediate neighbourhood, he came from Oldbury. I am speaking from memory and may be doing an injustice, but I think Birmingham is a little behind hand in the desire for science instruction.

8154. Do you know the Birmingham Midland Institute?—Yes, I know a little of it

8155. Are you aware that we have a very good laboratory there?—I am not aware of it.

8156. You are not aware that the number of students has been increasing to such a degree that we are unable to accommodate the applicants?—I was not aware that they had been increasing to that extent.

8157. You are, perhaps, not aware also, that among the teachers there is a bachelor of science, Mr Woodward?—Yes, I know Mr Woodward.

8158. He is a science teacher of considerable repute?—Yes; I should say he is a very efficient man.

8159. And we have several teachers of science in various schools in Birmingham, some of whom have been taught at the institute, and one of whom at least has completed his education at the School of Mines, Mr Bulpitt?—I was not aware of the extent to which science instruction is carried in Birmingham. The Midland Institute I always regarded as an institution somewhat resembling the Royal Institution here, where lectures were given rather to adults than to young students.

8160. Then, assuming that there is the desire which I have alluded to in Birmingham for scientific teaching, you would consider the time had come when an institution or college for science teaching might be desirable?—Most undoubtedly; my sole object in wishing to limit the number of those institutions is that they may not

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not be inefficient on account of the want of support. To be carried out efficiently, and to be of real service, they would be most expensive institutions; therefore I should not like to see so many of them started, in the first instance, nor many more than the present institution subsidised for that purpose.

8161. Mr. *Lowther*.] On the continent, in Switzerland and Germany, there are a very large number of teachers in proportion to those that are to be found in such institutions in England?—Yes

8162. Did you ever see them engaged in teaching?—Yes; I spent more than two years in Germany, not in a polytechnic school, but in three of the German universities, but I have also visited the polytechnic schools, and seen the teaching in them

8163. Did you approve of the style of teaching?—I considered that it was very good.

8164. Do you think that their mode of teaching requires more professors and teachers than our mode of teaching, could the work have been done by fewer people?—Not so efficiently, it may be that they could do the work with a less number, but from what I know of the work of many of those individual teachers in Zurich, I do not think there are too many teachers.

8165. In Germany they work very slowly, do they not?—My own remembrance is chiefly of Professor Bunsen's class in Marburg. Professor Bunsen's duties were of this kind, he used to give lectures from seven to eight in the morning on some chemical subject, say, organic chemistry; then he had a laboratory class from 10 to five. I think he was generally present himself nearly the whole of the day. In addition to that on Saturday, or at all events once a week, he gave a public lecture open to all without fees, upon some subject of general interest connected with chemistry; now this rather heavy work

8166. I think you said that in visiting chemical works, you found that there were the same processes used now which had been used 11 years ago. Have you ever visited any foreign chemical works, and from what you have seen, do you think they have made much more advance than we have?—I have seen very little of foreign chemical works; but as far as I could judge from the things exhibited at the Paris Exhibition last year, they have made more advance than we have in chemical inventions. The recovery of sulphur invention, of which I have spoken, was exhibited in Paris last year, and it struck me as very important. there were other improve-

ments in extracting the potash and salts from the residues of the manufacture of chloride of sodium.

8167. Were they invented by foreigners?—They were.

8168. Lord *Frederick Cavendish*.] I think you stated that for some years you have had as many students in your laboratory as it could hold?—Yes.

8169. If you had increased accommodation, do you think you would have an increased number of students?—I do.

8170. Do you think it would be advantageous to increase the accommodation there rather than to have more schools or colleges?—Yes, I think it would be much more desirable to have them under one roof, and the expense would be much less, the supervision would be more effective, and the mode of instruction would be more convenient.

8171. How many pupils in a class do you think one person could conduct?—I should think that 100 or 120 in one building could be taught by one professor, aided by a competent staff of assistants

8172. You might have had as many students as that in your class if you had the necessary accommodation?—Yes, so far as efficient instruction is concerned.

8173. You also recommended that, in order to supply proper teachers for science, there should be certain exhibitions, but would they be for those who solely devoted themselves to teaching, or would they be open?—I think it might be well to have special exhibitions to encourage men to train themselves for teaching; for that is a thing which is very much in abeyance. It seems to be thought that any one will do for a teacher.

8174. Practically you think you would confine it to those who would become teachers?—Yes; if there were a special course of instruction for teachers, I should make the holding of the exhibition depend upon their attendance upon this course, and passing an examination at the end of it, either in the first class or the second.

8175. You would recommend having separate courses for instructing teachers?—Yes, I think so, at all events in chemistry.

8176. Would it be possible at present to get a sufficiently numerous class to establish such a course?—There are no indications of that at this moment. In that list which I handed in there is one man out of 38 who is destined to be a teacher.

8177. *Chairman*.] Is there anything further that you would wish to state to the Committee on these subjects?—No.

Captain DONNELLY, recalled, and further Examined.

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8178. *Chairman*] Is there anything further which you wish to state to the Committee?—Yes, Mr. Bazley before he left wished me to hand in a letter from Mr. *Wheeler*, who is a science teacher, and which Mr. Bazley thinks of interest. (See *Appendix*)

8179. You are acquainted I believe with the operations of the Mining School of Cornwall?—Yes

8180. It has been stated in evidence before this Committee, that the establishment of a similar school among the miners of Northumberland and Durham would be exceedingly desirable, and it is thought that some of the funds might be contributed, and the buildings provided, by the loca-

lity, but that a difficulty would arise in finding persons prepared to devote their time to the organisation of such a school; would there be anything to prevent some officer of the department from spending two or three months in a given locality in order to organise such a school, if there were sufficient hope of its receiving local support?—I should say that if the organising teacher of the department went down, and explained at one or two public meetings what the system of the department was, and then left the people in the locality to work it out, they would find no great difficulty in doing it; and if they afterwards wished to have more advice and assistance from the department, the organising master would

would go down again, but I do not think it would be of any use for him to be in the place for so long a time as two or three months.

8181 But the department has no rule which should prevent him giving a sufficient amount of time and attention to the demands of a given locality?—No; the locality can of course retain his services as long as they like by paying for them.

8182 Mr. *Acland*.] Have you reason to think that the practice adopted by your department of sending selections from your museum has been beneficial?—Certainly; in fact it is contemplated as far as the museum affords opportunities, to send out instructive models in science, such as

the Darmstadt models, and other mechanical models.

8183 Have you reason to believe that the sending out of those models to the large agricultural society in the west of England has promoted knowledge of the advantages offered by your department?—Yes, at several meetings they have had the use of the food and animal product collections of the department, and I believe they have been very highly appreciated. The department has received thanks for them.

8184 You think that that practice has tended to make your department better known and more highly estimated in public opinion?—Yes, certainly

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Mr. JOHN CHARLES BUCKMASTER, called in; and Examined.

8185 *Chairman*.] You are the Organising Officer, I believe, of the Department of Science and Art?—I am

8186 Have you made yourself acquainted with the evidence which has been given before this Committee, and is there anything which you yourself wish to add before this Committee?—I have not had an opportunity of following very closely the evidence which has been given, I have heard the evidence given to-day, and I also heard the evidence given by Mr. Chance.

8187 Will you state what are the duties of your office?—The duties of my office are to explain the general arrangements of the department, and to render what assistance and advice I can with regard to the formation of classes for teaching elementary science.

8188 In the course of your visits to the different localities, have any points suggested themselves to your attention which would tend to increase the efficiency and number of those classes?—I think we ought, if possible, to give more attention to the teaching power of those engaged in giving instruction, for it is not always the man who has passed the best examination in science that is the most successful teacher; and if he should fail in teaching, from want of ability to communicate his knowledge, it is exceedingly difficult to reorganise a class when it has once been discontinued. It has occurred to me that we might in some way attach more importance to the man being able to communicate what he knows, by granting him a teacher's certificate, independently of his having passed an examination in science.

8189 How would you test that power?—I think before a man undertook the instruction of a class he should give a lesson in the subject which he proposes to teach before some person who is competent to form a judgment on his teaching power and manipulations, because experiments frequently form a very important part of the instruction.

8190 Where would you apply that test?—It might be tested with his own pupils.

8191 Would you make it the duty of an inspector to be present during the instruction, or, if not, who should be the judge with regard to whether the instruction was officially given?—It would be necessary that the man who forms an opinion upon the subject should himself be able to manipulate and teach, or at least to form some opinion with regard to the qualifications necessary for an efficient teacher.

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8192 But how would you bring the fact of a man being a good teacher to the knowledge of the department?—Almost all the classes are visited once a-year, and there is generally some preliminary arrangement before the starting of a class, and it seems to me that a man might go on teaching; but, before the examination of his pupils, there should be an opportunity afforded of judging of his teaching power. This is not, only fair to the teacher, but the pupils

8193 But by whom should the judgment be formed?—I cannot say by whom, but I think it desirable. I know that with the Committee of Council on Education it is always made an indispensable condition that a certified teacher should really know something of the art of teaching.

8194 You would have an inspection of classes for the purpose of ascertaining whether a man was a competent teacher?—That is one of the things that should be done, and to my mind one of much importance.

8195 Do you know as a fact that from the want of teaching power on the part of instructors, classes have been given up, and that it has not been possible to re-establish them?—Yes, I know of several instances where classes have been started by men who have passed our examinations, but who were thoroughly incompetent to teach or interest their pupils. The dry dreamy way in which the knowledge was communicated failed to create any enthusiasm; the pupils fell off, and the classes were broken up. I have on one or two occasions advised teachers to go to an elementary school and hear the master of that school give a lesson in some subject, so that he may get some idea of the method of communicating knowledge to his pupils.

8196 Is that the way in which you would recommend teachers to prepare themselves?—I believe a great deal may be done in that way, but the art of teaching, like any other art, has to be learnt.

8197 Where would you have it learnt?—A large number of science teachers are men who are also elementary teachers, and in such cases there is little difficulty; except in manipulation, it is chiefly those men who are engaged in teaching subjects which require much oral explanation, such as the natural and experimental sciences, and who have no idea of teaching as distinct from mere lecturing.

8198 Where would you have them taught the art of teaching?—I cannot say.

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8199. You

Mr. J. C.
Buckmaster.

Mr. J. C. 8199. You would not like to express a positive
Buckmaster. opinion which might pledge the department?—
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connection with the department, what would you
say?—I think there are several ways in which it
could be done.

8201. Will you tell the Committee what you
yourself consider the best way?—I should say
that teachers should go to some model school for
the purpose of learning to teach and experi-
ment; there would be no necessity for that in
the case of men who had already passed an
examination as elementary teachers, because
there you have a guarantee; but with the others
you have no guarantee.

8202. But seeing that there is always a great
difficulty in getting teachers, would not that dif-
ficulty be enhanced if additional requirements
were imposed upon them?—If it were under-
stood that men would be examined as to their
power of teaching before receiving payments,
they would make it part of their business to
become good teachers, and you would have more
efficiency.

8203. Although there might be a falling off
for a time, you think that, in the long run, there
would be a recovery, which would compensate
for it?—Yes, and there would also be an enthu-
siasm upon the part of pupils which no man can
create, unless he knows how to teach.

8204. Have you found in the course of your
tours, that there are many or any districts of the
country in which the fact of aid being granted by the
department is entirely unknown?—The arrange-
ments of the department with regard to the promo-
tion of science are by no means well understood
in the country. The Society of Arts and the
Science and Art Department are mixed up to-
gether in the greatest confusion; it was not until
the last 12 months that public attention has been
more particularly directed to the question that
persons have tried to inform themselves of what
the regulations of the department are for the pur-
pose of promoting scientific knowledge.

8205. Can you suggest any means of diffusing
information with regard to the operations of the
department?—It is very difficult for me to sug-
gest how it should be done. I am constantly re-
ceiving letters from persons desirous of informa-
tion, and I refer them to the department. I have
no authority to go to any place without the sanc-
tion of the department. Persons are writing to
me for all kinds of information about our plans,
all I can do is to refer them to the department.

8206. Are you aware how those applications
are treated by the department?—The depart-
ment sends me a letter, saying that my services
are required at such a place, and that I am to
communicate with some person named in the
letter, to make the necessary arrangements, and
all expenses attending the meeting are borne by
the locality, except my services.

8207. Have you any reason to believe that
there is any laxity on the part of the department
in dealing with such applications?—I am quite
outside the department, so far as official work is
concerned.

8208. What course would you suggest for
adoption, in order that information as to the ad-
vantages offered by the department might be more
generally diffused?—I think it should be stated
in the "Directory," or some official paper, that

my services are at the disposal of such places as
are desirous of information: persons have no
means of knowing this until they hear it from
some one. In some places I know the most
likely individuals, but if I were to go to a town
where they were entirely ignorant of our scheme,
I have no authority to go to any individual, and
say "The department is prepared to encourage
a scheme which is well adapted to the require-
ments of your place." Although no practical
results may immediately follow my visit, the
people have the information and may be able to
turn it to some account in the future.

8209. You are speaking now of cases where
you have delivered lectures by order of the de-
partment, and where you would like also to
remain some time afterwards for the purpose of
communicating with individuals?—I think I
could sometimes have brought our scheme to a
practical result, if I could have remained and
conferred with individuals; the excitement and
interest of a public meeting soon passes away,
and unless you can go to individuals and secure
a local committee the scheme frequently falls
through.

8210. Then what prevents you doing this?—I
have no authority.

8211. Have you ever applied for that au-
thority?—I have referred to it in my diaries.

8212. Have you made any personal application
for that authority?—I have asked for some dis-
cretionary power under such circumstances.

8213. Do you suppose that is because you have
too much work on hand, and that you are wanted
elsewhere, or that the matter has not been con-
sidered?—I cannot say, "Next week, I am to go
to Seaham Harbour to address a meeting of coal
miners and coal engineers. In the evening I am
to attend another meeting; the next day I am to
attend a public meeting in the theatre at New-
castle, the following day I must return home."

8214. In fact, sufficient time is not allowed
you for you to take those steps which you
consider necessary for the effectual performance
of your duties?—In some instances no practical
result would follow. Seven or eight years ago I
addressed a public meeting at which the Chairman
of this Committee presided, if I had not seen
the Chairman the following day, and through his
introduction seen other gentlemen upon the sub-
ject, I do not think anything would have come
of the meeting.

8215. But the Committee are anxious to know
what is the obstacle to your doing what you wish
to do, what, for instance, calls for your presence
in London next week?—Nothing; but if I were
to remain away more than sufficient to attend
these meetings I should not be paid. I am not
paid a salary, if I attend a meeting I receive
two guineas, I am, of course, paid my travelling
expenses, and 1*l.* a-day for every day I am
engaged in the work of the department; and if I
were to charge for any work not considered abso-
lutely necessary, it would be disallowed.

8216. Mr. Acland] Is the week of which you
have just spoken to be taken as a fair sample of
your ordinary engagements?—No; my engage-
ments vary with the time of year; in summer I
am sometimes a month without anything to do.
During the last year my work has increased
from the causes I have just mentioned. Under
the direction of the Royal Scottish Society of
Arts I have visited nearly all the towns of
importance in the south and west of Scotland
where

where they were previously unacquainted with our scheme, but it might so have happened that several journeys would have been necessary if each town had made its own separate arrangement with the department instead of this being done through the council in Edinburgh, and months might have been occupied in doing what I accomplished in four weeks.

8217. But do we understand you to state that the engagements of next week, in which you have merely to deliver a lecture in a place and then pass on, may be taken as a sample of what generally happens, namely, that you are forced simply to deliver a lecture and pass on?—That is frequently the case. A few days since I attended a deanery meeting of clergymen and schoolmasters in Somersetshire. It was a very large meeting, held at Shepton Beauchamp, about nine miles from Crewkerne. Prebendary Coles was anxious to know something about the scheme, and bring it under the notice of the clergy and teachers of the deanery, some of whom were interested in teaching natural science, and it was suggested that I should be invited to this meeting. It was an excellent opportunity of meeting a large number of gentlemen very difficult to meet except on such occasions.

8218. Have you had many opportunities such as this of meeting the clergy or any other bodies of gentlemen interested in primary education?—Not many, but I must say that from the clergy I have received much consideration and kindness.

8219. But have you had many opportunities of meeting such bodies of clergymen or other educational bodies for similar purposes?—Not very many, the meetings are only occasional.

8220. Are you of opinion that there is a fair opening in the rural districts for such efforts?—Certainly, especially the natural sciences.

8221. Lord *Frederick Cavendish*] How do you account for the very different degrees in which advantage has been taken of the aid offered by the department; for instance, in Lancashire and Yorkshire, and other localities?—When I first went into Lancashire, and attended a public meeting in Manchester, there was not a single certificated science teacher in the county, except one employed by Sir James Kay Shuttleworth in East Lancashire. I had to visit Manchester and the district three times before I could create any kind of interest; but at last the council of the Cheshire and Lancashire Union of Institutes took the matter up; we held meetings in various towns, organised committees, encouraged persons to become teachers, and started classes, and there are now 14 men teaching in Manchester and the neighbourhood, who were at that time artisans working in shops.

8222. Then you account for the greater success of science teaching in Lancashire than in other parts to the action of the department and of the board of that union of institutes of which you spoke?—Certainly.

8223 I believe the Yorkshire Union of Mechanics Institutes is now considering what steps should be taken to promote science teaching; has there been any consultation with you on the subject?—Yes; there have been circumstances in Yorkshire which have acted very prejudicially to our scheme; a very strong feeling, till within the last few months, has prevailed against the Government doing anything except build prisons; there is now a change in public opinion. Formerly, when I have had opportunities of attending meet-

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ings in Yorkshire to introduce the consideration of our scheme, a few influential gentlemen have always been ready to throw a wet blanket on everything which had the assistance of the State, and the people have been told for years that they ought to be very cautious about accepting any aid from the Government, for it would most assuredly destroy their independence and self-respect. I attribute our non-success in Yorkshire very greatly to the prevailing opinion I have just mentioned.

8224. Would you say that there was any less intelligence on the part of artisans and mechanics in Yorkshire than there is in Lancashire?—Certainly not, the working men of Leeds and many of them in Sheffield, Huddersfield, and Halifax, are quite equal to the men of Manchester, Bury, and Oldham, the constant migration which has taken place between the two counties, and the similar industries have made the men very analogous in their powers and habits.

8225 You consider that the great obstacle has been the dislike of the Government interference and assistance?—Yes; it destroys that enthusiasm and impulse which is necessary for success; there has been a heatiness in Lancashire, and a cold indifference and suspicion in Yorkshire.

8226. And you see signs of that feeling disappearing in Yorkshire?—Yes, they are now running to the other extreme.

8227. *Chairman.*] How do the facts stand in the Midland counties?—I am more disappointed with Birmingham than, perhaps, almost any other town in the Midland Counties. It has great facilities for this kind of instruction, and the industry of Birmingham is essentially scientific, and yet they have not in Birmingham availed themselves to the extent you might expect of the aid offered by the department.

8228. How do you account for that?—The directors of the Midland Institute have certain notions about payment on results, and they think or did think the Government ought to subsidise their institution; that the Government ought to pay a sum of money annually to the council or directors of the Midland Institute to apply as they think desirable to the objects for which the institute was established.

8229 Have you done much in the south of England?—Not much, the decline of the mining interest in Cornwall has operated very much against our scheme in that county. The Mining School, started by the late Sir Charles Lemon and the late Sir Henry Delabeche some years ago, would have been successful, but when the trade of a county declines or goes away there is not the same earnestness about scientific instruction.

8230. What have you to say with regard to the ports in the south of England, such as Plymouth and Southampton?—I visited Plymouth and Devonport three or four years ago. At Plymouth I had an interview with the mayor, through a friend, after hearing what I had to say, he said nothing of the kind could be done; they had tried it over and over again, and it always failed. He was prevailed upon by a requisition, which was drawn up by the citizens and largely signed, to call a public meeting and discuss the subject and see how far the scheme could be made available in Plymouth; that meeting resulted in the organisation of a very good committee, which was followed by classes which extended to Devonport and Stonehouse; and I have

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Mr. J. C. *Buckmaster.* reason to believe that those classes are in a satisfactory and prosperous condition.

8231. Mr. *Acland.*] You are not including in those pupils candidates for the navigation schools?—No, at Kingsbridge, a small town, my visit resulted in the formation of a class for teaching animal physiology.

8232. Have you anything to say about Torquay?—Yes; my visit resulted in the establishment of a science and art school. A few gentlemen were desirous of establishing an art school, I suggested that, as nothing existed, the committee for the art school should also be the committee for the science school, and that the school should be called a science and art school; and such a school was started, and has, I believe, worked successfully. The science teacher is also the master of the British school.

8233. Are there not at Torquay one or two gentlemen who take a great interest in scientific questions, and one gentleman at least who is very distinguished in science?—Yes, there is Mr. Pengelly, a distinguished geologist, and Mr. Vivian, an eminent naturalist.

8234. Have you succeeded with the aid of those gentlemen who are already interested in science, in influencing public opinion in favour of the action of your department in that district?—Yes; there is a very good feeling in favour of science teaching in Torquay.

8235. But has that resulted in actual study on the part of individuals?—Yes.

8236. How many?—There are probably between 60 and 100 pupils under instruction.

8237. *Chairman.*] This is the second year?—I believe it is the third year.

8238. Mr. *Acland.*] Have you been trying to organise science classes in Exeter?—Yes; my first visit to Exeter was surrounded by very unfavourable circumstances. Nothing came of this visit; I am not quite sure that we have fallen into the right groove. Sir Stafford Northcote was to have presided at a public meeting, but something occurred to prevent his attendance, and that destroyed the *éclat* which would have attached to the meeting. Sir John Coleridge was to have attended, but something occurred to prevent him. These disappointments were very discouraging to the object I had in view, and the enthusiasm necessary to give our science scheme a fair start.

8239. Are you speaking of something which occurred four or five years ago?—Yes; we subsequently had a meeting in the theatre of the Literary and Scientific Institution, and a committee was formed, the mayor presided, and from that time classes were started; but we have never succeeded in obtaining the right sort of men to teach; there are persons in Exeter of very considerable scientific attainments, but we have not obtained them as teachers. I was told that when the museum was started proper arrangements would be made for science classes as well as art classes, but one or two gentlemen on the committee, who had peculiar notions about the proper limits and functions of the Government, which threw difficulties in the way. We have not yet obtained that hearty co-operation of parties necessary for success in Exeter.

8240. *Chairman.*] You know the trade school at Bristol, I suppose?—Yes.

8241. Have you not visited either Taunton or Bridgewater?—No.

8242. Would you say that the Trade School

at Bristol was a school *su^o generis*?—There is no other school that I know of where science forms a regular part of the education of boys.

8243. Mr. *Acland.*] Do you know Sheffield and Leeds?—Yes.

8244. Would you apply what you have just now stated to the grammar schools in those towns?—I never knew that science was taught in grammar schools; after I had completed my training at Jernyn-street, Dr. Playfair suggested that I should send a circular to all the middle-class schools, and grammar schools, within 12 miles of London, offering to give gratuitously simple lectures or lessons on chemistry; not a single school accepted the offer.

8245. That is some years ago, is it not?—Yes, in 1855.

8246. *Chairman.*] The Trade School at Bristol being unique, would you say that the navigation school at Hull at all resembles the Trade School in efficiency, with respect to the teaching of science?—The science teaching at Hull is given with a view to a seafaring life; the teaching of the Trade School at Bristol is of a more varied character, a boy may be prepared in the Bristol Trade School to go into any industry requiring a knowledge of mechanics, drawing, mathematics, mining, or chemistry.

8247. But the pupils of the Navigation School at Hull are of about the same age, and the quality of the instruction given in that school is somewhat similar to that which is given in the Bristol Trade School, is it not?—The science teaching in Hull is excellent; but the boys are very much under the control and patronage, to some extent, of the Trinity House.

8248. Is there any other school of the same grade for boys of from 12 to 15 years of age, in which instruction in science is systematically given in connection with the Science and Art Department?—I know of no school of the same character, one was established at Wandsworth. I used to teach the chemistry and mechanics; I believe it would have been quite equal to the Bristol school. In 12 months the pupils were more than doubled, but it was found impossible to carry it on from fees paid by the pupils. Dr. Booth commenced a correspondence with the Council Office, asking for aid to the Trade School at Wandsworth; the correspondence extended over a long period, but the result was very unsatisfactory, the Committee of Council did not aid schools of that kind, and after two years it was abandoned with 120 scholars.

8249. How long is that ago?—About 10 years.

8250. What were the fees of the school at Wandsworth?—The same as at the Bristol school. Canon Mosely took an active part, and was on the committee of both schools.

8251. From what grade were the pupils drawn; was it from a higher grade, so that the Science and Art Department refused their aid on that account?—No; the pupils at Wandsworth were of the same class as those at Bristol, they were the children of the better class of mechanics and the humbler shopkeepers; but the Trade School at Bristol had to be sustained for many years by exceptional grants. If the department had withdrawn all their support to the Bristol Trade School in 1856 or 1857, that school must have ceased.

8252. The Trade School at Bristol was developed before the present regulations of the department

partment came into force, was it not?—Yes, and also the Wandsworth school.

8253. At Southampton is there any science teaching connected with the department?—I have recently attended a meeting at the Hartley Institute at Southampton, and after I had given my explanations there was a very long discussion about the detailed arrangements of the department. They objected entirely to the examination of teachers, and said that if the department paid on results it was no part of their business to inquire how the results were obtained; they said, in fact, anybody should be allowed to teach and receive payments.

8254. Has anything been done at Southampton?—Nothing

8255. Is there anything in Kent?—Nothing except at Woolwich and Deptford

8256. Is there anything in the Eastern Counties, north of the Thames?—We have one or two classes in Essex, but I do not think we have at present any classes in Suffolk or Norfolk.

8257. Is there anything at Ipswich?—Nothing.

8258. There is a working men's college there, is there not?—Yes, I understand it is a very excellent institution.

8259. But that is not in connection with the Science and Art Department?—No, there are no science classes there. I have never visited Ipswich. I saw accidentally a gentleman, and talked the matter over with him, but nothing came of our conversation.

8260. There is nothing in Yarmouth or Norwich, I suppose?—There is a navigation school at Yarmouth, but there is nothing at Norwich.

8261. That navigation school is rather of the nature of the Plymouth school than of the nature of the Hull school, is it not?—Yes.

8262. It is a school in which the masters are examined for certificates, but not on which the boys are trained for their profession?—I am not well acquainted with the navigation schools.

8263. Mr. Acland.] Have you any acquaintance with the science teaching at St. Mark's, or Battersea?—I know all the training schools in the country. I was one of the masters at Battersea, after Sir James Kay Shuttleworth and Mr. Tufnell handed it over to the National Society, the late Sir Robert Peel sent for me to confer with regard to the re-organizing of his school at Tamworth, in which he proposed that chemistry and mechanics should be taught instead of Latin and Greek. He authorised me to go to the expense of 100 l. for suitable apparatus.

8264. What became of that school?—The school was founded and endowed by his father; it was a sort of grammar school. When we began there were about 15 in the school, but the number soon went up to 60. The teacher who went down to be master of the school was a man who had been specially trained at Battersea, and had had special attention to the sciences which it was proposed to teach.

8265. What was the result?—After the death of the late Sir Robert Peel the school dwindled to a mere national school. Had he lived, I believe, the Tamworth school would have been a model of what we now require. The late Earl of Harrowby gave 200 l. for the purpose of educating a few teachers in chemistry and other subjects, as applied to agriculture. His idea was to establish agricultural schools in Staffordshire.

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8266. What was the result of that?—Three schools were started; but the feeling of the farmers was so strong against sending their children to the same school as the children of their labourers, that the farmers preferred sending their children to bad boarding schools rather than have the advantage of these schools, which they admitted were better.

8267. Are you prepared to say that advanced instruction in chemical science is a better training for farmers than a good middle class education?—What I understand by a good middle class education, is an education which confines itself almost entirely to literary subjects. At the same time, I do not believe that either the natural or experimental sciences are to be highly rated as a means of education.

8268. But suppose a good middle class education implies a knowledge first of the three R's, and then of geography, and then of the elements of mathematics, should you say that a course of that kind of instruction was of more or less importance than a course of training in agricultural chemistry?—I should say gave the three R's first, and then some special instruction in some of those sciences which have a bearing on agriculture. I should say that a knowledge of chemistry and natural science would be more valuable to a boy intended for a farmer than mathematics. Perhaps the mathematical boy would be best educated in the proper sense of education.

8269. Is that opinion a theory, or founded on any experience of your own, have you, in fact, had any experience with regard to the education of farmers which enables you to say, with confidence, that chemical knowledge is more important than good general training?—I have not had an opportunity of judging sufficiently to speak with confidence.

8270. With regard to training colleges, for instance, that at Battersea, will you be kind enough to state any facts which you have observed?—I am now speaking of 1849-50. The scientific teaching in training schools is very inferior to what it was 10 years ago.

8271. Was there not much more earnest teaching of chemistry at St. Mark's and at Battersea 10 years ago than was possible under the recent regulations?—The Revised Code put an end to science teaching in training colleges.

8272. Are you of opinion that chemistry may be introduced with advantage into the ordinary teaching of training schools for elementary masters?—Yes; the teachers were for years encouraged by the Committee of Council to pass examinations in science for the purpose of receiving grants of apparatus for their schools.

8273. Going back for a moment to your general review of England, I gather from your evidence that, having been all round the country, you have found great difficulty in inducing the lower and middle classes to apply themselves to science as a means of education, do you not think it is necessary, before science can be successfully cultivated in that rank, that their general education should be improved?—The elements of science may be taught much earlier than is generally supposed. Arithmetic is a science, but no one thinks of excluding it from an elementary school on the ground that it is too difficult, or that the children's knowledge of other subjects is not

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Mr. J. C. Buckmaster.

3 July 1868

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Buckmaster.
3 July 1858.

sufficient to derive any benefit from teaching arithmetic; and unless arithmetic is taught as a science it has little or no educational value in a school; and what is true of arithmetic is true of every other science.

8274. Are you aware that in England there are hardly any endowed schools in which the upper class of artisans could get a good secondary education at less than 1*l.* a-quarter?—I know of no such schools; it has occurred to me that very many schools, not exactly grammar schools or primary schools, but intermediate schools, and many of the colleges recently started, such as the

duce some science into their teaching with manifest advantage.

8275. Are you aware that they are doing so?—They say they are, but look at Dulwich College, there is a clause which binds the governors to teach one branch of science in the lower school, and one branch of applied science in the upper school; I do not believe they have ever had a science lesson since the college was started.

8276. *Chairman.*] Is there anything which you wish to add to your evidence?—I wish to hand in this memorial, which is dated 1856, and signed by 5,000 working men; it shows that the interest in this subject is not new.

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SCHOOLS IN ENGLAND AND WALES.

COUNTIES.		No of Schools.	No of Students	COUNTIES		No of Schools.	No of Students.
ENGLAND:							
1	Bedfordshire	1	13	33	Suffolk	None	None.
2	Berkshire	1	46	34	Surrey	9	812
3	Buckinghamshire	2	87	35	Sussex	None	None.
4	Cambridgeshire	1	24	36	Warwickshire	6	371
5	Cheshire	9	278	37	Westmoreland	None	None.
6	Cornwall	7	140	38	Wiltshire	None	None.
7	Cumberland	None	None.	39	Worcestershire	4	164
8	Derbyshire	3	61	40	Yorkshire	16	476
9	Devonshire	10	*752				
10	Dorsetshire	2	50	WALES			
11	Durham	2	49	NORTH			
12	Essex	7	153	1	Anglesea	None	None
13	Gloucestershire	7	496	2	Carnarvonshire	None	None
14	Hampshire	2	88	3	Denbighshire	None	None
15	Herefordshire	None	None	4	Flintshire	None	None.
16	Hertfordshire	None	None	5	Merionethshire	None	None.
17	Huntingdonshire	1	16	6	Montgomeryshire	None	None.
18	Kent	13	662	SOUTH			
19	Lancashire	60	2,520	1	Brecknockshire	None	None.
20	Leicestershire	3	77	2	Cardiganshire	None	None.
21	Lincolnshire	1	6	3	Carmarthenshire	1	73
22	Middlesex	20	†1,246	4	Glamorganshire	3	121
23	Monmouthshire	None	None.	5	Pembrokeshire	None	None.
24	Norfolk	1	81	6	Radnorshire	None	None.
25	Northamptonshire	3	196	TOTAL			
26	Northumberland	1	28			210	9,480
27	Nottingham	4	183				
28	Oxfordshire	2	75				
29	Rutlandshire	None	None.				
30	Shropshire	1	45				
31	Somersetshire	None	None				
32	Staffordshire	6	111				

* Includes Plymouth Navigation School, with 344 Students } Not examined in May
 † Includes Dock Street Navigation School, with 328 Students }

SCHOOLS IN SCOTLAND.

COUNTIES.		No of Schools.	No of Students	COUNTIES		No of Schools.	No of Students.
1	Aberdeen	3	*395	7	Kincardine	1	13
2	Ayr	2	83	8	Kircudbright	1	13
3	Dumbarton	1	12	9	Lanark	3	†1,760
4	Edinburgh	1	228	10	Orkney	1	10
5	Forfarshire	1	70				
6	Inverness	1	27	TOTAL			
						15	2,611

The following Scotch Counties do not contain any Science Schools—Argyle, Banff, Berwick, Bute, Caithness, Clackmannan, Cromarty, Dumfries, Fife, Haddington, Kinross, Linlithgow, Moray, Nairn, Peebles, Perth, Renfrew, Ross, Roxburgh, Selkirk, Stirling, Sutherland, and Wigtown.

* Includes Aberdeen Navigation School, with 317 Students, not examined in May.
 † Only about 10 per cent. of these apply for examination.

SCHOOLS IN IRELAND.

COUNTIES.		No. of Schools	No. of Students	COUNTIES.		No. of Schools.	No. of Students.
1	Antrim - - - - -	27	788	18	Roscommon - - - - -	9	69
2	Armagh - - - - -	9	290	14	Wexford - - - - -	1	40
3	Carlow - - - - -	2	60	15	Donegal - - - - -	1	18
4	Cavan - - - - -	1	84	16	Fermanagh - - - - -	2	30
5	Clare - - - - -	1	40	17	Galway - - - - -	1	48
6	Cork - - - - -	1	65	18	Kilkenny - - - - -	1	46
7	Down - - - - -	10	493	19	Mayo - - - - -	1	7
8	Dublin - - - - -	4	251	20	Tipperary - - - - -	1	9
9	Londonderry - - - - -	1	60	21	Tyrone - - - - -	2	31
10	Louth - - - - -	1	62	22	Waterford - - - - -	2	64
11	Meath - - - - -	3	281				
12	Monaghan - - - - -	2	89		TOTAL - - - - -	76	2,870

The following Irish Counties do not contain any Science Schools:— Kerry, Kildare, King's County, Leitrim, Limerick, Longford, Queen's County, Sligo, Westmeath, and Wicklow

S · I · P · M · I · M · A · R · Y .

	Number of Schools.	Number of Students.
ENGLAND AND WALES	210	9,480
IRELAND - - - - -	76	2,870
SCOTLAND - - - - -	15	2,611
GRAND TOTAL.	301	14,961

STUDENTS IN ENGLAND AND WALES:

No. of Schools		No. of Students.	No. of Schools.		No. of Students.
	Bedfordshire			Cornwall	
1	Tebworth - - - - -	18		Bodmin - - - - -	31
				Breage - - - - -	23
	Berkshire			Camborne - - - - -	24
1	Abingdon - - - - -	46		Falmouth - - - - -	14
				Penzance - - - - -	24
	Bucks.		7	Redruth - - - - -	10
	Slough - - - - -	22		St. Just - - - - -	14
	Wolverton - - - - -	65			140
2		87		Derbyshire	
	Cambridgeshire:			Derby - - - - -	12
1	Wisbech - - - - -	24	3	New Mills - - - - -	30
				Whaleybridge - - - - -	19
	Carmarthen.				61
1	Llanelly - - - - -	78		Devonshire.	
				Dartmouth - - - - -	28
	Chester			Exeter - - - - -	32
	Alderley Edge - - - - -	18		Kingsbridge - - - - -	17
	Chester - - - - -	30		Modbury - - - - -	10
	Compstall - - - - -	27		Plymouth (two schools) - - - - -	176
	Congleton - - - - -	12		Tavistock (two schools) - - - - -	84
	Crewe - - - - -	44	10	Torquay - - - - -	63
	Hyde - - - - -	41		Plymouth* - - - - -	34
	Macclesfield - - - - -	43			742
	Stockport (two schools) - - - - -	63		Dorsetshire.	
9		278	2	Blandford - - - - -	20
				Portland - - - - -	30
					50

* Navigation School, not examined in May.

STUDENTS IN ENGLAND AND WALES—continued

No. of Schools.		No. of Students.	No. of Schools.		No. of Students.
	Durham:			Lancashire—continued.	
	-Darlington	10		-Denton	33
	-Gateshead	39		-Droydsden	58
2		49		-Eagley	61
	Essex			-Earlestown	17
	-Canning Town	12		-Failsworth	8
	-Cold Norton	13		-Haslingden	18
	-Maldon	12		-Heywood	24
	-Purleigh	24		-Hollinwood	31
	-Southminster	21		-Lancaster	48
	-Stratford	58		-Lees	33
	-Rochford	13		-Liverpool, (two schools)	147
7		153		-Manchester (seven schools)	363
	Glamorgan			-Middleton	22
	-Cardiff	63		-Mossley	23
	-Swansea	45		-Nelson-in-Marston	36
	-Pontypridd	13		-Newton Heath	18
3		121		-Oldham (five schools)	199
	Gloucestershire:			-Padiham	10
	-Brimacombe	17		-Patricroft	27
	-Bristol	145		-Pendleton	20
	-Cheltenham	212		-Preston	57
	-Eastington	15		-Ramsbottom	17
	-Gloucester (two schools)	78		-Rawtenstall	55
	-Stroud	29		-Rochdale	47
7		496	60	-Royton	54
	Hampshire.			-St Helens	23
	-Andover	39		-Salford (two schools)	77
	-Southampton	49		-Southport	19
2		88	3	-Ulverstone	18
	Huntingdonshire:			-Warrington	102
1	-Huntingdon	16	1	-Werneth	33
	Kent			-Wigan	71
	-Chatham (two schools)	67			2,520
	-Dartford	36		Leicestershire.	
	-Deptford (two schools)	48		-Ashby-de-la Zouch	19
	-Greenwich (two schools)	62		-Leicester (two schools)	58
	-Plumstead	57			77
	-Woolwich (five schools)	392		Lincolnshire.	
13		662		-Grantham	6
	Lancashire.			Middlesex.	
	-Accrington	29		-Limehouse	24
	-Ashton-under-Lyne (two schools)	44		-Finsbury (Bath-street)	42
	-Baouf	42		-Bethnal Green (two schools)	221
	-Blackburn (two schools)	25	30	-Chelsea and Brompton (six schools)	212
	-Bolton (two schools)	260		-Great Ormond-street, London	15
	-Burnley (five schools)	228		-Hackney	48
	-Bury	79		-Islington	146
	-Chorley	20	1	-Leadenhall-street, London	30
	-Darwen	14		-Marylebone	48
				-Paddington	31
				-Regent-street, London	46
				-Westminster	29
				-Whitechapel	27
				-Dock-street, London*	328
					1,246
				Norfolk:	
				-Great Yarmouth	81

* Navigation School, not examined in May.

STUDENTS IN ENGLAND AND WALES—continued.

No of Schools.		No of Students.	No. of Schools.		No. of Students.
3	Northampton.			Surrey:	
	Kettering - - - - -	51		Croydon - - - - -	32
	Northampton - - - - -	116		Battersea (two schools) - - - - -	133
	Wellingborough - - - - -	30		Bermondsey - - - - -	22
		196		Brixton Hill - - - - -	9
1	Northumberland:			Lambeth - - - - -	155
	Alnwick - - - - -	28	9	Peckham - - - - -	363
				Southwark - - - - -	69
				Waterloo-road, London - - - - -	80
					812
4	Nottinghamshire:			Warwickshire:	
	East Retford - - - - -	55	6	Birmingham (five schools) - - - - -	350
	Eastwood - - - - -	13		Saltley - - - - -	21
	Newark - - - - -	34			371
	Nottingham - - - - -	61		Worcestershire:	
		163		Bromsgrove - - - - -	26
2	Oxfordshire:			Cradley - - - - -	6
	Banbury - - - - -	48	4	Oldbury - - - - -	61
	Culham - - - - -	27		Worcester - - - - -	71
		75			164
1	Shropshire:			Yorkshire:	
	Shrewsbury - - - - -	45		Almondbury - - - - -	26
6	Staffordshire:			Barnsley - - - - -	18
	Kinver - - - - -	25		Bingley - - - - -	17
	Walsall - - - - -	24		Birstall - - - - -	26
	Wolverhampton (four schools) - - - - -	62		Dewsbury - - - - -	17
		111	16	Elland - - - - -	22
			Halifax - - - - -	35	
			Huddersfield - - - - -	23	
			Hull (two schools) - - - - -	95	
			Leeds - - - - -	47	
			Middlesborough - - - - -	11	
			North Ormsby - - - - -	7	
			Ripon - - - - -	35	
			Thorne - - - - -	17	
			York - - - - -	80	
				476	

STUDENTS IN IRELAND.

No of Schools.		No of Students.	No. of Schools.		No. of Students.
27	Antrim:			Armagh:	
	Antrim - - - - -	66		Armagh - - - - -	13
	Ballycarry - - - - -	24		Ballywilly - - - - -	19
	Ballymena - - - - -	18		Bessbrook - - - - -	21
	Belfast (15 schools) - - - - -	480		Eglisk - - - - -	51
	Braidwater - - - - -	15		Lurgan - - - - -	61
	Carnunny - - - - -	16		Markethill - - - - -	20
	Carrickfergus - - - - -	42		Newry - - - - -	41
	Galgorm - - - - -	36		Portadown - - - - -	30
	Larne (two schools) - - - - -	90		Tandragee - - - - -	34
	Newtownbreda - - - - -	33	9		290
	Whitehouse - - - - -	18		Carlow:	
				Bagenalstown - - - - -	39
				Carlow - - - - -	21
			789		60

STUDENTS IN IRELAND—continued.

No. of Schools		No of Students	No of Schools		No of Students
1	Cavan . Bailieborough - - - -	84	1	Londonderry . Coleraine - - - -	60
1	Clare . Cooraclare - - - -	40	1	Louth Dundalk - - - -	62
1	Cork : Cork - - - -	65	1	Mayo Newport - - - -	7
1	Donegal : Raphoe - - - -	18		Meath : Drogheda Oldcastle Trim - - - -	29 190 62
	Down Ballyboley - - - - Banbridge - - - - Comber (two schools) Crossgar - - - - Downpatrick - - - - Gilford - - - - Holywood - - - - Loughinisland - - - - Newtownards - - - -	84 64 96 16 20 35 76 18 184	3	Monaghan Castleshane - - - - Monaghan - - - -	281 16 23
10		493	2	Roscommon : Athlone (two schools) - - - -	69
	Dublin . Dublin (three schools) Santry - - - -	191 60	1	Tipperary Roscrea - - - -	9
4		961		Tyrone . Fintona - - - - Strabane - - - -	8 23
	Fermanagh . Enniskillen - - - - Garrison - - - -	17 13	2		31
2		80		Waterford : Portlaw - - - - Waterford - - - -	9 55
1	Galway Galway - - - -	43	2		64
1	Kilkenny : Kilkenny - - - -	46	1	Wexford . Enniscorthy - - - -	40

STUDENTS IN SCOTLAND.

No of Schools		No of Students	No of Schools		No of Students
3	Aberdeen : Aberdeen - - - - Aberdeen* - - - - Newhills - - - -	61 317 17	1	Inverness : Inverness - - - -	27
1	Ayr : Beith - - - -	395 7	1	Kilmarnock : Kilmarnock - - - -	76
1	Dumbarton : Dumbarton - - - -	12	1	Kincardineshire . Banchory - - - -	13
1	Edinburgh : Leith - - - -	228	1	Kirkcudbright. Corsock - - - -	13
1	Forfarshire : Dundee - - - -	76	3	Lanarkshire : Glasgow (three schools) † - - - -	1,760
			1	Orkney : Kirkwall - - - -	10

* Navigation School, not examined in May.

† Only 176 of these wish to be examined.

Appendix, No. 2.

App. No. 2.

PAPERS handed in by Mr. Cole, 30 April 1868.

No. 1.

ROYAL SCHOOL OF MINES

1. How many years has the Jermyn-street School been established?
It is now (1867-8) the 17th Session, the school having been established in 1851.
 2. How many students have passed through the school?
 1. As students for one to three years (associate or matriculated students) - - - - - 233
 2. As occasional students - - - - - 1,113
- TOTAL - - - 1,346

3. The amount of Fees received each year from Students since the Commencement:

Session	£.	s.	d.
1851-52	686	10	-
" 1852-53	636	3	4
" 1853-54	721	10	-
" 1854-55	675	8	4
" 1855-56	726	3	4
" 1856-57	461	7	4
" 1857-58	517	-	-
" 1858-59	582	1	-
" 1859-60	661	10	-
" 1860-61	810	-	-
" 1861-62	1,034	15	-
" 1862-63	764	1	10
" 1863-64	1,029	11	8
" 1864-65	719	7	-
" 1865-66	771	15	-
" 1866-67	972	15	-
TOTAL	£.	11,769	16 10

N.B.—These amounts include the sums received for the "Working Men's" and "Evening Lectures."

4. The number of Students in each subject in 1865 or 1867.

	Session 1865-6.	Session 1866-7.
Chemistry	24	39
Natural History	11	5
Physics	22	28
Geology	15	17
Mining	6	3
Mineralogy	5	5
Metallurgy	5	9
Applied Mechanics	6	2

N.B.—These numbers do not include the associates.

5. The number of Students educated in Jermyn-street under scholarships:
Twenty-one; viz., 14 as Royal Exhibitioners (established 1861-2); one free scholar from Edinburgh, two from Cheltenham, one from Truro, and three from Bristol. Besides these, 22 certificated masters or pupil teachers have been admitted to the lectures on payment of an examination fee of 1 l., and two gold medallists have been admitted free.

FINANCIAL STATISTICS—SCIENCE and ART.

	Salaries and General Management.	New and Permanent Buildings.	Purchase of Works of Art.	Cost of Management.				Grants in Aid			East London Museum.	Jermyn Street.	Edinburgh Museum.	Royal Dublin Society.	Royal College of Science, Dublin.	
				Science and Art Department.	South Kensington.	National Portrait Exhibition.	Total Cost.	Science Schools.	Art Schools.	School of Naval Architecture.						
	£.	£.	£.	£.	£.	£.	£.	£.	£.	£.	£.	£.	£.	£.	£.	
Estimates 1868-9	8,507	32,500	24,000	11,850	34,240	3,000	49,090	18,900	37,750	3,600	10,000	12,258	8,219	2,185	6,268	
" 1867-8	8,317	32,500	21,250	7,850	34,225	-	42,075	8,600	22,000	2,800	5,000	11,299	5,328	2,185	5,943	
Reports 1866	5,760	18,038	13,887	5,839	25,905	3,742	35,386	5,874	16,728	753	-	7,153	3,185	7,569	-	
" 1865	7,398	19,998	14,846	7,233	40,087	-	47,920	26,605	-	-	-	8,703	4,780	14,059	-	
Estimates 1864	5,760	24,000	500	21,540	24,155	-	45,695	20,000	-	-	-	7,414	2,837	7,472	-	
Report 1863	4,847	25,855	989	25,863	23,461	-	48,824	18,948	-	-	-	6,660	2,113	7,017	-	
" 1862	4,704	3,142	-	24,328	18,480	-	43,808	17,748	-	-	-	6,314	2,392	6,000	-	
" 1861	4,391	-	-	28,876	20,210	-	49,086	17,497	-	-	-	6,706	2,072	6,000	-	
" 1860	3,819	3,394	-	21,578	24,000	-	45,578	16,244	-	-	-	6,684	2,270	6,000	-	
" 1859	3,615	5,691	-	18,906	12,452	-	31,358	15,408	-	-	-	6,187	1,922	6,060	-	
Estimates 1858	3,625	5,570	-	28,400	9,445	-	37,845	15,900	-	-	-	6,241	1,334	6,060	-	
				Department of Science and Art.				Cost of Schools throughout Kingdom.								
Report 1857	3,325	-	-	22,499			-	29,774								
" 1856	4,569	-	-	33,496			-	23,303								
" 1855	5,545	-	-	19,478			-	20,722								
" 1854	TOTAL Cost for Science and Art throughout Kingdom													£. 26,596.		

App. No. 2.

No. 3.

ANSWERS to Mr. Dixon.

Section II.

1. Number of teachers in 1867, 200.
2. Average amount paid to each on 1867 examination, 40 l.
- 3, 4, and 5. (There was not sufficient time to obtain this information).
6. The total cost of the Queen's Prizes issued in 1867 for Science was:—

	£. s. d.
For Books - - - - -	586 14 5
For Medals - - - - -	152 6 9
TOTAL - - - - -	739 1 2

7. The total amount paid as results in 1867, was 8,000 l.

No. 4.

PAYMENTS to SCIENCE TEACHERS in 1862 (before change of System).

Name of Teacher.	School.	—
		£. s. d.
Brazier, James - - - - -	Aberdeen, M. I. - - - - -	20 - -
Beveridge, Robert - - - - -	ditto - - - - -	12 - -
Maver, David - - - - -	ditto - - - - -	20 - -
Beesley, Thomas - - - - -	Banbury - - - - -	31 - -
Beale, John H. - - - - -	ditto - - - - -	41 10 -
Eardley, Fras. - - - - -	Belfast - - - - -	91 10 -
Rambach, David W. - - - - -	Birmingham, Art School - - - - -	29 - -
Williams, W. M. - - - - -	Birmingham, Midland Institution - - - - -	53 - -
Fulton, Hugh - - - - -	Bristol, Trade School - - - - -	8 10 -
Coomber, Thomas - - - - -	ditto - - - - -	116 10 -
Rowden, W. T. - - - - -	ditto - - - - -	124 10 -
Wood, Charles S. - - - - -	Bristol, Mining School - - - - -	90 - -
Clement, Leonard - - - - -	Burnley, &c. - - - - -	91 - -
Bownas, John - - - - -	Calne - - - - -	44 - -
Tate, Ralph - - - - -	Belfast, Lisburn, and Carrickfergus - - - - -	184 - -
Dowling, John - - - - -	Cork, Bandon, and Clonmel - - - - -	145 - -
Clough, James C. - - - - -	Dedham - - - - -	7 10 -
Jones, John - - - - -	Dudley - - - - -	23 - -

Name of Teacher.	School.	£ s. d.		
M'Ivor, Alexander	Edinburgh	6	-	-
Mayer, John	Glasgow	81	-	-
Jeffery, Walter	Gloucester	109	-	-
Noble, John	Halifax	89	10	-
Mellor, James	Oldham and Hollinwood	49	-	-
Tindall, George	Huddersfield	26	-	-
Meaden, Henry P.	Accrington, Burnley, and Haslingden	130	10	-
Bentley, Buzi	Kirkheaton	27	-	-
Ward, George	Leeds	9	10	-
Collingwood, D. C.	Liverpool	50	-	-
Birkenhead, E. H.	Liverpool and Wigan	188	10	-
Pike, Robt. W.	Bethnal Green, Birkbeck School	41	10	-
Taylor, Charles	Charterhouse	16	-	-
Cooke, M. C.	Highbate	41	-	-
Howard, John	Islington	21	-	-
Runtz, James	Kingsland, Birkbeck School	10	-	-
Bithell, Rich.	Kingsland, British School	47	-	-
Stockton, William	Poplar	16	-	-
Strachan, R.	ditto	85	-	-
Douglas, John C.	London, Birkbeck School	27	-	-
Chadwick, John	Macclesfield	50	10	-
Snelus, George J.	ditto	29	10	-
Hudson, Fearnade	Manchester, Corporation-street	54	10	-
Crossley, Wilham	Middlesboro'-on-Tees	26	10	-
Twate, Charles	Redruth	18	-	-
Pearoe, Richard	ditto	25	-	-
Jones, Thomas	St Leonards	22	-	-
O'Neill, Charles	Salford	74	-	-
Jarman, George	Huddersfield and Slathwaite	121	10	-
Dorrell, John	Slough	19	10	-
Hudson, Washington	Stockport and Pendleton	22	-	-
Pullen, Moses	Painwick and Stroud	60	10	-
Davis, Urnah J.	Upton St. Leonards	44	-	-
Hetherington, J. H.	Windsor	5	-	-
TOTAL		£	2,694	-

Average payment, 52 £ each, nearly.

App No. 2.

No. 5.

PAYMENT TO TEACHERS in London and its District Science Schools on the Results of the Examination in May 1867.

SCHOOL.	TEACHERS.	£. s. d.	Total Amount.
London.		£. s. d.	£. s. d.
Bath-street, City-road	Davidson, Ellis A.	14 - -	14 - -
Battersea, Sir Walter St. John's School.	Martin, James Snelus, G J.	48 - - 99 - -	147 - -
Bethnal Green, British School	Pike, R W.	79 2 6	79 2 6
Bethnal Green, National School	Simpson, B.	78 7 6	78 7 6
Chelsea, St. Mark's Training College.	Eastburn, Rev. C. F. Lawson, W. Atkins, G Briggs, Henry	97 10 - 130 - - 28 - - 10 - -	265 10 -
Working Men's College, Great Ormond-street.	Snelus, G J.	17 - -	17 - -
City of London College	Gibson, Rev B W.	10 - -	10 - -
Kingsland and Dalston	Bithell, Dr. R.	15 - -	15 - -
Lower Islington	Howard, John	89 5 -	89 5 -
Lambeth	Duckett, W Griffiths, J. A.	37 - - 20 - -	57 - -
Peckham	Tate, R (Middle and Upper Class School).	- - -	- - -
Royal Polytechnic	Snelus, G. J. Coles, F.	35 10 - 10 - -	45 10 -
Croyden	Sullivan, M.	29 - -	29 - -
Deptford, St John's	Farncomb, C (teacher not qualified to claim payment).	- - -	- - -
Deptford, St. Paul's	Busbridge, W. Dorrell, C. F.	15 - - 27 - -	72 - -
Greenwich	Griffiths, John A. Jones, Thomas	60 5 - 88 - -	148 5 -
Plumstead	Farlie, C J Rowden, W T. Shipman, Charles	60 - - 58 - - 86 5 -	204 5 -
Woolwich, Royal Arsenal Military Institution	Jones, Thomas Duckett, W. Davidson, G Brown, L.	3 - - 45 17 6 72 15 - 17 - -	188 12 6
Woolwich, National School	Swiss, Henry Farlie, C J. Noble, John Rowden, W T.	71 5 - 42 - - 15 - - 42 - -	170 5 -
Woolwich, St. Thomas	Clark, J J. Busbridge, W. Byatt, Horace	9 - - 98 15 - 62 15 -	171 10 -
		£.	1,751 12 6

Average, 87 l. 11 s. per School.

No. 6

LIST OF TEACHERS Employed.

	Subjects.	Schools.	Amount.		
			£	s	d.
Atkins, George	X	St Mark's, Chelsea	28	-	-
Bithell, R.	IV	Kingsland and Dalston	15	-	-
Briggs, Henry	VII	St Mark's, Chelsea	10	-	-
Browne, Leonard	XXIII.	Woolwich, Royal Arsenal	17	-	-
Busbridge, Walter	I, II, III	Deptford and Woolwich	148	15	-
Byatt, Horace	I.	Woolwich, St. Thomas'	68	15	-
Clark, John J	IV	Woolwich, St Thomas'	9	-	-
Coles, Ferdinand	X	Royal Polytechnic	10	-	-
Davidson, Ellis A.	II, III.	City, Middle Class School	14	-	-
Davidson, George	I, II, III.	Woolwich, Royal Arsenal	72	15	-
Dorrell, Chas F.	I	Deptford, St Paul's	27	-	-
Duckett, William	I, II, III	Lambeth and Woolwich	82	17	6
Eastburn, Rev. C. F.	IV	St. Mark's, Chelsea	97	10	-
Farlie, Chas J.	I, III.	Plumstead and Woolwich	102	-	-
Gibsons, Rev B. W.	X.	City of London College	10	-	-
Gniffiths, John A.	I, II	Lambeth and Greenwich	80	5	-
Howard, John	{ IX., X., XIV., XV., XVI., XXIII.	Lower Islington	89	5	-
Jones, Thomas	{ I., II., III., VII., XIV., XXIII.	Woolwich and Greenwich	91	-	-
Lawson, William	XXIII.	St. Mark's, Chelsea	130	-	-
Martin, James	IV.	Battersea	48	-	-
Noble, John	X.	Woolwich	15	-	-
Pike, Robert W	{ IX., XIV., XXIII.	Bethnal Green, Birkbeck School	79	2	6
Rowden, Wm. T.	{ I, II, III, VI, VII	Woolwich and Plumstead	100	-	-
Shipman, Chas.	I, II	Plumstead	86	5	-
Simpson, Bentham	{ VIII, IX, XII, XVI., XXIII.	Bethnal Green National School.	78	7	6
Snelus, George J.	IX., X., XIV.	Battersea and Royal Poly- technic	161	10	-
Sullivan, Michael	I, II, III.	Croydon	29	-	-
Swiss, Henry	I, II, III.	Woolwich National School	71	5	-
Average, 62 L 10 s 6 d.					

App. No 2.

No. 7.

ROUGH STATEMENT OF EXPENDITURE for SCIENCE TEACHING under each of the following Heads, in the Year 1867-8.

1867-8.		£. s. d.
1. General Management - - - Estimate, 8,317 l.	Proportion of Salaries of Secretary, Assistant Secretary, Chief Clerk, Clerks, Accountant, &c. } say 1-10th	880 - -
2. New Buildings - - - Estimate, 32,500 l.	Proportion of expenditure on Science Schools cannot be stated at present.	- - -
3. Purchase of Works of Art, &c. &c. Estimate, 21,250 l.	The direct vote for Science Purchases is - - - - - but many objects are indirectly for Science, and the amount can scarcely be stated	1,250 - -
4. Science and Art Department - Estimate, 7,850 l. Expenditure, 9,720 l.	Viz --Examination Papers } Inspection - - - } say 3-5ths Travelling - - - } of 9,720 l. Incidental - - - }	6,885 - -
5. South Kensington Museum - Estimate, 34,225 l.	Proportion for Education, good Naval Architecture, Animal Products, &c , cannot well be distinguished.	- - -
6. National Portrait Gallery - - -	Nil for Science - - - - -	- - -
7. Science Schools - - - Estimate, 8,600 l. Expenditure, 10,200 l.	- - - - -	10,200 - -
8. Art Schools - - - Estimate, 22,000 l.	Proportion for Mechanical Drawing cannot be given.	- - -
9. Naval Architecture - - - Estimate, 2,800 l. Expenditure, 2,108 l.	- - - - -	2,108 - -
10. East London Museum - - - 5,000 l. to account	Will be chiefly devoted to Science -	- - -
	£.	20,218 - -

Appendix, No. 3

PAPER handed in by Mr. *Whitworth*, 7 May 1868.Science Form, No. 298
South Kensington, May 1868.

App. No. :

Science and Art Department of the Committee of Council on Education, South
Kensington

MR WHITWORTH'S SCHOLARSHIPS FOR MECHANICAL SCIENCE

At Whitehall the 5th day of May 1868.

By the Right Honourable the Lords of the Committee of Her Majesty's Most Honourable
Privy Council on Education

MY Lords read Mr Whitworth's letter of 4th May 1868 transmitting a memorandum on his scholarships and on the establishment of 60 exhibitions of 25 l for the present year preparatory to the competition for his scholarships, and requesting that the Science and Art Department may conduct the necessary examinations and correspondence.

Their Lordships have great pleasure in acceding to Mr. Whitworth's request and giving every assistance in their power in carrying out his patriotic munificence.

Sir,

Manchester, 4 May 1868

REFERRING to your letter of March 28th by which you transmit to me a copy of the Minute which the Lords of the Committee of Council on Education had passed in acknowledgment of my endowment of scholarships for promoting mechanical science, and to the concluding sentence of the Minute which invites further suggestions and offers to render assistance in carrying out the intentions of the endowment

1 I beg leave to enclose for the information of the Lords of the Committee of Council on Education a memorandum on the subject of the endowment, which I trust will meet with the approval of their Lordships, and that they will cause it to be circulated and the necessary correspondence arising out of it to be conducted by the Science and Art Department.

2 I would beg leave to ask the Lords of the Committee of Council on Education to undertake the examinations for these scholarships

3 As respects the preparation of the necessary details for the examinations in the use of tools, I am willing to be responsible myself with the aid of friends, and I propose to obtain the consent of a few gentlemen to advise with me from time to time in whatever may arise in the future for my consideration

4 In reply to the invitation of their Lordships to submit any suggestions, I venture to submit for consideration whether honours in the nature of degrees might not be conferred by some competent authority on successful students each year, thus creating a faculty of industry analogous to the existing faculties of divinity, law, and medicine I am of opinion that such honours would be a great incentive to exertion, and would tend greatly to promote the object in view.

5 I venture further to express a hope that the Government will provide the necessary funds for endowing a sufficient number of professors of mechanics throughout the United Kingdom

6 In conclusion, I inform you that the necessary arrangements for securing the endowment have been made, and I have given instructions for the preparation of the draft of a deed of trust which will be sent for the approval of the Lord President.

I am, &c
(signed) *Joseph Whitworth.*To Henry Cole, Esq.,
Secretary of the Science and Art Department.

MEMORANDUM ON SCHOLARSHIPS FOR MECHANICAL SCIENCE.

To be competed for in May 1869.

I. HAVING offered to the Lords of the Committee of Council on Education to "found 30 scholarships of the annual value of 100 l each, to be applied for the further instruction of young men, natives of the United Kingdom, selected by open competition for their intelligence and proficiency in the theory and practice of mechanics and its cognate sciences, with a view to the promotion of engineering and mechanical industry in this country," I propose that the following should be the general arrangements in the first instance, which may be modified after the first competition has taken place in May 1869.

II That the 30 scholarships of 100 l each should be open to all of Her Majesty's subjects whether of the United Kingdom, India, or the Colonies, who do not exceed the age of 26 years, and be held either for two or three years, as experience may prove to be desirable, that 10 scholarships should be competed for and awarded in May 1869, at the annual national examinations in science, provided that a sufficient number of candidates prove themselves to be competent, that the successful candidates should be required to spend the period of holding the scholarships in the further satisfactory prosecution of the studies and practice of mechanical engineering, and pursue their studies according to the spirit of the endowment, making periodical reports of them, that the student should state where he proposes to pursue his studies, the Lord President of the Council deciding if the proposal can be allowed, also if the student's progress be satisfactory, and the manner in which it shall be tested from year to year. In deciding if the plan of study proposed by the student be satisfactory, as much latitude as possible may be allowed. If the student wish to complete his general education instead of continuing his special scientific study, he may be permitted to do so. He may go to the universities or colleges affording scientific or technical instruction, or he may travel abroad. The successful artisan should be encouraged to study theory, and the successful competitor in theory aided in getting admission to machine shops and other practical establishments. All further details would be hereafter prepared and issued by the Science and Art Department.

III The candidates must be of sound bodily constitution.

IV. The first competition should be in the following theoretical subjects —

- | | |
|---|-------------------------------------|
| 1. Mathematics (elementary and higher) | 4 Physics |
| 2. Mechanics (theoretical and applied) | 5. Chemistry, including metallurgy. |
| 3. Practical plane and descriptive geometry,
' and mechanical and freehand drawing | |

And in the following handicrafts:—

- | | |
|-----------------|---------------------------------|
| 1. Smith's-work | 3. Filing and Fitting |
| 2. Turning | 4. Pattern making and moulding. |

V No candidate should obtain a scholarship who has not shown a satisfactory knowledge of all the following theoretical subjects —

- | | |
|---------------------------|--|
| 1 Elementary mathematics. | 3 Practical plane and descriptive geometry
and freehand drawing |
| 2 Elementary mechanics. | |

with the power to use one or more of the following classes of tools —

- | | |
|----------------------------|--------------|
| a The axe | d. The file |
| b The saw and plane. | e The forge. |
| c. The hammer, and chisel. | |

I propose that the maximum number of marks obtainable in the theoretical subjects and those obtainable by the most skilled workman should be about equal.

VI My object in devising the foregoing scheme has been, while requiring a practical acquaintance with a few simple tools as a *sine qua non*, to render the competition accessible on fairly equal terms to the student who combines some practice with his theory, and to the artisan who combines some theoretical knowledge with perfection of workmanship.

Preparatory Exhibitions of 25 l. for the Year 1868.

VII. As the scholarships scheme can only come into full operation by degrees, I propose from the fund ultimately available for the scheme at once to create 60 exhibitions or premiums, of the value of 25 l. each, tenable until April 1869, and to place them at the absolute disposal of the governing bodies of the following educational institutions and towns, in order that they may award them to youths under 22 years of age, who may thus be aided to qualify themselves, and must undertake to compete for the scholarships of 100 l in May 1869

VIII.—

- | | |
|--|---|
| 3 Exhibitions to Owens College, and 2 to the
Grammar School, Manchester, the seat of my
Workshops. | 3 University of Oxford
3 University of Cambridge.
3 University of London. |
|--|---|

And

And one to each of the following universities, colleges, and public schools —

App No.

University of Durham	Westminster
University of Dublin	Winchester
University of Edinburgh.	St Paul's, London.
Watt Institution, Edinburgh	Mechants Tailors
University of Glasgow	Christ's Hospital
Andersonian University, Glasgow	City of London
University of St Andrew's	Shrewsbury
University of Aberdeen	Marlborough.
To each of the Queen's Colleges at Belfast, Cork,	Cheltenham.
Galway, Ireland.	Chester
King's College, London	Clifton
University College, London,	Brighton,
Eton	Liverpool
Harrow,	
Rugby.	2 to the College of Preceptors
Charter House.	8 to the Science and Art Department

I propose that the following exhibitions shall be given to artizans only —

2 to the Society of Arts

Also one for artizans to each of the following towns —

Birmingham	Leeds
Bristol.	Northampton.
Swansea and Cardiff	Sheffield
Hullfax or Huddersfield.	

And if there be any of the above unapplied, they may be given by the Science and Art Department to any other scholastic institution which makes satisfactory arrangements for affording instruction in mathematics and mechanics, freehand and mechanical drawing.

IX. I would point out that the exhibitions to artizans may perhaps be increased to 50 *l* for the year, by connecting them with the Science and Art Department, under the Minute of the 21st December 1867.

(signed) *Joseph Whitworth*

Manchester, 4 May, 1868:

MINUTE ON MR WHITWORTH'S OFFER TO ENDOW SCHOLARSHIPS.

At Whitehall, the 27th day of March 1868.

By the Right Honourable the Lords of the Committee of Her Majesty's Most Honourable Privy Council on Education

MR LORDS consider Mr Whitworth's letter to the First Lord of the Treasury, dated 18th March 1868. In this letter Mr. Whitworth offers to found 30 scholarships of the annual value of 100 *l* each, to be applied for the further instruction of young men, natives of the United Kingdom, selected by open competition for their intelligence and proficiency in the theory and practice of mechanics and its cognate sciences, with a view to the promotion of engineering and mechanical industry in this country, and he expresses hopes that means may be found for bringing science and industry into closer relation with each other than at present obtains here

It is unnecessary now to repeat the thanks which the First Lord of Her Majesty's Treasury and the Lord President of the Council have already conveyed to Mr. Whitworth for his generous offer, which they are convinced the country will fully appreciate

Mr Whitworth proposes that these scholarships should be tenable on conditions to be defined by a deed of trust regulating the administration of the endowment fund during his life, and that thereafter the management of this fund, subject to the conditions specified therein, should rest in the Lord President of the Council or other Minister of Public Instruction for the time being.

It is the wish of my Lords to see provision made in several large centres of manufacturing industry in the United Kingdom for affording to all classes of Her Majesty's subjects ample opportunities for acquiring instruction in the sciences which are applicable to productive industry. My Lords are of opinion that by the union of local and private efforts, supplemented as far as is proper by State assistance, this provision will be best made.

This will be rendered easy if the munificent example set by Mr. Whitworth shall be extensively followed by others.

My Lords will be happy to receive any further suggestions from Mr Whitworth should he desire to make them, and to be informed if the Department can render him any assistance in carrying out his liberal intentions.

Appendix, No 4.

PAPER handed in by Captain Donnelly.—(See Evidence, No. 143.)

RETURN OF SCHOOLS HAVING DAY CLASSES IN SCIENCE.

TOWN.	SCHOOL.	Number of Individual Students.	Practical, Plane, and Solid Geometry	Mechanic Construction and Drawing	Building Construction	Elementary Mathematics	Higher Mathematics	Theoretical Mechanics	Applied Mechanics	Acoustics, Light, and Heat.	Magnetism and Electricity	Inorganic Chemistry	Organic Chemistry	Geology	Mineralogy.	Animal Physiology	Zoology	Vegetable Physiology and Economic Botany	Systematic Botany	Mining	Metallogy	Navigation.	Nautical Astronomy	Steam	Physical Geography		
ENGLAND.																											
Andover	British School - - - - (Day Class) - - -	38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	
	Ditto - - - - - (Evening Class) - - -		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Birmingham	St Barnabas - - - - (Day Class) - - -	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	
	Ditto - - - - - (Evening Class) - - -		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bristol	(Day Classes) - - - -	143	57	57	57	57	-	57	57	-	57	57	57	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	(Evening Class) - - - -		16	26	11	21	-	16	-	-	-	17	36	36	-	-	-	-	-	-	-	-	-	-	-	-	-
Bromsgrove	{ Literary and Mechanics Institute } (Day Class) - - -	23	-	-	-	-	-	-	-	-	-	-	-	-	-	23	-	-	-	-	-	-	-	-	-	-	-
Burnley	Carlton Road School - - (Day Class) - - -	63	-	-	-	-	-	-	-	-	-	47	-	-	-	24	-	-	-	-	-	-	-	-	-	-	-
	Ditto - - - - - (Evening Class) - - -		45	-	-	-	-	-	45	-	-	45	-	20	-	10	-	-	-	-	-	-	-	-	-	-	-
Cheltenham	Science School - - - - (Day Class) - - -	132	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	7	-	-	-	-	-	-	-	
	Ditto - - - - - (Evening Class) - - -		10	-	-	-	-	-	54	54	33	34	11	18	-	8	7	-	7	-	18	-	-	-	-	-	18
Cold Norton	National School - - - -	10	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Culham	Training College - - - -	22	-	-	-	-	-	2	-	-	-	15	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-
Derby	Grammar School - - - -	13	-	-	-	-	-	-	-	-	13	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-
Hull	Navigation School - - - -	73	-	-	-	69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	65	63	70	73	-	
Kettering	Boys' National School - (Day Class) - - -	16	-	-	-	-	-	-	-	-	-	-	-	-	-	16	-	-	-	-	-	-	-	-	-	-	-
Liverpool	Liverpool Institute - - (Day Class) - - -	83	-	-	-	83	-	-	-	-	-	63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Llanely	Copper Works School - - (Day Class) - - -	43	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	
	Ditto - - - - - (Evening Classes) - - -		-	-	22	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
Macclesfield	Modern Free School - - -	41	-	-	-	-	-	-	-	-	-	41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manchester	Mechanics' Institution - (Day Class) - - -	200	-	-	-	-	-	-	-	30	30	60	-	-	-	60	-	-	-	-	30	-	-	-	-	55	
	Ditto - - - - - (Evening Class) - - -		127	127	127	-	12	12	-	-	-	-	25	-	-	27	-	-	-	-	-	-	-	-	-	-	-
Oldbury	National School - - - -	35	-	-	-	-	-	-	-	-	-	-	-	-	35	-	-	-	-	-	-	-	-	-	-	-	-
Olham	Parish Church School - -	25	25	25	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

APPENDIX TO REPORT FROM THE

RETURN OF SCHOOLS HAVING DAY CLASSES IN SCIENCE—continued.

TOWN.	SCHOOL.	Number of Individual Students.	Practical Plane, and Solid Geometry	Machine Construction and Drawing	Building Construction	Elementary Mathematics	Higher Mathematics	Theoretical Mechanics	Applied Mechanics	Astronomy, Light and Heat	Magnetism and Electricity.	Inorganic Chemistry.	Organic Chemistry.	Geology.	Mineralogy.	Animal Physiology	Zoology	Vegetable Physiology and Economic Botany	Systematic Botany.	Mining	Metallurgy.	Navigation.	Nautical Astronomy.	Steam.	Physical Geography	
<i>IRELAND—continued</i>																										
Carlow	Christian Schools	19	19																							
Carrockfergus	Model School	26																								
Coleraine	Model National School	57				24																				26
Cooralare	National School	83				88																				57
Cork	Model School	55								12	10															
Dublin	Central Model School	107	65														54									
	King's Hospital School	45				41					97															
	Incorporated Society's Day School	19				12		12																		46
Dundalk	Free Library, &c.	49				36		15		16	14															13
Eglisli (County Armagh)	National School	50									50															28
Fintona	National School	8				8																				8
Galway	Model School	42				22		9			36															
Gilford	National School	38									28															
Holywood	Sullivan's Schools	70								72																57
Kilkenny	Model School	52				15				50																
Loughlinland	National School	20															28									18
Markethill	Coolmalish National School	20																								20
Newtonbreds	National School	25																								25
Newtonwards	Model School	98				40																				80
Oldcastle	Endowed Schools	165									80															88
Raphoe	National School	9				9																				
Santry	Incorporated Society's Training School	64	23			64	24	64	64	64	64															
Strabane	(Class of National School Teachers)	21				21												64	64			24	24	64		64
Tandragee	The Common School	35				7		2		35	2															
Trim	Model School	30												30												
Waterford	Model School	50										50														
	TOTAL for IRELAND	1,656	107			487	24	131	64	409	506	50		46		83	72	64	64			121	86	64		702
	TOTAL for the UNITED KINGDOM	4,894	289	253	253	986	25	307	132	458	774	544	57	395		578	292	196	71		60	1,017	252	165		1,352

Appendix, No. 6.

PAPER handed in by Mr. *Mundella*, 11th June 1868.

App. No 6.

LETTER from Mr *Thurlow* to Mr. *A J Mundella*.

Dear Sir, Trinity School, Nottingham, 6 February 1868.
 THE subject of technical scientific education has been in my mind very much of late. As I have now been for a considerable period local secretary to the science classes in this town, and know, too, the deep interest you take in the advancement of education of all kinds in general, and of this branch in particular, I venture to intrude a few remarks and suggestions upon your notice.

The instruction given in the science classes is sound, and imparted by duly certified teachers; but yet it is a fact that the classes are not large, nor attended by those whom the department had specially in view in encouraging their establishment. That something more must be aimed at than the present classes are likely to achieve seems now to be the opinion of those in authority. A Minute has been passed by the Science and Art Department for the establishment of scholarships, to be held by scholars of elementary schools, who are between the age of 12 and 16 years, and who shall pass at the examination of science classes in the month of May in each year, so as to gain a third Queen's prize in some subject sanctioned by the department. If, previously, the scholar has passed in the three first grade subjects for drawing, and succeeds in the science examination, the department will grant 10/ towards his maintenance at school, but if he succeed in his science examination, and has not passed in drawing, then the managers are required to find 5/ to meet a Government grant of 5/ for the aforementioned purpose. This is the point where I imagine the Minute will be found to break down in practice. Moreover its effect will be almost *nil*, for the scholarships are only in the proportion of one per cent. of the scholars in attendance.

If there really is a desire, on the part of the Government, to encourage scientific instruction in schools, a more liberal and practical scheme must be devised than that set forth in the recent Minute. There seems to me no reason why the same plan should not be adopted as exists in the case of instruction in first grade drawing.

The first necessity seems to me to be, the provision of suitable elementary text-books on the scientific subjects in which instruction is to be imparted, and then a system of examination precisely answering to the method adopted in the case of drawing. Elementary text-books for class instruction would soon be produced if there was known to be a want, or, if such were not procurable, they would soon be forthcoming if only the department adopted a similar course to that pursued when the first grade drawing copies were needed, *viz.*, of offering prizes for the best.

Then, again, the examination could be conducted by means of questions supplied from the department of a sufficiently elementary character to be classed as first grade questions. To the successful competitors there might be awarded a pass certificate, and to the more meritorious a certificate and a prize, exactly answering to the course pursued by the department in the case of the drawing.

For the encouragement of the introduction of this kind of teaching in schools, the same scale of payment on results might be made to the managers, to go to the teacher in way of augmentation of his income.

For the supply of necessary apparatus, diagrams, and specimens, the department would only need to return to the plan which was in force some years since, *viz.*, of making grants to school managers to enable them to purchase such, where the master had satisfied the department, by examination, of his competency to use the same. I say nothing of the subjects of instruction, as these would vary with the locality.

It seems to me that by some such plan as I have sketched, our present primary schools might be utilized as a means of laying a solid foundation in the principles of science, and thus a taste created and students provided for our advanced science classes. Failing this, there would still be the broad principles taught, which the individual might perfect by his own reading, if so inclined.

A. J. Mundella, Esq

I am, &c.
(signed) R. Thurlow.

Appendix, No. 7.

PAPER handed in by Mr *George Gibb*, 8 June 1868.

WORKING MEN'S COLLEGE, HALIFAX.

App

TECHNICAL EDUCATION

Technical Instruction:

IN and around Halifax, dyeing and machine-making are the staple industries, therefore it has been determined by the founder and supporter of the Working Men's College to make provision for the teaching of subjects bearing on such occupations. Besides the general classes for instruction in reading, writing, arithmetic, algebra, geometry, book-keeping, English literature, geography, &c, and those in chemistry and French already in operation, it is proposed at once to open classes in

The Chemistry of Dyeing,

under Mr. Jarman, of Huddersfield, who possesses an excellent theoretical and practical knowledge of the subject, and others in

Practical Geometry, Machine Drawing, and Freehand,

under Mr. Stopford, head master of the School of Art, Halifax, whose accurate professional knowledge of the subjects above named will ensure the success of the students who enter the classes. A large well-ventilated room, with a good supply of the drawing boards, instruments, models, and copies required will be supplied, free of expense, to the students

Both in the science classes, and those under the charge of Mr. Stopford, pupils are eligible to compete for prizes offered by the Science and Art Department of the Committee of Council on Education. These prizes consist of books, mathematical instruments, boxes of colours, &c., and the examinations are of such a nature that any moderately intelligent student who has attended during the session can carry off one or more prizes. They are unlimited in number, every pupil reaching the very moderate standard required, receives a prize in any subject.

As it is wished to make these classes available to all, the fees are very low, viz. —

Chemistry Classes:

Five shillings per session for one class, 2 s 6 d for each of the others, chemicals and all requisite apparatus being supplied free at the laboratory. The session is from October to April.

Drawing Classes:

Freehand, machine drawing, practical geometry, any one or all; to students attending the general classes of the Working Men's College, 2 s. 6 d. per half-session from September to Christmas, or from Christmas to April; to others 3 s. 9 d. per half-session.

App No 7.

General Classes

Reading, mathematics, geography, English literature, &c 2 s per term (about 2 d per week)

A class in Latin is about to be begun, the charge for which is included in the above
Book-keeping, by agreement, French, by agreement.

The chemistry classes will meet three times per week on Wednesday, Thursday, and Friday, from half-past seven to half-past nine

The drawing class (at present) on Thursday from half-past seven to half-past nine

The general classes meet on Monday, Tuesday, Wednesday, and Thursday, from a quarter-past seven to a quarter-past nine

It is earnestly hoped that employers of labour will bring this matter under the notice of their workpeople, and the intelligent workmen of Halifax are strongly recommended to avail themselves of the unusual advantages here offered to assist them in keeping their country in the van of the world's progress

The general classes and the drawing class commence in the first week of September
The chemistry classes early in October

August 1867

Appendix, No. 8.

PAPER handed in by Mr. *Flatt*, 18 June 1868.

SYLLABUS of STUDIES at the OLDHAM SCHOOL of SCIENCE and ART.

App.

SCIENCE.

Instruction is given in the following subjects by *Thomas Mitchell*, F.R.G.S., &c., Civil Engineer, and Certified Teacher at South Kensington by the Science and Art Department in Practical, Plane, and Descriptive Geometry, Mechanical and Machine Drawing, Building Construction, Theoretical and Applied Mechanics.

1. *Practical Geometry, Plane and Solid*.—Classes meet on Wednesdays and Fridays, from 7.30 to 9.30 p.m. Books recommended: 'Tate's Practical Geometry and Binns' Orthographic Projection (Gleig's series); or, for more advanced pupils, Burchett's Practical Geometry and Binns' Geometrical Drawing.

2. *Mechanical and Machine Drawing*.—Classes meet on Mondays and Tuesdays, from 7.30 to 9.30 p.m.

3. *Building Construction*.—Classes meet on Mondays and Tuesdays, from 7.30 to 9.30 p.m.

4. *Theoretical Mechanics*.—Text Book: Buckmaster's Elements of Mechanical Physics. Class meets on Thursdays, from 7.30 to 9.30 p.m.

5. *Applied Mechanics*.—Books recommended: Baker's Elements of Mechanism (Weale's series), and Tate's Elements of Mechanism and Exercises in Mechanics. Class meets on Tuesdays, from 8.30 to 9.30 p.m.

The school is well supplied with models, diagrams, and experimental apparatus, provided in accordance with the recommendation of the Science Department at South Kensington.

Fees for Full Course.

Artizans, 5 s. per session; one half to be paid at the commencement, and the other half at the end of the first three months.

Non-Artizans and those who do not intend to sit at the Government examination, 10 s. 6 d. per session; to be paid in advance.

Day Classes

Day classes are in operation for the study of practical machine and architectural drawing, and meet on Mondays and Fridays, at 3 p.m. Terms: 10 s. 6 d. per quarter of ten weeks.

Students are also trained for the professions of civil, mining, or mechanical engineering draughtsmen and surveyors, or for the competitive examinations of the Indian civil service engineers' department.

For further particulars apply to Mr. Mitchell, Highfield, Greenhill, Oldham.

Classes for the study of the following subjects are conducted by *J. Philip*, M.A., to whom the Science and Art Department at South Kensington has granted an Honorary Diploma without examination.

1. *Geometry*.—Original exercises, based on Euclid's Elements, are proposed one Friday and solved on the following Friday.

2. *Algebra*.—Regular progressive instruction is given, and the shortest method of operation exemplified on the black-board.

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3. *Trigonometry*.

App No. 8.

3. *Trigonometry*.—A course of lessons in this subject will be commenced early in the session.

Students in book-keeping, mensuration, or other mathematical subjects are also admissible to these classes

Books: Euclid, Algebra, and Trigonometry, by Todhunter or Colenso. Classes meet on Mondays and Fridays, at 7 30 p m.

C. P. Bahr, PH D., of the University of Giessen, will give instruction in

1. *Chemistry*.—The course of instruction is calculated to prepare students for the examinations which are held yearly by the Science and Art Department

It comprises—1 the elements of inorganic and organic chemistry; 2. Qualitative analysis

A suitable apparatus has been procured for performing the necessary experiments.

Terms: 5 s. per quarter for non-artizans, and 2s. 6 d per quarter for artizans. Entrance fee 5s per session, for renewing materials Ten lectures constitute one quarter. The class meets every Monday at 7,30, in the laboratory of the Lyceum

Text book. Buckmaster's Elements of Chemistry.

2. *Magnetism, Electricity, and Galvanism*.—Terms: 5s. per quarter for non-artizans, and 2s 6d. per quarter to artizans Entrance fee 2s. 6d., for renewal of materials. Ten lectures constitute one quarter. The class will meet on Thursdays, at 7 30, p m.

Text Book. Electricity, Galvanism, Magnetism, &c. of the Irish National Schoolbook series.

Vegetable Physiology and Economic Botany.

Teacher, Mr. C Walters

Fees for the Session: Artizans, one lesson per week, 2s. 6d., non-artizans, 5s. The class will meet on Saturdays, from 6 30 to 7 30 p.m.

ART.

Teacher, Mr. T. Heywood.

Classes for Drawing

The course of study comprises the following subjects.—Freehand, landscape, perspective, and model drawing—flower painting, shading in chalk from the cast, &c.

Day Classes.

Elementary Tuesdays and Fridays, from 3 to 5 p.m., 10s. 6d per quarter. From 4 to 5 p.m., 5s. per quarter

Advanced Tuesdays and Fridays, from 3 to 5 p.m., 12s. 6d. per quarter. From 4 to 5 p.m., 7s. 6d per quarter

Evening Classes.

Elementary Tuesdays and Fridays, from 7 30 to 9.30, 2s 6d. per quarter

Advanced Tuesdays and Fridays, from 7 30 to 9 30, 4s. per quarter.

Non-artizans or others who wish to join the evening class, and be exempt from the Government examinations, elementary, 6s. per quarter; advanced, 10s 6d. per quarter. All fees payable in advance

The quarters of the public classes commence about January 15th, April 1st, July 25th, and October 1st.

Ten consecutive weeks constitute a quarter of the special classes, commencing at any time.

Appendix, No. 9.

PAPER handed in by Captain *Donnelly*, R.E., 25 June 1868.

Science Form, No. 299
South Kensington, April 1868.

C. U. 114
App. No 9

Science and Art Department of the Committee of Council on Education,
South Kensington

At Whitehall the 24th day of April 1868

By the Right Honourable the Lords of the Committee of Her Majesty's Most Honourable
Privy Council on Education

BUILDING GRANTS FOR SCIENCE SCHOOLS.

My Lords read applications and consider the subject of building grants for Science Schools

My Lords will be prepared to make grants towards the building of Schools of Science at the rate of 2s 6d per square foot of internal area, up to a maximum of 500l for any one school, on condition that the school—

a. Be built under the Public Libraries Acts (13 & 14 Vict. c. 65, 18 & 19 Vict. c. 70, 29 & 30 Vict. c. 114).

Or—

b. Be established in connection with a School of Art aided by a department building grant.

And that the terms of the Minute of the 18th December 1866 (No. 603), relating to building grants for Schools of Art, so far as applicable to Schools of Science, be complied with.

Appendix, No. 10.

PAPER handed in by Mr. Thomas Coomber, F.C.S.

App. No. 10.

BRISTOL MINING SCHOOL.

*THE scheme of practical instruction has been drawn up by Mr. George Greenwell, the eminent mining engineer. The course lasts two years.

The first year's course is—

- 1 The different modes of working coal.
- 2 The different modes of ventilation; viz., natural, furnace, and mechanical ventilation.
- 3 The drainage of mines by pumping engines, and other contrivances.
- 4 Coal-drawing and the engines, and various mechanical expedients employed for that purpose.
- 5 The character of different coals.
- 6 Drawing and planning, with operations.

The books which the students read and are examined in are.—Dunn on the winning and working of collieries. The same author on the prevention of accidents in mines. Fenwick on subterranean surveying, and Ralph Moore on ventilation.

The second-year's course of study is—

- 1 Hedley's ventilation.
- 2 Atkinson's papers on ventilation in the proceedings of the North of England Institute of Mining Engineers
- 3 Atkinson and Goulson's papers on tubing, in the same volumes.
- 4 Nicholas Wood on underground tunnelage.
- 5 Hull's Coal Fields of Great Britain.
- 6 Elementary geology and chemistry, with the examination by analysis of coals, and the assay of the useful metals.
- 7 On boring, with the tools employed in sinking.
- 8 The pupils are each to produce a plan of a colliery establishment, with details; say depth 100 fathoms. Thickness of seam 5 feet. Inclination, 1 in 18. Water 250 gallons per minute. Coal required, 500 tons per day. The seam supposed to be fiery. The royalty a tract of 500 acres. The pit supposed to have been at coal work three years. There must be a surface plan showing the situation of the engines and machinery, and also the railway and branches, narrow gauge, a section of the strata and details of the engines, pumps, cages, tubs, &c. An estimate of cost of establishment, and of working charge of coals; also a plan of the underground workings, shewing the ventilation.

For the best of the above, with a satisfactory examination thereon, a prize of 5*l.* is given.

To those pupils who do themselves credit at the school a certificate is given, a copy of which I enclose. This is highly prized, and has been proved of value to several to whom it has been awarded.

Appendix, No 11.

PAPER handed in by Captain *Donnelly*.

MEMORANDUM of SUGGESTIONS for Enlarging the System of STATE AID to SCIENTIFIC INSTRUCTION, drawn up in accordance with the Instructions of the Lords of the Committee of Council on Education. App. No 11.

THE system and rules of the Science and Art Department for administering the grant for scientific instruction appear fairly to meet the requirements of one large class of persons. Sufficient aid is afforded and encouragement thereby given to the elementary instruction in science of the adult artisan class.*

The development that this system has at present taken has been almost entirely in creating evening classes. Being a pure system of payment on results, however, it is quite possible under it for schools for boys of 10 to 15 years of age to flourish, and to earn large payments, as for instance the Bristol Diocesan Trade School, the Bethnal Green Birkbeck School, and the Glasgow Secular School do, but as yet few such schools have sought this aid. The reason is obvious. Schools cannot combine State aid to elementary and science instruction. It is only in large towns and under peculiar circumstances that day schools wholly devoted to secondary instruction can exist. Their establishment must be a work of time. The action of the department has therefore been principally confined to promoting evening instruction in mechanics' institutions and such places. Though payments are not made for the instruction of middle class students, their instruction has incidentally been aided and encouraged by the establishment and existence of these classes, affording them opportunities of instruction which did not exist before. Between 12 and 13 per cent. of the students in science classes at present are middle class students.

There remain two; as far as the machinery of education is concerned, broad classes but slightly affected by the present system of State aid to instruction in science. These are the younger artisan class; broadly the children of the weekly wage class, before they leave school, say of from

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* The progress of the Science Schools since the passing of the general Science Minute, June 1859, is shown in the following Table —

Year	Number of Schools	Number under Instruction
1860	9	500
1863	70	1,350
1864	91	4,660
1865	153	6,835
1867	313	10,230

The 313 schools had 560 classes in different subjects. Of the 10,230 persons under instruction 4,590 came up for examination, besides 400 persons not taught in classes aided by the department. 8,437 papers were worked, 6,120 were passed.

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10 to 14 years of age, and the younger middle classes, the sons of the employers of labour and so forth, who are eventually to have the management and direction of works, before they leave school.

There can be no doubt that to meet the requirements of the day, it is essential that there should be a more or less general diffusion among all classes engaged in productive industry of scientific, or as it is sometimes loosely called, technical instruction; — scientific instruction that is taken up from the point of view of its future application to industry, and not as a purely educational system.

To meet the wants of the younger artisan class it appears to be only necessary to remove some existing restrictions † which prevent payments being earned for instruction in science given during the three attendances of an elementary school receiving aid. This restriction was imposed when the schools were aided under the whole system, which it was considered justified and required some check of this kind. If teachers of elementary schools were permitted to earn payments for the instruction in science, — as in drawing, of the more advanced students in these schools, the results of the present science system show conclusively that they would very soon form such classes, and would induce a considerable percentage of the parents to allow their children to remain longer at school.

Probably it would be advisable that the payments should be made through the Education Department, who would then have full control of the matter. The Science and Art Department acting according to its present system would simply have to make a return of the results of the examinations to the Education Office.

To meet the requirements of these schools it would be advisable to have a sixth standard of examination below the present fifth class, and make a payment of 10s. on passing it. Whether it would be advisable to make any restriction as to the subjects of instruction or not, is doubtful. It is generally better to leave this to work itself out.

It has not been the policy of the State in this country to aid or interfere with the education of the middle classes except to some slight extent, and that indirectly, by State endowments in colleges. The

† Sections XXIII and XXIV of the Science Directory

‡ Payments to Professors and Examiners, Exhibitions, Scholarships, Medals, and Prizes in the University of London, the Universities of Scotland, and the Queen's University and Colleges in Ireland.

App. No. 11. The general opinion of the country, working through the Schools Inquiry Commission and such agencies, can alone be looked to make any important change in the way of introducing the study of science. Nothing however can have much effect on the grammar schools and middle class schools of the country generally until the universities, which give the key of education in the country, allocate a fair proportion of their endowments to the reward of scientific studies. Till such knowledge pays at the universities the middle class schools, which look more or less to them, cannot be expected to change their courses of instruction.

Should it however be considered good policy for the State to intervene more than it does at present in furthering scientific instruction among the middle classes, it would appear far more judicious to use existing machinery than to establish new. Money granted as endowments among the universities and colleges of the country would be more economically and effectively expended than in the creation of special State institutions.

The instruction in the primary schools can of course only be of an elementary character. That in the adult night classes, though in some cases carried a little further, for want of time, means, and apparatus, cannot go to any depth. Such instruction generally diffused is of the greatest use. But it only goes far enough to warn people of the mistakes they may fall into from sheer ignorance; to teach them not to be satisfied with mere empiricism; to show them how science may be applied to their work, and to induce them to follow it up.

The question then arises of providing instruction of a far more advanced character. The application of science to the arts can only be by those who have a thorough knowledge of special branches. The masters, foremen, and others, who will take it up in this way are necessarily but a small per-centage of those engaged in industry. Any of the poorer classes who show a special ability and aptitude for science can only follow it out if supported while pursuing their study. The richer classes can pay for their instruction. It is only necessary to provide the opportunity. Whatever the universities and higher educational establishments of the country may do to afford instruction in science, the science will only form one portion of a general course of education. It would be foreign to their objects to afford advanced instruction in one special branch of science, and grant diplomas to men who had not time or did not wish to pursue other studies, and possibly were very slightly generally educated.

It is not in the least necessary that the institutions for giving this instruction should be spread about in country towns. The schools and classes attended by artizans at work and boys living at home can only be effective according as they are widely spread. But when it comes to the student devoting his whole time and being supported, it may as well be done in London as in Manchester or Birmingham, and besides the advantages of accessibility, etc., the best instruction can only be obtained in the capitals.

A college of science has lately been created in Ireland. The course of instruction, which lasts three years, is general during the first two years for all the students. During the third year it is specialised under the heads of agriculture, mining, engineering, and manufactures. In England the only public institution besides the Royal School

of Naval Architecture for advanced scientific instruction is the Royal School of Mines, Jermyn-street. It has not quite as large a staff of professors as the college of Science in Dublin.

There are now 17 royal exhibitions to the institutions competed for at the May examinations of the department. They are of the value of 50*l.* per annum, and are tenable for three years. Six, therefore, become vacant every year except every third year, when five only become vacant. The fees are remitted, and the 50 goes to support the student. They are more eagerly competed for. The number might with advantage be increased, at all events in a few years.

A very simple and probably effective extension of this action would be to allow that, wherever a locality raised funds to establish exhibitions to support deserving students in London or Dublin, the fees for instruction should be remitted for those students, and perhaps the local funds supplemented. Any place, Leeds for instance, organising its system of elementary science classes in any way that suited its requirements, could then for a few hundreds a year support several of the most promising students here in London, where they would receive the best scientific instruction to be had anywhere.

The present constitution* and the name "School of Mines" prevents that institution filling the position of an advanced school of general science effectually. At the same time, far the larger portion of the scientific instruction given in it is general, and would form a course applicable to any industry. This is not known and a proposition to send students there would unless they were intended for mining, not be understood. The Royal School of Naval Architecture and Marine Engineering has as yet not got any staff for instruction in experimental science. This instruction is given by lecturers appointed from year to year, and in a small temporary chemical laboratory. It is therefore most advisable that a college of general science should be organised or constituted in London on the plan of the Irish College of Science to meet the requirements here indicated.

A change is most desirable in every way. It is greatly to be regretted that the admirable courses of lectures of the professors at the Royal School of Mines are attended by so few students. Though the separate courses are in some cases fairly attended, there are only some five or six students entered, besides the Royal exhibitioners, for the full course of the school, that is for the Associateship. This must always be so. The field that a school of mines applies to is but limited. It does not get known in the country, and even the separate courses are not taken that advantage of which one would suppose.

In time it may be found desirable to establish a third college of science in Edinburgh, and perhaps a fourth in the north of England. There is no call for these however at present.

Much is said about the necessity for technical instruction, and efforts will no doubt be made to induce the State to supply it. It becomes therefore necessary to consider how far, if at all, the

* A Commission consisting of Lord Granville, Sir C. E. Trevelyan, and Mr. Lowe, decided in 1862 that the instruction in the Royal School of Mines should embrace only those branches of general science which are applicable to mining, and that it should be a special mining school similar to those on the Continent.

the State can take thus up advantageously as distinct from the general scientific instruction previously considered.

This action is proposed from two rather different points of view. The one proposal is to have a technical school adapted to the staple industry of a place, the other apparently to teach trades which do not exist there, with the idea of their introduction.

Real technical education—the teaching of a trade or art itself on scientific principles—necessarily entails workshops for practice. It would be scarcely possible to devise a more effectual blow to the manufacturers of a place than for the State to establish a real technical school for their trade, with its workshop, under no constraint to pay its expenses, underselling them and interfering with their market. A State pottery school and Messrs Minton could not exist side by side. On the other hand, for the State to teach trades, where they don't exist, with the view of introducing them, and thereby most probably tempting them away from where they have established themselves, could at the most only be innocuous so long as it was ineffectual.

If then it were possible to keep pace with trade, the more efficient the schools were, the more injuriously would they affect private enterprise. It is, therefore, not necessary to dwell on the constant shiftings of trade according to the labour market, the difficulty of determining what was, and what should be, the staple industry of a place, and many other such points, which would render the administration of a system of technical schools an impossibility in this country.

The only technical schools which the State advantageously deal with are such as the military schools, the school of naval architecture and marine engineering, etc.—that is, where it is said to be instructing apprentices for the purpose of itself employing them partially or wholly.

With regard to general industry, it may be taken that the action of the State cannot safely go further than by aiding and encouraging instruction in general science, or such applied science as mining and metallurgy. The Commission for the College of Science for Ireland laid down that its aim should be to impart a sound and thorough knowledge of those branches

of science which may be applied to industry, leaving it to the student subsequently to specialise his knowledge and turn his attention in the direction he may find most suitable.

The system of payment on results is so well established, permits of such complete freedom of action, is applicable to such a variety of circumstances of schools, and has borne such good fruit that I take for granted it will not be proposed to alter it.

As much pressure may, however, be brought to bear on the Government, it is perhaps right to point out, that the experience of this department has proved nothing more decisively than that, in the conduct of science or art schools, any general joint action between the State and the locality is sure to lead to difficulties. Whatever system of guarantees for salary, etc., may be invented, the fact that the liability is really limited to one of the partners is sure to have its effect. It is impossible for the State to withhold the whole grant and close up the establishment after it has been in operation a few years because the locality does not comply with every tittle of its contract; and so matters go on getting worse from year to year. If pure payment on results cannot be wholly adhered to, care should be taken that the department is only committed to some definite piece of work when the locality has fulfilled its portion, and that no continuous partnership is entered into.

In conclusion, it is only necessary to point out that aiding instruction in science on the plan now being followed with the proposed extension, can and will aid pure technical instruction in the very best way. That is to say, if the masters of works will either separately or in combination establish schools for the instruction of their *employés*, the State, by paying on the results of elementary and scientific instruction, would assist in the instruction of the students just up to the point of their learning the absolute trade. There is nothing to prevent manufacturers with energy and public spirit establishing as good schools as those of M. Schneider, at Creuzot, and obtaining as much Government aid towards them.

(signed) *J. F. D. Donnelly,*
Captain, R. N.

12 November 1867.

App. No. 12.

(See Evidence 888)*

VALUE OF SCIENCE PRIZES.

	£.	s.	d.
Issued in 1860 - - - - -	46	18	4
" 1861 - - - - -	168	1	-
" 1862 - - - - -	319	-	5
" 1863 - - - - -	228	10	1
" 1864 - - - - -	841	14	-
" 1865 - - - - -	829	11	11
" 1866 - - - - -	540	9	10
" 1867 - - - - -	739	1	2

(signed) W. G. Groser, Storekeeper.

(See Evidence 988)

IMPORTS from France into England.—Extracted from the Statistical Returns published by the Board of Trade.

The IMPORTS of the following Articles, the manufacture of which is influenced by Scientific or Artistic Knowledge, have increased since the French Treaty of 1860

	In 1859, the Year before the Treaty	In 1861, the Year after the Treaty	In 1866	
	£	£	£	
Books - - - - -	83,443	86,537	88,615	
China, porcelain, and earthenware - -	40,091	79,088	101,784	
Clocks - - - - -	90,226	161,466	190,821	
Cotton manufactures - - - - -	371,774	399,210	589,216	
Flowers (artificial) - - - - -	97,273	275,092	291,269	Falling off since 1862.
Furniture (wood) - - - - -	not stated	14,310	47,386	Falling off since 1865
Glass (flint, cut and uncut) - - - - -	9,126	41,141	31,478	
" (plate) - - - - -	19,101	16,174	105,449	
Hats, &c. (straw) - - - - -	69,664	31,184	1,182,700	
" (felt) - - - - -	not stated	not stated	66,967	
Hides, dressed, &c. - - - - -	122,178	89,439	320,512	
Iron and steel manufactures - - - - -	6,916	24,489	91,738	
Lace - - - - -	22,364	37,847	78,012	
Leather manufactures (gloves and boots) -	698,777	785,113	1,182,766	Increase in gloves only, falling off in boots
Linen manufactures - - - - -	22,689	12,121	62,143	
Musical instruments - - - - -	86,869	105,376	164,743	
Opera glasses - - - - -	-	-	77,822	
Paper hangings - - - - -	10,107	14,750	22,864	
" of other sorts, including pasteboard	16,082	19,152	71,784	
Plating of straw, &c - - - - -	125,192	90,178	146,063	
Silk manufactures - - - - -	1,372,065	4,471,169	6,787,629	Decrease in plush.
Skins - - - - -	68,997	18,667	22,491	
Watches - - - - -	210,733	321,400	241,341	Falling off since 1861
Woolen manufactures - - - - -	607,609	1,057,837	1,151,092	Considerable fall- ing off since 1862.

The IMPORTS of the following Articles have Diminished since the French Treaty of 1860.

	In 1859, the Year before the Treaty	In 1861, the Year after the Treaty.	In 1866.	
	£	£	£	
Bronzes - - - - -	28,008	81,508	46,235	
Buttons, &c - - - - -	56,041	42,094	33,996	
Embroidery, &c - - - - -	67,761	46,550	36,018	
Prints and drawings - - - - -	22,973	12,268	12,482	
Silk (thrown) - - - - -	298,427	152,133	100,896	

27 May 1868.

G. F. Duncombe.

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A List of Persons Certificated as Competent to act as TEACHERS of ART SCHOOLS, with their present Occupations, so far as known

Group 1 Elementary Drawing and Colouring. Group 5 Modelling the Figure.
 Group 2. Painting Group 6a. Mechanical Drawing.
 Group 3 The Figure drawn and painted Group 6b Architectural Drawing.
 Group 4 Modelling Ornament

Present Occupation	Names of Masters and Students in Training	School where previously Taught.	Certificates obtained.
School of Art, Coventry - - -	Anderson, John -	Stoke - - -	1, 2, 3, 6a.
Private Teacher - - -	Anderson, H. T. -	Metropolitan Dis- trict.	1.
Private Teacher - - -	Andrew, F. W. -	Metropolitan Dis- trict	1.
Occupation not known - - -	Arthur, T. -	Metropolitan Dis- trict	1.
School of Art, Edinburgh - - -	Ashworth, Susan -	Metropolitan Dis- trict.	1, 2
Occupation not known - - -	Atkins, Catherine -	Training Class -	1.
Private Teacher - - -	Atkinson, G. M. -	Cork - - -	1, 6a.
Occupation not known - - -	Atkinson, Mary -	Training Class -	1
Schools of Art, Newcastle-under Lyme, and Stoke-on-Trent.	Bacon, J. P. - -	Manchester - -	1, 6a.
School of Art, Inverness - - -	Bain, R. L. - -	Dundee - - -	1.
Private Teacher - - -	Baines, Catherine -	Metropolitan Dis- trict.	1, 2.
School of Art, Stirling - - -	Baker, L. - -	Metropolitan Dis- trict	1
School of Art, Southampton - - -	Baker, W. J. - -	Unconnected with the Department	1.
School of Art, Lambeth - - -	Bale, Edwin - -	Metropolitan Dis- trict	1, 4, 5, 6a.
School of Art, Glasgow - - -	Banner, A. - -	Dundee - - -	1, 6a, 6b
Occupation not known - - -	Barrett, Mary - -	Metropolitan Dis- trict	1.
Occupation not known - - -	Beal, Emma - -	Training Class -	1.
School of Art, Bloomsbury - - -	Bélinsaye, Laura de la	Metropolitan Dis- trict.	1
Occupation not known - - -	Benny, James - -	- - -	1.
School of Art, Birkenhead - - -	Bentley, John - -	Macclesfield - -	1, 4, 6a, 6b.
School of Art, Exeter - - -	Birkmyer, James -	Liverpool - - -	1, 2, 6a, 6b
Training Class Student - - -	Black, Amy E. - -	Metropolitan Dis- trict	1, 2.
School of Art, Kilmarnock - - -	Black, Francis M. -	Dundee - - -	1.
School of Art, Birmingham - - -	Blizard, Edward -	Spitalfields - -	1, 6a, 6b.
Private Teacher - - -	Boon, William - -	Hanley - - -	1, 2, 4, 6a.
School of Art, Bromsgrove - - -	Bowen, W. P. - -	Worcester - - -	1, 2.
School of Art, Stourbridge - - -	Bradley, Eleanor -	Metropolitan Dis- trict.	1.
Training Class Student - - -	Bradbury, Alfred A.	Leeds - - -	1, 6b
School of Art, Cork - - -	Brenan, James - -	Dublin - - -	1, 2, 3, 4a.
Private Teacher - - -	Brown, John - -	Metropolitan Dis- trict.	1, 4, 6a.

App. No. 12.

Present Occupation	Names of Masters and Students in Training	School where previously Taught.	Certificates obtained.
School of Art, Limerick - - -	Brophy, N. A. - - -	Limerick - - -	1, 6a, 6b
School of Art, Cheltenham College -	Brooke, Alfred N. - -	Manchester - - -	1, 6a.
School of Art, Liverpool, North District.	Burkinshaw, S. - - -	Birmingham - -	1, 2, 6a.
School of Art, Cardiff - - -	Bush, James - - -	Cermerthen - - -	1.
Private Teacher - - -	Bustin, R. B. - - -	Metropolitan District.	1.
School of Art, Westminster - - -	Burchett, E. S. - - -	Metropolitan District.	1, 6a, 6b.
Occupation not known - - -	Butler, Mary E. - - -	Training Class - -	1.
Occupation not known - - -	Cahill, R. S. - - -	Unconnected with the Department	1.
School of Art, Bridport - - -	Campbell, J. A. D. - -	Metropolitan District	1, 2, 6a, 6b.
School of Art, Dorchester - - -	Carter, David - - -	Coventry - - -	2.
School of Art, Hanley - - -	Carter, James - - -	Unconnected with the Department.	1, 2, 3, 6a.
Training School, South Kensington -	Casabianca, Florence -	Metropolitan District.	1, 2.
School of Art, St. Martin's, London -	Casey, W. L. - - -	Cork - - -	1, 2, 3.
Training Class Student - - -	Cutley, William - - -	Boston - - -	1.
School of Art, South Kensington -	Channon, Mary E. - - -	Metropolitan District.	1, 2.
School of Art, Hull - - -	Chandler, Edwin - - -	Plymouth - - -	1, 2, 3, 6b.
Private Teacher - - -	Charles, Rebekah C. -	Training Class - -	1.
Training Class Student - - -	Childe, Eilen E. - - -	Bloomsbury - - -	1.
Private Teacher - - -	Chittenden, Thos. - -	Training Class - -	1.
South Kensington - - -	Clack, Thos. - - -	Coventry - - -	1, 2, 3, 4, 6a.
School of Art, West London - - -	Clarke, C. M. - - -	Manchester - - -	1, 2.
Retired - - -	Cleland, P. - - -	Aberdeen - - -	1.
Private Teacher - - -	Clifton, J. S. - - -	Unconnected with the Department.	1.
Occupation unknown - - -	Cole, Lætitia M. - - -	Metropolitan District.	1.
Occupation not known - - -	Collier, Thomas F. - -	Training Class - -	1.
Private Teacher - - -	Collins, Emma - - -	Liverpool - - -	1.
Occupation not known - - -	Colson, John - - -	Unconnected with the Department.	1.
School of Art, Norwich - - -	Cochrane, Robert - - -	Unconnected with the Department.	1, 2, 6a.
School of Art, Weston-super-Mare -	Cosbie, W. S. - - -	Liverpool - - -	1, 2, 3, 6a, 6b.
Training Class Student - - -	Cox, William - - -	Training Class - -	1.
School of Art, Chester - - -	Cranster, Walter - - -	Training Class - -	1, 6b.
Training Class Student - - -	Croasdale, Elizabeth -	Training Class - -	1.
Private Teacher - - -	Croome, John D. - - -	Unconnected with the Department.	1, 2.
Training Class Student - - -	David, Mary R. - - -	Metropolitan District.	1.
City Middle Class Schools - - -	Davidson, E. A. - - -	Metropolitan District	1, 6a, 6b.
Training Class Student - - -	Davis, Flora - - -	Metropolitan District.	1.
School of Art, Bridgewater - - -	Davis, James - - -	Metropolitan District.	1, 6a.
School of Art, Lambeth - - -	Dennis, Henry J. - - -	Metropolitan District	1, 6a.
Training Class Student - - -	Dickinson, Henry D. -	Training Class - -	1.
Training Class Student - - -	Dixon, Laurina - - -	Metropolitan District	1.
Private Teacher - - -	Dodge, Sarah A. - - -	Metropolitan District.	1, 2.
School of Art, Great Yarmouth - - -	Dominy, I. S. - - -	Devonport - - -	1, 2, 6a, 6b.
Private Teacher - - -	Drummond, J. G. - - -	Cork - - -	1, 2, 6b.
Training Class Student - - -	Duckett, William - - -	Lancaster - - -	1, 6b.

Present Occupation.	Names of Masters and Students in Training.	School where previously Taught.	Certificates obtained.
Private Teacher - - - -	Duncan, W. S. -	Dundee - - - -	1, 6a, 6b.
Greenwich Hospital School - - - -	Dundas, James -	Dundee - - - -	1, 2, 6a, 6b.
Private Teacher - - - -	Earle, Emily -	Training Class -	1
Occupation not known - - - -	Eavestaff, Anna -	Training Class -	1.
Private Teacher - - - -	Edgley, Sarah J. -	Metropolitan District -	1.
Occupation not known - - - -	Edwards, Catherine -	- - - -	1.
Occupation not known - - - -	Edwards, John -	Dunfermline -	1, 6a.
Private Teacher - - - -	Edwards, Maria -	Metropolitan District -	1.
School of Art, Darlington - - - -	Elton, Samuel -	Metropolitan District -	1, 6a.
Private teacher - - - -	Elliott, Rebecca -	Metropolitan District -	1.
Private Teacher - - - -	Ferrier, R. E. -	Metropolitan District -	1.
School of Art, Liverpool (South District) - - - -	Finnie, John -	Newcastle - - -	1, 2, 6a.
School of Art, Lewes - - - -	Fisher, Alexander -	Dudley - - - -	1, 2, 4, 6a, 6b.
Private Teacher - - - -	Fisher, Ellen -	Training Class -	1
Occupation not known - - - -	Foster, William -	Manchester - - -	1, 6a.
School of Art, Macclesfield - - - -	Ford, James -	Penzance - - -	1, 2, 4, 6a, 6b.
School of Art, Clonmel - - - -	Fraser, Edw. A. -	Dublin - - - -	1, 6b.
Schools of Art, Andover and Salisbury - - - -	Frazer, John P. -	Aberdeen - - -	1, 2, 3, 6a, 6b.
Private Teacher - - - -	Freed, Mary Ann -	Metropolitan District -	1.
Private Teacher - - - -	Fussell, Fred R. -	Nottingham - - -	1.
Private teacher - - - -	Grammage, Emma -	Liverpool - - -	1
School of Art, Bloomsbury - - - -	Gann, Louise -	Metropolitan District -	1
Occupation not known - - - -	Gallimore, S. -	Stoke - - - -	1, 6b.
School of Art, Penzance - - - -	Geoffroy, Henry -	Unconnected with the Department -	1.
Training Class Student - - - -	Gibbons, Albert -	Crencester - - -	1.
Training Class Student - - - -	Gibbons, Owen -	Crencester - - -	1.
Designer - - - -	Gibbs, Charlotte -	Metropolitan District -	1.
Schools of Art, Preston and Lancaster - - - -	Gilbert, H. -	Metropolitan District -	1, 6a.
Occupation not known - - - -	Gill, George R. -	Metropolitan District -	1, 6a, 6b.
Occupation not known - - - -	Gillo, Robert -	Bath - - - -	1
King's College, London - - - -	Glenny, W. J. -	Metropolitan District -	1, 2, 6a, 6b.
Occupation not known - - - -	Godwin, Mary -	Metropolitan District -	1
School of Art, Frome - - - -	Goepel, James S. -	Training Class -	1, 6b.
Enamel Painter - - - -	Gray, George -	Potteries - - -	1.
Occupation not known - - - -	Gray, Thomas -	Aberdeen - - -	1, 6a.
Occupation not known - - - -	Green, Charlotte -	- - - -	1.
Occupation not known - - - -	Greenhill, Mary E. -	Training Class -	1.
School of Art, Ipswich - - - -	Griffiths, W. T. -	Unconnected with the Department -	1, 6a, 6b.
In India - - - -	Griffiths, John -	Metropolitan District -	1, 2, 4, 5, 6b.
School of Art, Truro - - - -	Griffiths, Richard -	Carnarvon - - -	1, 6a.
Training Class Student - - - -	Grubb, Wm. M. -	Dundee - - - -	1.
Schools of Art, Dudley and Wolverhampton - - - -	Gunn, Archibald -	Unconnected with the Department -	1, 6a, 6b.
Training School, South Kensington - - - -	Hagreen, H. B. -	Unconnected with the Department -	1, 6a.
Hampstead Night Class - - - -	Hale, Robert -	Manchester - - -	1, 6a.
Training Class Student - - - -	Hall, Fanny -	Training Class -	1.

App. No. 12, 1

Present Occupation.	Names of Masters and Students in Training.	School where previously Taught.	Certificates obtained.
Sandhurst College - - - -	Harley, R. - - -	Unconnected with the Department.	1, 2, 3.
Private teacher - - - -	Hardess, Maria -	Metropolitan District.	1, 2.
Occupation not known - - -	Harrison, J. C. -	Leeds - - -	1.
Schools of Art, Henley-on-Thames and Reading	Havell, C R - - -	Unconnected with the Department.	1.
Occupation not known - - -	Hayden, E - - -	Warrington - - -	6a.
Occupation not known - - -	Healy, James - - -	Dublin - - -	1.
Occupation not known - - -	Heazle, William -	Cork - - -	1.
Private Teacher - - - -	Hill, John - - -	Warrington - - -	1, 6a, 6b.
Smethwick Night Class - - -	Hill, Henry - - -	Birmingham - -	1
Private Teacher - - - -	Hipwood, Sarah -	Metropolitan District	1, 2.
School of Art, Edinburgh - - -	Hodder, Charles D. -	Metropolitan District.	1, 2.
School of Art, Torquay - - -	Holmes, Thomas -	Dublin - - -	1, 2, 6a.
Occupation not known - - -	Holt, Mary Ann - -	Metropolitan District.	1.
Occupation not known - - -	Home, Emily G. - -	Training Class - -	1.
Occupation not known - - -	Hone, Alfred - - -	Unconnected with the Department.	1, 4.
Training Class Student - - -	Horneastle, Jane -	Training Class - -	1, 2.
Schools of Art, Carmarthen and Llanelly.	Hosford, F F - - -	Cork - - -	1, 2.
School of Art, Boston - - - -	Howard, Vernon - -	Metropolitan District.	1, 2, 6a.
Occupation not known - - -	Huckvale, Elizabeth	Leeds - - -	1.
Private Teacher - - - -	Hull, Clementina -	Training Class - -	1.
Private Teacher - - - -	Hull, Susanna, E. -	Metropolitan District.	1.
Private Teacher - - - -	Hulme, Fred E. - -	Metropolitan District.	1, 6a, 6b.
Occupation not known - - -	Hulme, Robert C. -	Metropolitan District.	1, 6a.
Occupation not known - - -	Humphreys, Jane - -	Metropolitan District	1.
Occupation not known - - -	Hunter, Jessy - - -	Carmarthen - - -	1.
School of Art, Perth - - - -	Hutton, David C. -	Dundee - - -	1.
Occupation not known - - -	Inskipp, Janet - - -	Unconnected with the Department	1.
Occupation not known - - -	Johnson, Annie - -	Metropolitan District.	1.
Training Class Student - - -	Jones, David - - -	Carmarthen - - -	1, 2, 6a, 6b.
Occupation not known - - -	Judd, Florence - - -	Training Class - -	1.
School of Art, Dublin - - - -	Julyan, Mary - - -	Metropolitan District.	1, 2, 3.
Occupation not known - - -	Kelly, Edwin J. - -	Macclesfield - - -	1, 6a, 6b.
Schools of Art, Gloucester and Stroud	Kemp, John - - -	Cork - - -	1, 2, 6a.
Training Class Student - - -	Kemp, Minna - - -	- - -	1.
Training Class Student - - -	Kemp, Mrs. A. - - -	Training Class - -	1.
Private teaching - - - -	Kennedy, James - -	Dublin - - -	1, 4, 6a, 6b.
School of Art, Dundee - - - -	Kennedy, John - - -	Dublin - - -	1, 2, 6a.
School of Art, Kidderminster	Kennedy, Joseph - -	Dublin - - -	1, 6a, 6b.
Occupation not known - - -	Keyworth, Annie R -	Reading - - -	1.
School of Art, Cheltenham	Knight, J. F. - - -	Metropolitan District.	1.
Training Class Student - - -	Lang, Isabella - - -	Training Class - -	1.
Private Teacher - - - -	Lanckenick, J. C. -	Metropolitan District.	1.
Training Class Student - - -	Larking, Mary - - -	Metropolitan District.	1.
School of Art, Carlisle - - -	Lees, Herbert - - -	Metropolitan District.	1, 2, 6a.
Occupation unknown - - - -	Legge, Lionel - - -	Metropolitan District	1, 4.
Training Class Student - - -	Lindsay, Thomas M. -	Training Class - -	1.
School of Art, Calcutta - - -	Lock, Henry H. - - -	Metropolitan District.	1, 4, 6b.

Present Occupation	Names of Masters and Students in Training	School where previously Taught	Certificates obtained.
Private Teacher	Lord, John	Dublin	1, 6a.
	Lushington, Alice	Training Class	1
School of Art, Dublin	Lyne, Robert E.	Unconnected with the Department	1, 2, 3, 6a.
Flower Painting	Manly, Alice E.	Bloomsbury	1.
School of Art, Queen-square	Mateaux, Clara	Metropolitan District.	1.
School of Art, Oxford	Macdonald, Alex	Dundee	1, 2, 3, 6a, 6b.
Training Class Student	M'Carty, Wm M.	Training Class	1.
School of Art, Waterford	M'Cloy, Samuel	Belfast	1
School of Art, Cape of Good Hope	M'Gill, W M	Dudley	1, 2, 6a, 6b.
Training Class Student	M'Minn, Jane K	Training Class	1
School of Art, Dublin	Mayne, Arthur J.	Dublin	1.
School of Art, Aberdeen	Menzies, John	Aberdeen	1, 2, 6a, 6b.
Private Teaching	Mills, Eliza	Metropolitan District.	1, 2.
School of Art, Spitalfields	Mills, Samuel F	Metropolitan District	1, 2, 6a, 6b.
School of Art, Cirencester	Miller, James	Aberdeen	1, 6a, 6b.
Works, South Kensington	Moody, Francis W		1, 4, 6b
School of Art, Edinburgh	Morley, William A.	Metropolitan District.	1, 4, 5, 6a.
School of Art, Manchester	Muckley, William J	Birmingham	1, 2, 3, 6a.
Private Teacher	Mulligan, James A	Unconnected with the Department	1, 6a
Training Class Student	Nesbitt, Sidney	Boston	1
School of Art, Exeter, Student	Nevett, John C.	Exeter	1.
School of Art, Durham	Newton, George	Unconnected with the Department.	1, 2, 3.
School of Art, Bristol	Nichols, Alfred	Metropolitan District.	1, 2, 4, 5, 6a
Architectural Draughtsman	Notley, Robert		1.
School of Art, Shrewsbury	Noyes, H J.	Unconnected with the Department	1.
Private Teacher	Offord, John	Unconnected with the Department.	1.
School of Art, St. Thomas, Charter house, London	Parker, John	Birmingham	1, 2, 3, 6a.
Occupation unknown	Peal, Samuel E	Metropolitan District	1, 4, 5, 6a.
School of Art, West London	Pilsbury, Wilmot	Birmingham	1, 2, 3, 6a, 6b.
Occupation unknown	Pozzi, William E.	Metropolitan District.	1, 2, 4, 6a.
Training Class Student	Priest, Mary A.	Training Class	1.
Training Class Student	Pritchard, Zachariah	Macclesfield	1, 2, 6a, 6b.
Designer	Protat, Mons. H.	Unconnected with the Department.	6a
Schools of Art, Bath and Chippenham	Puckett, Robert C.	Metropolitan District	1, 2, 3, 4, 5, 6a.
Training Class Student	Pullin, Elizabeth	Training Class	1
Private Teacher	Pyne, C. C.	Unconnected with the Department.	1
Occupation unknown	Rafter, Henry	Unconnected with the Department	1.
School of Art, Birmingham	Rambach, D. W.	Unconnected with the Department	1
Ornamental Draughtsman	Randall, John	Metropolitan District	1, 2, 3, 6a.
School of Art, Nottingham	Rawle, John S.	Unconnected with the Department.	1, 2, 3, 6a, 6b.
Training Class Student	Rawson, William	Leeds	1.
Private Teacher	Rees, Mary	Metropolitan District.	1, 2.
Private Teacher	Richardson, J. V.	Unconnected with the Department.	1.

App. No. 22.

Present Occupation	Names of Masters and Students in Training	School where previously Taught.	Certificates obtained.
Occupation unknown - - -	Ridley, Charlotte - - -	- - - - -	1.
Occupation unknown - - -	Riley, Benjamin - - -	Manchester - - -	1.
Training Class Student - - -	Roberts, William - - -	Southampton - - -	1.
Training Class Student - - -	Robinson, Thos W H - - -	Leeds - - -	1.
Schools of Art, Devonport and Tavistock.	Robyjohns, F R. - - -	Tavistock - - -	1, 2, 6a.
Occupation unknown - - -	Robson, George - - -	- - - - -	1.
Private Teacher - - -	Routledge, Robert - - -	Manchester - - -	1, 6a.
School of Art, Carnarvon - - -	Rowland, J. C. - - -	Unconnected with the Department.	1.
School of Art, Taunton - - -	Rowe, John - - -	Penzance - - -	1, 6a.
Leamington Night Class - - -	Ryan, Charles - - -	Dublin - - -	2, 2.
Architectural Draughtsman - - -	Ryan, James - - -	Dublin - - -	1, 6a.
Training Class Student - - -	Ryder, Emily S. - - -	Training Class - - -	1.
Schools of Art, Devizes, Trowbridge, and Warminster	Ryles, George - - -	Poteries - - -	1, 6a.
Works, South Kensington - - -	Sadler, Alfred - - -	Metropolitan District	1.
Training Class Student - - -	Sawkins, Isabella - - -	Metropolitan District	1, 2.
Training Class Student - - -	Schutze, E. Eliz. - - -	Training Class - - -	1.
Lambeth School of Art Student	Shepherd, Emily J. - - -	Lambeth - - -	1.
Occupation unknown - - -	Shiel, Edward - - -	Unconnected with the Department	1, 6a.
Training Class Student - - -	Slack, Mary E. - - -	- - - - -	1.
Training Class Student - - -	Slocombe, Fred. - - -	Training Class - - -	1, 6a.
Dublin Night Class - - -	Smeeth, Joseph F. - - -	Dublin - - -	1.
Belfast Night Class - - -	Smeeth, Rowland - - -	Belfast - - -	1.
School of Art, Leeds - - -	Smith, Daniel - - -	Leeds - - -	2.
Training Class Student - - -	Smith, Isabella F. - - -	Bloomsbury - - -	1.
School of Art, Bristol - - -	Smith, John N. - - -	Dundee - - -	1, 2, 6a, 6b.
Schools of Art, Leeds and Bradford - - -	Smith, Walter - - -	Metropolitan District	1, 2, 4, 5, 6a.
Training Class Student - - -	Soden, Susannah - - -	Metropolitan District	1.
School of Art, Sheffield - - -	Sounes, W. H. - - -	Metropolitan District	1, 4, 5, 6a.
School of Art, Lambeth - - -	Sparkes, John - - -	Unconnected with the Department.	1, 2, 6a, 6b.
Training Class Student - - -	Spragge, Catherine - - -	Training Class - - -	1.
Artist - - -	Stannus, Anthony - - -	Belfast - - -	1, 2.
School of Art, Leeds - - -	Stevenson, A. - - -	Dundee - - -	1, 6a.
School of Art, Ipswich - - -	Stevenson, Rea L. - - -	Halifax - - -	1, 2, 6a, 6b.
School of Art, Halifax - - -	Stopford, Wm - - -	Cork - - -	1, 6a, 6b.
School of Art, Leeds - - -	Sturgeon, W. - - -	Leeds - - -	1, 2, 6a, 6b.
Training Class Student - - -	Sullivan, Michael - - -	Training Class - - -	1, 6b.
School of Art, York - - -	Swallow, John Charles - - -	Metropolitan District	1, 2, 4, 6a.
Private Teacher - - -	Swallow, J. Florence - - -	Metropolitan District	1, 2.
North London School of Art, Kingsland	Swinstead, C. - - -	Metropolitan District	1, 6a.
Occupation unknown - - -	Sylvester, H. - - -	Metropolitan District	1, 6a.
School of Art, Lincoln - - -	Taylor, Edward R. - - -	Burslem - - -	1, 2, 3, 6a.
Training Class Student - - -	Theaker, George - - -	Sheffield - - -	1.
Training Class Student - - -	Thomas, Stephen - - -	Penzance - - -	1, 2, 6a, 6b.
School of Art, Warrington - - -	Thompson, J. C. - - -	Unconnected with the Department.	1, 2.
Wellington College - - -	Tucker, Raymond - - -	Unconnected with the Department.	1, 6a.

Present Occupation.	Names of Masters and Students in Training.	School where previously Taught.	Certificates obtained.	App No. 12.
Training Class Student - - -	Tucker, Wilham -	Worcester -	1.	
Training Class Student - - -	Wade, George A -	Preston -	1.	
Occupation unknown - - -	Waite, James -	Newcastle -	1	
Occupation unknown - - -	Waite, Robert -	Cheltenham -	1, 6a.	
Private Teacher - - -	Walker, J. W. -	Norwich -	1, 2, 6a.	
Training Class - - -	Walker, Susie -	Training Class -	1.	
Private Teacher - - -	Wardle, George -	Macclesfield -	1, 6a, 6b.	
	Warry, Jessie -	Training Class -	1.	
Teacher in Canada - - -	Way, Charles J. -	Metropolitan District.	1, 6a.	
School of Art, Newcastle-on-Tyne -	Way, W C. -	Metropolitan District.	1, 2, 6a, 6b.	
Occupation unknown - - -	Weale, Frances -	- - -	1	
Training Class Student - - -	Webb, Anna Day -	Metropolitan District	1.	
School of Art, Bloomsbury, Student -	Webb, Mary Whitman	Metropolitan District	1	
Occupation unknown - - -	Weston, Sophia -	Training Class -	1	
Private Teacher - - -	Wheeler, Sarah A. -	Metropolitan District	1, 2.	
Modeller, in America - - -	Whitaker, C. H. -	Training Class -	1, 4, 5.	
School of Art, Brighton - - -	White, J. -	Unconnected with the Department.	1, 6a.	
School of Art, Croydon - - -	Wigzell, M. -	Metropolitan District	1.	
Private Teacher - - -	Wilkinson, Ellen -	Training Class -	1.	
Maidstone Night Class - - -	Williamson, J. B -	Belfast -	1, 2.	
Occupation unknown - - -	Wilson, Catherine -	Metropolitan District.	1.	
Occupation unknown - - -	Williams, W. O -	Unconnected with the Department	1.	
School of Art, Bloomsbury - - -	Wilson, Helena -	Metropolitan District.	1, 2, 3	
School of Art, Cambridge - - -	Wood, Daniel -	Metropolitan District	1, 2, 4, 6a.	
School of Art, Coalbrookdale - - -	Woolner, Henry -	Unconnected with the Department.	1, 2, 5, 6a.	
Occupation unknown - - -	Wrigley, Wilham -	Aberdeen -	1, 6a.	
Private Teacher - - -	Wright, Henry W. -	Unconnected with the Department	1	
South Kensington - - -	Wylde, Robert G -	Metropolitan District	1.	
School of Art, Worcester - - -	Yeates, George P. -	Unconnected with the Department	1, 2, 3	

(Confidential)

NOTES ON PUBLIC EDUCATION,

Prepared at the desire of the Right Hon. Lord Robert Montagu, M.P., Vice President of the Committee of Council on Education.

South Kensington Museum,
28 November 1867

My Lord,

In obedience to your Lordship's desire I have prepared a few notes on public education, which I hope you will regard only as brief suggestions for maintaining and improving the existing arrangements rather than as proposing any new or comprehensive plan.

PRIMARY OR ELEMENTARY EDUCATION

1. Since the system of payments on results, which in the first instance had been tried successfully in schools of science and art, was introduced into primary schools, I have always considered that State aid to elementary education should be so afforded as to encourage in every kind of school, and without conditions, the teaching of reading, writing, and cyphering, and to pay for those subjects by results. The condition of limiting the aid to schools employing a certificated teacher always seemed to me illogical, impolitic, and indefensible. Payments on results for reading, writing, and cyphering.

2. If this condition were removed, State aid could be easily extended to all schools throughout the country, and a partial, if not perfect, system of national education, so far, 072.

- App. No. 12. would be possible, without disturbance to the existing voluntary system. I have never believed in the prophetic fears, that the quality of general education would be lowered by encouraging the universal teaching of reading, writing, and cyphering alone; but granting that such an apprehension has some force in respect of the supply of teachers, it appears to me that it might be met by simply putting a sufficient premium on the employment of certificated teachers.
- Status of the certificated teachers. 3. I think the principle of an augmentation grant to a school employing a certificated teacher should be revived; and just as the State keeps soldiers and sailors on half-pay, and has a militia and a naval reserve, it might be good public policy to maintain a force of certificated teachers who might always be in the market to be engaged. I would pay annually to a certificated teacher, I° a low registration fee whether employed or not, II° an augmentation grant when employed, and III° a capitation grant for the attendance and the good order of the school where he is employed.
- Half time system 4. Measures should be taken to encourage the "half time" system for children above a certain age, as advocated by Mr Chadwick, which I believe is generally as efficacious as full attendance at school.
- Vagrants. 5. All idle vagrants in the streets under 12 years of age should be sent to union schools, and the parents who are thus offenders against society and their offspring should be compelled to pay towards their teaching. The educational systems in Switzerland and Prussia offer suggestions.
- Inspection. 6. The system of inspection and examination might be improved and largely increased with great advantage and without a proportionate increase of cost.*
- Drilling, gymnastics, and music universal. 7. I think that drilling, gymnastics, and music, should be made a part of elementary education in all schools as far as possible, and that the State should make payments in aid of those subjects which are commonly taught abroad. In respect of teaching elementary science, I call attention to the advice given by Adam Smith, a century ago, who said—"There is scarce a common trade which does not afford some opportunities of applying to it the principles of geometry and mechanics, and which would not therefore gradually exercise and improve the common people in those principles, the necessary introduction to the most sublime as well as to the most useful sciences. The public can encourage the acquisition of those most essential parts of education by giving small premiums and little badges of distinction to the children of the common people who excel in them."
- Permissive rating 8. I think a permissive local rating Bill is very desirable, as proposed by Mr. Bruce. It exists already for libraries, art schools, and museums,—why not for primary instruction? As its adoption would be voluntary it should be accepted by the State on the same terms as the present voluntary system.
- Graduated fees for different classes. 9. Measures might be usefully taken to induce the children of all classes of society to attend elementary schools, especially in small places, as they do the schools of art and the science schools. Gradations in the payment of fees should be encouraged. The Birkbeck Schools directed by Mr. Ellis offer valuable suggestions in this respect.

II. SECONDARY OR TECHNICAL INSTRUCTION.

10. I concur generally in the paper of 12th November 1867 which Captain Donnelly has prepared on this subject.
- Elementary schools and science 11. I recommend that the managers of elementary schools be free to establish classes for teaching science through certificated teachers, and that payments on results be made to them, and that all fears of competition with elementary education be ignored. (See Education Minute of 20th February 1867)
- Free and grammar schools. 12. If effective measures can be taken to deal with the funds and management of the old free and common grammar schools, the teaching of art and science might be largely introduced into them without increased charge on Parliamentary funds.
- Upper grammar schools. 13. I consider that the State might usefully establish professorships, with prizes and perhaps scholarships for science at Eton, Harrow, Rugby, &c., as well as at the Universities. A very few thousand pounds expended annually in this direction would, I conceive, be the most efficient means of aiding technical instruction. Such an expenditure would act in increasing the public revenue in a few years. Until increased honours are awarded at the Universities for acquiring experimental science, and the knowledge is felt to be remunerative, experimental science will stand no chance with the study of classical learning, and the industrial position of this country in comparison with other countries generally will get from bad to worse. (Some Parliamentary Votes are already made to universities for science, see Estimates, Class IV)† The address of Mr. J S Mill, Rector of St. Andrew's, whilst fully estimating the great value of classical knowledge, shows the necessity for scientific teaching, in the most eloquent terms. It is a text book on the subject. (See also Mr Lowe's Address to the Philosophical Institution at Edinburgh.)

14. Four

* That is for systematically making reports on the deficiency of schools, with the view of adopting some such measures as Mr. Lowe suggests.

† See pp 6 and 7.

14. Four establishments should be formed in the nature of training colleges for teaching practical science. There is already one at Dublin. The School of Navigation and Science, now building at South Kensington, might be readily enlarged into such a college. Arrangements, I believe, might be made for a third, either in connection with the University at Edinburgh or at Glasgow, and a fourth might be created in the Midland Counties. The latter college, as well as that for Scotland, might be located in that place which offered to endow the greatest number of scholarships in it.

Training colleges for science.

15. Captain Donnelly's paper fully states the objections to State "trade" schools, so I do not repeat them.

III PUBLIC LIBRARIES AND MUSEUMS

16. Public libraries, galleries, and museums should be viewed as the highest instruments of public instruction, and be rendered as effective as possible to that end. Full titles, inventories, and catalogues should be prepared as well for the learned as the unlearned visitor. The superior manners and general culture of the mass of the people, especially in art and science, in many parts of Europe, are to be attributed to the influence of the greater number of public libraries and museums than with us, and to the facilities offered to all classes to study them*. The British Museum, which possesses treasures of the greatest instructional value, is still somewhat treated in its management and purpose only as a collection of things "rare and curious," as they were defined by Sir Hans Sloane a century ago, and not as a great public educational institution which it might be made

Public libraries and museums necessary to public instruction.

17. I strongly recommend, both on religious and moral grounds, that arrangements be made as at Kew Gardens and Museum, Hampton Court, and Greenwich Picture Galleries, &c. to admit the public to national institutions on Sunday afternoons. A more elevating measure could not be devised.

Sunday opening.

18. To render public libraries and museums, which are supported in the main by public funds, proper instruments of public instruction, and to manage them effectively and economically, it seems to me indispensable that they be placed under the sole responsibility of a Minister of the Crown. Numerous boards render executive management impotent, and are quite incompetent to deal with the proper expenditure of public funds. Boards are useful for counsel, but obstructive for action. On this subject, as well as on better administration of public museums, public opinion has been maturing for more than 30 years. See especially "Quarterly Review," No. 175, December 1850, "Edinburgh Review," January 1866.

Minister of Public Instruction.

19. The greater number of such public institutions of science and art are already under a Ministerial authority. It would be of great public benefit in every way to subject the remainder to the same authority* (See Estimates, Class IV, Learned Societies). But I allude especially to the British Museum, the National Gallery, National Portrait Gallery, and Patent Museum in London, also to the National Gallery, and Royal Irish Academy in Dublin, and the National Gallery, Edinburgh.

Public museums under Minister of Public Instruction.

IV. GENERAL PRINCIPLES OF ADMINISTRATION.

20. I consider it necessary that elementary education, secondary, or technical instruction, the management of public libraries, galleries, and museums, and all the votes given for education, science, and art, should be concentrated in their administration of them, so far as the expenditure of public funds at least is concerned, under the sole authority of the same Minister of the Crown.

General principles of administration.

21. This Minister of Public Instruction ought not, I venture to think, to be the Lord President of the Council. The work appears to me ample enough to engage the sole attention of a minister who, I also venture to think, ought to rank as a Secretary of State. He would sit in either House, according to the circumstances of the Cabinet. There should be an Under Secretary also in Parliament.

22. In my opinion, the present work at the Privy Council Office, with all the calls for charters, health, cattle plague, quarantine, &c., made upon the attention of the Lord President, make it impossible for that high functionary to devote sufficient time to numerous questions involved in public instruction viewed comprehensively.

23. To enlarge elementary education, making it truly national; to reform the educational charities; to increase technical instruction throughout the United Kingdom, to reorganise the British Museum,† the National Portrait Gallery, &c., so as to make them work efficiently and harmoniously together, are functions which ought not, I conceive, to be treated as of secondary importance to any others.

To the Vice President of the
Committee of Council on Education.

I have, &c.
(signed) *Henry Cole.*

* See list of such institutions in France, &c., printed by the Department.

† In doing this the family Trustees should be kept of course, but they should revert to their original functions there should be no further elections of "Elected Trustees," and the "Official Trustees" would at once give way to a single responsible minister.

PARLIAMENTARY VOTES for Science for the Middle and Upper Classes in 1887-8, exclusive of the Cost of the Queen's Colleges, Ireland.

<i>University of London.</i>	£. s. d.	£. s. d.	The Amounts to each Class of Subjects were as follows—		
Two Examiners in Mathematics and Natural Philosophy - 200 l. each	400 -- --		<i>Mathematics</i>		
Two Assistant Examiners in Mathematics - - - 50 l. each	100 -- --		University of London - - -	500 -- --	
Two Examiners in Chemistry - - - 175 l. each	350 -- --		" St. Andrew - - -	100 -- --	
Two Assistant Examiners in Chemistry - - - 25 l. each	50 -- --		" Glasgow - - -	100 -- --	
Two Examiners in Experimental Philosophy - - -	200 -- --		" Edinburgh - - -	180 -- --	961 -- --
Two Examiners in Botany, 75 l. each	150 -- --		<i>Chemistry</i>		
Two Examiners in Geology, 75 l. each	150 -- --		University of London - - -	400 -- --	
Two Examiners in Physiology and Zoology - - - 150 l. each	300 -- --	1,700 -- --	" St. Andrew - - -	125 -- --	
			" Aberdeen - - -	100 8 8	
<i>University of St. Andrew's.</i>			" Glasgow - - -	400 -- --	
Professor of Natural Philosophy - - -	150 -- --		" Edinburgh - - -	200 -- --	1,815 8 8
" Mathematics - - -	100 -- --	384 -- --	<i>Natural and Experimental Philosophy.</i>		
" Chemistry - - -	125 -- --		University of London - - -	200 -- --	
<i>University of Aberdeen.</i>			" St. Andrew - - -	150 -- --	
Professor of Chemistry - - -	40 8 8		" Glasgow - - -	121 -- --	
Assistants - - -	150 -- --	490 8 8	" Edinburgh - - -	280 -- --	761 -- --
Professor of Botany - - -	300 -- --		<i>Botany.</i>		
<i>University of Glasgow.</i>			University of London - - -	150 -- --	
Professor of Mathematics - - -	60 -- --		" Aberdeen - - -	300 -- --	
Assistant - - -	100 -- --		" Glasgow - - -	100 -- --	
Professor of Natural Philosophy - - -	21 -- --		" Edinburgh - - -	160 -- --	710 -- --
Assistant - - -	100 -- --		<i>Geology</i>		
Professor of Natural History - - -	200 -- --		University of London - - -	- - -	150 -- --
" Chemistry - - -	200 -- --	1,258 -- --	<i>Physiology, Zoology, and Natural History.</i>		
Two Assistants - - -	200 -- --		University of London - - -	300 -- --	
Professor of Botany - - -	100 -- --		" Glasgow - - -	200 -- --	
" Civil Engineering and Mechanics - - -	275 -- --		" Edinburgh - - -	160 -- --	650 -- --
<i>University of Edinburgh.</i>			<i>Mechanics and Civil Engineering.</i>		
Professor of Mathematics - - -	80 -- --		University of Glasgow - - -	- - -	275 -- --
Assistant - - -	100 -- --				
Professor of Natural Philosophy - - -	180 -- --				
Assistant - - -	100 -- --				
Professor of Natural History - - -	160 -- --				
" Botany - - -	160 -- --	980 -- --			
" Chemistry - - -	200 -- --				
TOTAL - - -	£	4,812 8 8	TOTAL - - -	£	4,812 8 8

No annual reports are made to Parliament of the results of this expenditure.

Mathematics, Natural Philosophy, Natural History, Chemistry, Mineralogy, and Geology, Engineering, Agriculture, Anatomy, and Physiology, and Political Economy, are taught in the Queen's Colleges of Belfast, Cork, and Galway.

App No 12.

LIST of Royal Exhibitors to the Museum of Irish Industry and Royal College of Science, *Dublin*.

YEAR.	Name.	Science School where Taught.
1865 - - - -	Frank Clowes - - - -	Middle class student
	James Craik - - - -	Middle class student
	John Connelly - - - -	Bandon.
	Wm. B. Leonard - - - -	Drogheda.
1866 - - - -	Charles G Stewart - - - -	Camden Town.
	John M'Allan - - - -	Self-taught
	Stewart Williamson - - - -	Middle class student.
1867 - - - -	Phineas S Abraham - - - -	Self-taught
	James R Kilroe - - - -	Santry
	William Hunt - - - -	Santry.
	Edward T Hardman - - - -	Dublin Central Model School.
	Richard J. Cruise - - - -	Middle class student

(See Evidence, 930)

LIST of Royal Exhibitors to the Royal School of Mines, *Jermyn-street*.

YEAR.	Name.	Science School where Taught.
1863 - - - -	Charles Berrell - - - -	Middle class student.
	William T Rowden - - - -	Trade School, Bristol
1864 - - - -	Geo J. Snelus - - - -	Science teacher.
	William Thorpe - - - -	Middle class student.
	Edward Richards - - - -	Poplar Navigation School.
1865 - - - -	Thomas Jones - - - -	Science teacher.
	Edward Collens - - - -	Trade School, Bristol.
	John A. Griffiths - - - -	Mechanics' Institution, Manchester.
1866 - - - -	German Green - - - -	Lower Islington, Public School
	Fred. J M. Page - - - -	Middle class student (City of London School).
1867 - - - -	William Garnett - - - -	Middle class student (City of London School).
	Archibald Liveridge - - - -	City of London College and Royal Polytechnic Institution.
	Alex. W. Bickerton - - - -	Painswick.
	Wm. J. Solla - - - -	Royal Polytechnic Institution.

Appendix, No. 13.

App. No. 13.

UNIVERSITY OF EDINBURGH.

GRADUATION IN SCIENCE.

The degrees of bachelor of science (Sc. B) and of doctor of science (Sc. D.) are given in the following departments of science:—

Division I.—PURE SCIENCE.

- Section A —Physical and natural science.
 „ B.—Mental science.
 „ C.—Philology.

Division II.—APPLIED SCIENCE.

This comprises—

- Section A.—Agriculture
 „ B.—Engineering (civil and mechanical).
 „ C.—Veterinary surgery.

Full details of the curriculum and examinations in each division are given in the "University Calendar" for 1868-69, published by Messrs. Edmonston & Douglas; price 2 s. 6 d.

GRADUATION IN SCIENCE.

Division II.—APPLIED SCIENCE.

ALL candidates for the degree in Applied Science must give proof of having received a liberal education by being either—

- 1.—B A or M.A.
- 2.—M B or M.D.
- 3.—Sc. B or Sc D.
- 4.—Holders of two departmental certificates in the Faculty of Arts of Edinburgh.
- 5.—Matriculated students of the University of London.

Or failing any of these qualifications, the candidate must pass a preliminary examination in English, Latin, logic, arithmetic, the elements of mathematics and mechanics, and either Greek or two modern languages (of which French must be one), as an alternative for Greek. The examination will be the same as that required of medical students.

The department of "Applied Science" is divided into—

- A.—Agriculture.
 B.—Engineering and mechanical science
 C.—Veterinary surgery.

A.—There will be two examinations for the degree of bachelor of agriculture (Agr. B.), and one for that of master of agriculture (Agr. M.) The examinations will be both written and oral.

The first examination is the same as that required for the first examination in the case of Sc. B, and relates to the knowledge of the candidate of the following subjects—

- | | |
|-----------------|--------------------------|
| 1. Mathematics. | 4. Geology. |
| 2. Chemistry. | 5. Zoology. |
| 3. Botany | 6. Experimental physics. |

This examination is compulsory on all candidates who do not possess the following qualifications—

A.—Masters

A.—Masters of arts who have taken honours in the natural sciences.

Masters of arts who have not taken honours in the natural sciences are exempted from mathematics and experimental physics only

B.—Bachelors and doctors of medicine who have taken honours in the natural sciences at their professional examinations, and who have passed in higher mathematics, natural philosophy, and logic, in their extra professional or preliminary examinations.

C.—Holders of certificates from the classes in science devoted to the foregoing subjects in the University of Edinburgh, showing that the candidate obtained 80 per cent of the available marks during the session. Any of the subjects cleared by such a certificate will be omitted from the written examination

The candidate who has passed successfully this examination may present himself at the next examination for his degree of bachelor of agriculture (Agr. B.)

For this examination the candidate must produce certificates of acquaintance with practical agriculture, and is required, with the view of specialising his studies, to profess *one*, and not more than one, of the following groups of subjects, with their practical relations to agriculture:

A.— <i>Natural Sciences</i>	-	-	-	{	Botany,
				{	Geology,
				{	Zoology.
B.— <i>Experimental Science</i>	-	-	-	{	Chemistry,
				{	Physics
C.— <i>Mechanical Science</i>	-	-	-	{	Mechanics,
				{	Engineering.

The certificates of the Royal Agricultural Society, the Highland Society, and the Royal Agricultural College, will be accepted for practical agriculture

Successful candidates who have thus acquired the degree of Agr. B. may at the next period of examination, provided they have attained the age of 21, proceed to the examination for the degree of master of agriculture (Agr. M.)

For this degree the candidate will be required to submit to a searching examination on *one* of the following subjects, in its special relation to agriculture.

- A.—Agricultural chemistry—organic and inorganic
- B.—Agricultural mechanics
- C.—Engineering (civil)—surveying, drawing, &c.
- D.—Natural history—botany, geology, &c.
- E.—Animal physiology—breeding, rearing, &c., of animals.

Should the candidate pass successfully this examination, he will receive the degree of master of agriculture (Agr. M.)

The examinations for degrees will be conducted by university examiners, and an examiner appointed by the Highland Society

B.—*Engineering—Civil and Mechanical.*

1st. All candidates for a degree in engineering must have the qualifications required for matriculation before passing a science degree.

There will be two examinations in engineering for the degree of *bachelor of engineering* (Sc. Mach. B.), and a third for the degree of *master of engineering* (Sc. Mach. M.)* The examinations will be both written and oral. The first examination is as to the general knowledge of the candidate on the following subjects:—

1. Mathematics.
2. Natural Philosophy
3. Chemistry.

This examination is called the first bachelor of engineering examination, and is compulsory on all who do not possess the following qualifications:—

- A.—Masters of arts who have taken honours in the departments of mathematics or natural science
- B.—Bachelors in science in the University of Edinburgh or London.
- C.—Graduates in science who have passed the first bachelor of science examination in the University of Edinburgh.

The candidate who has successfully passed the first bachelor of engineering examination may proceed to the second examination, which is to be entitled the second bachelor of engineering examination.

The candidate will be examined in the following subjects:—

- (A) Mathematics applied to mechanics.
- (B) Engineering—Civil engineering, mechanical engineering, surveying and levelling.
- (C.) Drawing—Geometrical projection, mechanical drawing, plans and surveys.

The candidate having passed successfully the first bachelor of engineering examination (or having the qualifications necessary to escape this examination), after passing with approval

* *Scientiæ Machinabilis [Magister] (Pliny, lib. cap.).*

App. No. 13.

approval the second examination, shall be recommended to the Senatus for the degree of bachelor of engineering.

This degree will indicate that the student has received such a preparation as will qualify him to enter with advantage the office of a civil engineer or the workshop of a mechanical engineer as a pupil.

Should the candidate desire to become a master of engineering, he may present himself for a third examination. All candidates for this degree must prove that they have passed at least two years as a pupil under a civil engineer in practice, or in a mechanical workshop. He must then profess one, and not more than one, of the subdivisions in each of the two following groups of subjects.—

- | | | |
|------------------------------------|---|--|
| 1st. <i>Practical Engineering.</i> | { | (a) The design of machinery, with complete drawings, specifications, and estimates |
| | | (b) The preparation of designs, specifications, and estimates for some civil engineering work. |
| 2nd. <i>Applied Science -</i> | { | a. Applied mathematics. |
| | | b. Chemistry |
| | | c. Geology. |
| | | d. One branch of experimental physics. |
| | | e. Telegraphy. |

The class of machinery, or the nature of the engineering work in which the student is examined, will be chosen with reference to the special work in which he has been engaged during his pupilage

This degree will indicate that the student is qualified to practise the profession of an engineer.

The examination for degrees will be conducted by University examiners, and an examiner appointed by the Institute of Civil Engineers

For the degrees in sections A. and B. (agriculture and engineering), the same rates will be charged as for the degrees in science.

C.—*Veterinary Surgery.*

The University of Edinburgh propose to institute a degree in veterinary surgery, open to qualified students of all the veterinary schools in Great Britain who comply with the regulations laid down for such degree

All candidates for examination for such degree must be 21 years of age, and have obtained by examination a veterinary diploma or license from some recognised teaching or licensing body in Great Britain

This diploma or license will be accepted as satisfactory evidence of the candidate's general education, and of his acquaintance with the groundwork of his profession, and will exempt him from the preliminary and the "bachelors" examinations, required in the other sections of the department of applied science.

Candidates will be also required to produce certificates of attendance upon at least three out of the following list of classes in the University of Edinburgh:—

- | | |
|---|---------------------|
| 1. Anatomy. | 4. Natural history. |
| 2. Institutes of medicine (physiology). | 5. Botany. |
| 3. Surgery. | 6. Agriculture. |

Candidates thus qualified will be admitted to examination for the degree of master of veterinary surgery (C.V.M.)

The examinations in all the above subjects, in their applications to veterinary surgery, will be both oral and written, and be held at the close of the winter session. They will be conducted by the University examiners on the respective subjects of examination, assisted by an examiner appointed by the Council of the Veterinary College of Edinburgh, and an examiner appointed by the Royal College of Veterinary Surgeons.

For the degree of veterinary surgery, the fee will be 10 l. 10 s.

Appendix, No. 14.

SYLLABUS of the Course of INSTRUCTION in the SCIENTIFIC DIVISION of the
GRAMMAR SCHOOL, LEEDS.App. No

1. ELEMENTARY COURSE of about one year.

Elementary Principles of two or more
of the following subjects. { Mechanics.
Natural Philosophy.
Chemistry.
Botany.

2. ADVANCED COURSE of one or more years.

A. PURE SCIENCE.

B. PROFESSIONAL COURSES, MEDICAL, ENGINEERING, &c.

Science is taught not only as an efficient instrument for mental culture, but attention will, when required, be more confined to particular subjects connected with a profession.

A. PURE SCIENCE { Mechanics.
Natural Philosophy.
Chemistry.
Biology, *i.e.*, Zoology, Botany, &c.

B. PROFESSIONAL COURSES.

1. *Medical* - Chemistry, Chemical Analysis, Botany.
2. *Engineering, &c.* Mechanics and Mechanism, Metallurgy, &c.

PRINCIPAL TEXT BOOKS

Chemistry, Williamson's.
Chemical Analysis, Conington's.
Botany, Oliver's.
——— Henfrey's.

Zoology, Dallas'.
Mechanism, Baker's.
Geology, Page's.
Physics, Gaynot's.

It is desirable that parents should give notice of a wish to enter their sons in the scientific division before the conclusion of the previous half-year

Appendix, No 15

PAPERS handed in by Mr. Roscoe, 18 June 1868

OWENS' COLLEGE, MANCHESTER.

App No. 15

FUND for the Endowment of a PROFESSORSHIP of ENGINEERING and Adjuncts.

At a meeting of engineers, held nearly twelve months ago, it was decided to make efforts to raise a sum of at least 10,000 *l* for the above purpose

The amount already promised is about 8,750 *l*, contributed by the firms and gentlemen whose names will be found annexed to this statement

The contributors were called together a few days ago, and they decided that as the necessity for the establishment of such a professorship in Manchester was urgent, the funds already collected should be at once handed over to the trustees of the College, with a view to their securing the services of a suitable professor, able to commence his course after the Christmas Vacation

The meeting expressed a strong opinion, that if the subject were fairly brought before the engineers of Manchester, and the manufacturing districts, a large amount of support could not fail to be received, and they desire it to be known that the duties of the professor and his assistants would ultimately comprise such a course as the following

The stability of structures, the strength of materials, metals and metallurgy, the principles of the action of machines, prime movers, the principles of hydraulics, the mathematical principles of surveying and levelling, the engineering of earthwork, masonry, carpentry, structures in iron, roads, railways, bridges and viaducts, tunnels, canals, works of drainage and water supply

Evening lectures and classes would be held in addition to the day lectures, so as to make a considerable portion of the instruction accessible to those whose time might be occupied during the day in other ways

It is to be considered that pupils who embrace this opportunity of acquiring the theoretical portion of a "technical education" would also be enabled to avail themselves of any or all of the following courses of study, already provided by the college, under the direction of the respective professors, viz

PROFESSORS.

Languages and literature of Greece and Rome	{ J G Greenwood, B A, Fellow of University College, London.
English language and literature, and ancient and modern history	{ A. W. Ward, M A, Fellow of Saint Peter's College, Cambridge
Logic, mental and moral philosophy, and political economy	{ W Stanley Jevons, M A, Fellow of University College, London.
Mathematics	{ Thomas Barker, M A, Fellow of Trinity College, Cambridge
Natural Philosophy	{ William Jack, M A, Fellow of Saint Peter's College, Cambridge.
Jurisprudence	- Richard C. Christie, M A.
Chemistry	- Henry E. Roscoe, B.A., F.R.S.
Natural history	- Wm C. Williamson, F.R.S.
Oriental languages and literature	- } T. Theodoros.
Modern languages and literature	- }
Drawing (teacher of)	- Mr. Wm. Walker.

These courses of study are followed in whole or in part by 152 day students and 310 evening students, so that engineering students would have the advantage of contact with a large number of others, under proper restraints of discipline. The erection of new and enlarged college buildings is in contemplation; and it is hoped that in them additional facilities for study and training would be afforded to all who might avail themselves of the opportunities of instruction furnished by this college.

SUBSCRIPTIONS TO THIS DATE.

App No. 1

Messrs. Beyer, Peacock & Co.	- £. 3,000	John Ramsbottom, Esq.	- - £. 200
Joseph Whitworth, Esq.	- - 1,000	Messrs. Mather & Platt	- - 200
Charles P. Stewart, Esq.	- - 1,000	John Hawkshaw, Esq.	- - 100
John Robinson, Esq.	- - 1,000	Matthew Curtis, Esq.	- - 100
William Fairbairn, Esq.	- - 500	Henry Wren, Esq.	- - 100
Messrs. Platt Bros., & Co.	- 500	Messrs. John Hetherington & Sons	100
Messrs P. R. Jackson & Co.	- 500	George Peel, Esq.	- - 100
Messrs W. & J. Galloway & Sons	250	John Carlisle, Esq.	- - 100

The names of additional subscribers will be received by Joseph Whitworth, Esq., Chorlton-street, or by the Honorary Secretary, John Robinson, Esq., Atlas Works, and payments may be made to the credit of Joseph Whitworth, Esq., Treasurer of the Owens' College Engineering Professorship Fund, with the Manchester and Liverpool District Bank, King-street, Manchester

Atlas Works, Manchester,
December 1867.

OWENS' COLLEGE EXTENSION.

OWENS' COLLEGE was founded by the munificent bequest of Mr John Owens, merchant, of Manchester, who bequeathed the bulk of his property to trustees, to found "an institution for providing or aiding the means of instructing and improving young persons of the male sex (and being of an age not less than 14 years) in such branches of learning and science as were then and might be thereafter usually taught in the English Universities."

The college was opened on the 12th of March 1851. The number of students in the ordinary day classes in the first session was 62, in the present session it is 110,* and the average number for the last five years has been 115. In 1852-53 evening classes were started, in which instruction is given in almost all the subjects taught in the day classes. The number of evening students has increased from 28 in 1852-53 to 279 in 1866-67,† and the average number for the last five years has been 295. It thus appears that the total number of persons taught in the college has averaged 400 during the last five sessions. The number of day classes held has increased from 15 in 1852 to 32 in the present year, and the number of evening classes from 2 to 25.

From its foundation Owens' College has been affiliated to the University of London. More than 130 of its students have matriculated in the University, and about one-half of these have proceeded to the higher examinations for degrees.

It would probably be found that in no institution of the kind in the kingdom are so many persons under instruction in so confined a space. The class-rooms are too few in number, some of them are unduly crowded, and others are quite unfit for the use to which they are put.

It is, then, not too much to affirm that the utmost measure of success attainable in the present buildings has been reached. The trustees have no power to spend any portion of the original endowment in the purchase of land or the erection of buildings. Unless ampler and more appropriate accommodation is provided for the college, future sessions may witness a decline as steady as its growth has been, for in the early years of such institutions not to go forward is to go back.

The erection of new buildings is not, however, all that is needed to enable Owens' College to fulfil the object of its foundation. The proper function of the college may be defined as being to furnish the highest general education, leading to degrees in arts and science, and the special training required for professional and mercantile life. To accomplish this, a very considerable extension of the scheme of studies pursued is called for. Nor can there be a doubt what the prevailing character of this extension should be. Due provision being made for the pursuit of classics and mathematics, and of the other branches of what may be called the older University studies, it is obvious that the special characteristic of a college for the manufacturing districts should be the study of experimental and applied science.

The college already possesses professorships of Greek and Latin (including the Greek Testament), Hebrew and Arabic, English Language and Literature, French and German, History, Mathematics, Natural Philosophy, Logic, &c., Political Economy, Jurisprudence, Chemistry, and Natural History. To these it is proposed to add.

1. A separate professorship of Latin and Comparative Grammar.
2. At least one professorship of Engineering; and if possible, of Surveying and Architecture.
3. A professorship of applied Geology and Mining.
4. A professorship of Astronomy and Meteorology.

It would be necessary, further, to provide most of these chairs with all the apparatus for complete and successful study; to set aside considerable sums for the extension and regular maintenance of the library, and of the Physical and Natural History Departments; and, above all, to place the Chemical Department in a position of efficiency worthy of the present state of the science, and of its importance in relation to the interests of this district.

App No. 15.

With these additions and extensions, the college would begin to assume the proportions and to possess the substantial advantages of a university for the manufacturing districts. The experience of Glasgow proves that academical institutions may flourish in the heart of a mercantile and manufacturing society; and the munificence with which a subscription for erecting new university buildings has been recently commenced shows not more the liberality of the people of Glasgow than their sense of the benefits which the University has conferred upon their city.

The substance of the above statement was laid before a meeting held in the Town Hall, Manchester, on the 1st February 1867, his Worship the Mayor in the chair; when the following resolutions were passed:

Proposed by the very Rev. the Dean of Manchester, and seconded by Mr. Oliver Heywood,

"That this meeting, having heard with satisfaction the statements of the trustees and professors of Owens' College, as to its constitution, operations, and present success, and the suggestions offered for supplying the requirements of the college, and for rendering it on an extended basis, in effect, the local University of Lancashire and the neighbouring counties, is of opinion that the time has come for the public of the district to unite for the purpose of developing the college on a more comprehensive scale, and in appropriate and convenient buildings."

Proposed by Mr. Thomas Bazley, M.P., seconded by Mr. Thomas Ashton, and supported by Sir Elkannah Armitage, Knt.,

"That the trustees and professors of Owens' College, and the following gentlemen (the list contains the names of 69 gentlemen), with power to add to their number, constitute a Committee for raising a fund which it is desirable should be not less than 100,000 £, or, if possible, 150,000 £, for the purpose of carrying into effect the proposed system of extension."

Proposed by Mr. W. R. Callender, sen., and seconded by Mr. John Platt, M.P.,

"That an Executive Committee be appointed, consisting of the following gentlemen (with power to add to their number) —

Thomas Ashton, Esq., *Chairman.*

Oliver Heywood, Esq., *Treasurer*

Benjamin Armitage, Esq.,

Charles F. Beyer, Esq.,

W. R. Callender, jun., Esq.,

Richard Johnson, Esq.,

John L. Kennedy, Esq.,

Sigismund J. Stern, Esq.,

with Principal Greenwood,

Professor Christie,

Professor Roscoe,

And six trustees of the college

[The following gentlemen were accordingly elected by the trustees out of their body].

Robert D. Darbishire, Esq.,

Murray Gladstone, Esq.,

W. H. Houldsworth, Esq.,

Alfred Neild, Esq.,

John Robinson, Esq.,

John Edward Taylor, Esq.,

and that such committee have power to determine on and carry out measures for raising the required fund, and that they be requested to prepare a scheme of such extent as may be deemed desirable and warranted by the funds subscribed, such scheme to include the recommendation of a site and of plans of buildings, the endowment of professorships, and other means of imparting instruction and encouraging study in the various departments of learning and liberal arts, and of science and its applications. The committee to report from time to time to the subscribers."

The Executive Committee confidently appeal to the public of Manchester and of the manufacturing districts for funds to enable them to purchase a suitable site, and to erect commodious and appropriate buildings, in which the actual work of the college may be more efficiently carried on, and such additions made as have been indicated above.

Thos Ashton, Chairman of the Executive Committee.

Oliver Heywood, Treasurer.

J. G. Greenwood,

W. H. Houldsworth, } Hon. Secretaries

Owens' College, 1 March 1867.

Appendix, No. 16.

PAPER handed in by Dr. *Stevenson Macadam*, 2 July 1868.

Apj

WATT INSTITUTION, EDINBURGH.

CLASS OF MATHEMATICS.—SYLLABUS FOR 1866-67.

Junior Class.

Arithmetic.—Different Scales of Notation,—Theory and Practice of Vulgar and Decimal Fractions,—Logarithmic Arithmetic,—Square and Cube Roots

Algebra.—Algebraic Notation,—Addition, Subtraction, Multiplication, and Division;—Algebraic Fractions,—Simple Equation with one, two, and three unknown quantities,—Quadratic Equations,—Involution and Evolution,—Ratios and Proportion,—Arithmetical and Geometrical Progression

Geometry and Mensuration of Surfaces, along with the Course on Algebra.

Exercises will be given for solution by the Students on all the divisions of the Course. Text Books—"Pryde's Edition of Gray's Arithmetic," and "Practical Mathematics," by the Scottish School Book Association.

Senior Class.

Revision of the higher parts of the Junior Course Quadratic and Higher Equations, and the application of Algebra to Geometry. Trigonometry and its applications to Surveying, Mensuration of Heights and Distances, and Navigation,—Mensuration of Surfaces and Solids. Geometry. Construction and use of Logarithms, and Logarithmic Arithmetic—Exercises throughout the Course.

ABSTRACT of the TREASURER'S ACCOUNTS of the WATT INSTITUTION and SCHOOL of ARTS, from 31st October 1866 to 31st October 1867.

RECEIPTS	£. s. d.	DISBURSEMENTS	£. s. d.
I. Interest received on Bank Account with British Linen Company - -	3 4 7	I Lecturers' Salaries, etc. -	246 6 3
II Students' Fees - -	194 10 -	II Taxes, Insurance, Fire, Light, etc - - -	38 8 10
III. Annual Subscriptions -	60 11 6	III Attendants' Wages, Expense of Collecting Subscriptions, etc - -	27 13 -
IV. Rents of Property to 15th May 1867 - - -	89 16 -	IV. Printing, Advertising, Books, and Stationery - -	36 9 6
V. Balance, being deficiency on Receipts for year -	42 14 -	V. Miscellaneous Charges -	10 11 8
		VI. Repairs on Buildings, etc.	31 6 10
TOTAL - - - £.	890 16 1	TOTAL - - £	890 16 1

Examined, compared with vouchers, and found correct.

George Crochton.
W. T. McCulloch

Edinburgh, 16 March 1868.

Appendix, No. 17.

App. No. 17.

PAPER handed in by Captain *Donnelly*, 3 July 1868.

THE NATIONAL SCHOOL, MIDDLETON, NEAR MANCHESTER.

Sir,

June 30 1868.

WITH regard to the inspection of the science classes and the examinations of the candidates at the May examinations, I think the present system most excellent, provided due care be taken in the formation of the local committee.

Referring to payments to teachers, I am of opinion that a teacher who conducts a class of a specified minimum number of pupils should be guaranteed a certain sum independent of the result of the examination, and this payment might be made in the form of certificate money, say 20 *l* for the holder of a first-class, and 15 *l* and 10 *l* for the holder of a second and third respectively. In other respects I would leave the payments on results as at present, but teachers who devote themselves entirely to science teaching should have no reduction made on the gross sum due to them as is the present custom on amounts over 60 *l*.

I think until the system is more widely spread and better known and appreciated it would be impolitic to reduce the number or value of the Queen's Prizes.

As teaching, accompanied by experiment or illustrated by examples, is not only more attractive but likely to be much more effective, I would recommend liberal assistance to schools and classes in the purchase of apparatus, maps, diagrams, &c. Scientific instrument dealers should be prevailed upon to modify the present enormous prices in favour of science classes recommended and aided by the Science and Art Department.

I am of opinion that much of the success of the present system depends on the influence of the teacher, but if the present method of granting certificates to any one who gains a first or second-class Queen's Prize be continued we shall have many teachers admitted who are deficient in the very elements of general education, and whose character and attainments will fail to command the respect and confidence of either local committees or pupils. I am further of opinion that candidates for science certificates should either present some evidence of the possession of a good general education or pass a preliminary examination in the following subjects at least, viz, the English language, with the option of a further examination in Latin or a modern language, or elementary mathematics.

Thomas Bazley, Esq., M.P.

I have, &c.,
(signed *George H. Wheeler*.)

Appendix, No. 18.

PAPER handed in by Dr. Frankland, 3 July 1868.

App. No

LIST of STUDENTS working in the CHEMICAL LABORATORY of the ROYAL SCHOOL of MINES, the ROYAL COLLEGE of CHEMISTRY, during the present Summer Session, their Ages and Destinations, as far as could be ascertained.

—	Names of Students	Age	Time of Entrance.	Destination.
London - - -	1. W. G Whiffin - -	17	1 Jan 1867 -	Quinine Manufacturer.
London * - - -	2 Archbald Liversidge	21	1 Oct. 1867 -	Royal Exhibitor (undetermined).
London * - - -	3. Wm. Garrett - -	17	1 Oct. 1867 -	Royal Exhibitor (Engineering)
Birmingham * - -	4 Alex Bickerton - -	25	1 Oct. 1867 -	Royal Exhibitor Science Teacher
London * - - -	5. Wm. Johnson Sollas -	19	1 Jan. 1867 -	Royal Exhibitor (undetermined).
Tunbridge Wells * -	6. R. Aldridge - -	18	1 Oct 1867 -	Scientific Chemistry.
Wareham * - - -	7. W. L Pike - -	20	1 Oct 1867 -	Clay Merchant.
York - - - -	8 F. W Bayley - -	22	1 Oct. 1867 -	Mining Engineer.
Lancashire * - - -	9 R. Kay Shuttleworth	20	1 Oct 1867 -	Mining Engineer.
Edinburgh - - -	10 James E. Stoddart -	17	1 Oct. 1867 -	Manufacturing Chemist.
Greenock - - -	11 J D Scott - -	26	1 Jan 1867 -	Sugar Refiner.
Cornwall * - - -	12 J Clemes - -	19	1 Oct. 1867 -	Mining Engineer.
London - - - -	13 Fr Storks - -	18	1 Oct 1866 -	Analytical Chemist.
Burton-on-Trent -	14. J. Bell - -	19	1 April 1868 -	Brewer
Burton-on-Trent -	15 E L. Baylis - -	22	1 April 1868 -	Brewer
Burton-on-Trent -	16 Adrian Brown - -	16	1 April 1868 -	Undetermined.
London - - - -	17 Matthew Jackson -	18	1 Oct 1867 -	Manufacturing Chemist.
Flint - - - -	18 Sydney K Muspratt	18	1 Oct 1867 -	Manufacturing Chemist.
Bristol * - - -	19. Hy Wm. Ll. Tanner	17	Jan 1868 -	Professional Chemist
London - - - -	20. B. Lyell - -	17	1 April 1868 -	Science.
Burton-on-Trent -	21 C J Goer - -	24	1 April 1868 -	Brewer (at Bass & Cos.)
London - - - -	22 Alf. Netley - -	17	1 April 1868 -	Undetermined.
Plymouth - - -	23. Rt Burnard - -	19	1 Oct 1867 -	Artificial Manure Manu- facturer
London - - - -	24. Ed. Midwinter - -	17	1 Oct 1867 -	Manufacturing Chemist.
London - - - -	25 — Nelson - -	30(?)	19 Feb 1867 -	Gelatine Manufacturer
London - - - -	26 J Wilson Bell - -	15	1 Oct. 1867 -	Artificial Manure Manu- facturer
Burton-on-Trent -	27 Hy Daniel - -	24	1 April 1868 -	Brewer (Salt & Co.)
Maidstone - - -	28 F Fremhn - -	18	1 April 1868 -	Brewer
Dudley - - - -	29 Ed Terry - -	22	1 Oct. 1867 -	Mining Engineer.
Ornel, Oxford - -	30 H S. Stephenson -	23	1 April 1868 -	Church.
Stonehurst College -	31. G E L Shadwell -	25	1 April 1868 -	Law
Glasgow - - - -	32 Rev Mr. Williams -	(?)	1 April -	Church (Cath)
London - - - -	33 — Cochrane - -	20	1 Feb. 1868 -	— (?)
London - - - -	34. — Osborne - -	20	1 April 1868 -	Medicine
London - - - -	35. — Duffield - -	45(?)	1 June 1868 -	— (?)
Burton-on-Trent -	36 Horace Brown - -	20	1 June 1868 -	Brewer.

DESTINATION OF STUDENTS.

Chemical Manufactures	- - - - -	9
Brewing	- - - - -	6
Undetermined	- - - - -	7
Mining	- - - - -	4
Professional Chemistry	- - - - -	3
Engineering	- - - - -	1
Science Teaching	- - - - -	1
Sugar Refining	- - - - -	1
Church	- - - - -	2
Law	- - - - -	1
Medicine	- - - - -	1

Appendix, No. 19.

App. No. 19.

PAPER handed in by Mr. Buckmaster, 3 July 1868.

MEMORIAL.

To the Right Honourable Earl Granville, K.G., the President of the Council on Education, and the Right Honourable W. F. Cowper, M.P., the Vice-President of the Council on Education, the Memorial of Working Men belonging to the Royal Polytechnic, the London Mechanics, and other Institutions in London,

Humbly Showeth,

THAT during the years 1828, 1829, and 1830, 400 mechanics' institutions were established, and since the latter period they have increased to nearly 4,000. The primary object contemplated by these institutions was to secure to the operative classes the means of acquiring a sound and useful education, which should not only remedy in some degree the neglect of early instruction, but also improve their general culture and extend their knowledge in that direction which would make them more skilful and more successful in their industrial occupations.

That for some years these institutions laboured to accomplish the objects for which they were established, but from the want of some systematic starting point and a definite object to attain, they have gradually degenerated into places of mere amusement and recreation, and the lectures are usually of such a general and desultory character that they can scarcely be regarded of any educational value.

Your memorialists do not contemplate any interference with the rational amusements of the people, nor any great change in the general character of existing institutions. There will always be a large class of persons satisfied with the reading of a newspaper, a popular lecture, or a game of chess, and were these not provided by the institutions they would probably be sought for at the public-house.

Your memorialists are of opinion that a large number of young men, apprentices and others, would gladly avail themselves of systematic instruction if it were imparted by competent teachers on terms within their means.

That mechanics' institutions are the best centres for this instruction, regard being had to the industrial wants of the locality in which these classes may be established.

Your memorialists would respectfully suggest that the elements of the natural sciences, political economy, physics, chemistry, and drawing, should be taught, in our elementary schools. From the want of such instruction men fall into serious social errors, and labour, instead of being an enlightened and intelligent application of principles, is but too often a dull round of monotonous drudgery. A closer relationship should be encouraged between the elementary schools and mechanics' institutes, so that the instruction

given at the one should always be regarded as preparatory to that to be continued at the other.

We are of opinion that the industrial progress of the Continent and America must, in a great degree, be attributed to the better education of the artisans of those countries. Without an intelligent appreciation of those laws upon which our industrial prosperity depends, and which we are daily called upon to apply, it is impossible to sustain for any great length of time that supremacy in production which is every day becoming more mental and less physical.

Your memorialists are of opinion that voluntary effort is not sufficient to sustain with efficiency the class instruction of mechanics' institutions, nor can the working classes as a general rule pay fees sufficient to secure the services of competent teachers; and to be dependent on charitable aid for that which ought in some degree to be regarded as our right, is a humiliation to which the industrial classes ought not to be subjected.

Your memorialists therefore pray that the Government Board of Education be invested with power to organise, systematise, and direct, in connection with local authority, those institutions desirous of obtaining assistance.

That in consideration of this power the Board of Education be authorised to assist classes in connection with mechanics' institutes, with grants of books, apparatus, and such pecuniary aid as may be essential to their efficiency and permanency. It is desirable that such aid should not interfere with the free action of the classes beyond what is absolutely necessary to secure the correct expenditure of the public money.

With a view of giving encouragement to class instruction in mechanics' institutions, exhibitions or scholarships should be attached to the Government School of Mines, as a reward to those who had distinguished themselves by examination. Artizans employed on our public works might be selected, other things being equal, from those holding a certificate in some speciality relating to their occupation.

And your memorialists, as in duty bound, will ever pray.

Appendix, No. 20

LETTER handed in by Mr. Powell, M.P.

App. No. 20.

My dear Powell,

Cambridge, 11 July 1868

YOU ask me what this University is doing in the way of promoting scientific education; a great advance has been made in the last few years, but it still falls far short of what I wish, and of what I think ought to be done, the University has strained its resources to supply museums of natural science, chemical laboratories, and so on, and the facilities now given here for the study of natural sciences are at least very tolerable, they may be studied practically as well as theoretically. The appliances for this purpose might be made much more complete if the colleges would aid the University, but at present, as you know, while the colleges have ample means, the University is poor, and there is too much collegiate, too little public, spirit for the colleges to combine for common objects and sacrifice their collegiate interests to those of the University; however, the appliances for learning are a small part of the question, they are useless unless there be good teachers and students willing to learn. The number of students in natural science is gradually increasing, the University recognises such studies as a pathway to a degree or to honours, and the colleges have in several instances held out the offer of rewards in the way of scholarships, and so on, for proficiency in such studies. This is the case at Trinity, St John's, Caius, Peterhouse, Sidney, and Downing, and will probably extend to the others. But after all that may be done in this way, I do not think this alone will meet the real want of the country in respect of scientific education. It will do something in the way of supplying teachers in schools and elsewhere and in diffusing sound scientific principles in place of some of the quackery which is now current, but will be a very long while in reaching the lower stratum of those connected with manufactures. We want a different class of students here besides those who now come, it is not likely, or desirable, that the actual artizan class should assemble here in numbers, but the master manufacturers might well be educated here. At present the traditions and habits of the place are such, that few who are engaged in trade think of sending here those sons whom they intend for like pursuits. I want to see these traditions broken through, and many of that class coming here, and I regret very much that our Senate have rejected the proposal for non-collegiate students, because it might have opened a door for a new class of students. I think also that the University might do something to assist the class I have been writing of, if they would open their examinations in science to students who had resided a less time than is now required for a B.A. degree, so that those who came with a view to a speciality, might obtain what they wanted in the most direct way. I lay stress on some residence here, and study here, because I do not think that anywhere else science is so philosophically treated. I should be the last to say that philosophy without practice was the needful thing, but neither is practice without principles, indeed I believe that the need now felt is for instruction in the principles of science. Practice is learnt empirically, but the principles, the laws of nature and their relations to each other, are not taught in the workshop or laboratory, and are not understood. This need is disguised when people talk of "technical education": it is not education in *technicalities* which is wanted, this is learnt during apprenticeship, but education in the principles which are practically applied, but not understood, and, therefore, not made the most of.

The question of expense in relation to education here is only a bugbear, it depends entirely on the student himself. Any one who likes to attend my lectures on chemistry can do so on payment of a small fee, without being a member of the University at all. I usually have some such students, and the laboratory is open to them as well as lectures, so that they can learn practical as well as theoretic chemistry, at, I believe, a less expense than anywhere else. The most promising students, those who may with advantage make study and the advancement of science the business of their lives, are sufficiently provided for by the college endowments; others must treat scientific education as they do other parts of education—be willing to pay a little for it for the sake of future advantage to be gained from it.

There is one great advantage to be met with here, and that is that different branches of science are taught side by side; their bearings one on another can, therefore, be more easily apprehended; and the prevalence of mathematical study has no inconsiderable influence in promoting exactness and logical consistency in the treatment of scientific questions.

As to bringing here the class of students that I wish to see here, I do not know what more can well be done than to open the door as wide as possible; if this cannot be done from within, you may help us to do it from without.

I am, &c.
(signed) G. D. Living.

Appendix, No. 21.

App. No. 21.

LETTER from Dr. Barry to the Chairman of the Committee.

SIR,

Cheltenham College,
14 July 1868.

I GREATLY regret that unexpected circumstances, increasing the usual occupations of this period of our school year, have hitherto prevented me from furnishing that statement which you did me the honour to request.

You are doubtless aware that Cheltenham College has attempted (to an extent hitherto unknown in our "Public Schools") a scheme of instruction in which the teaching of languages, though not neglected, holds a secondary place, and mathematics and experimental science assume the leading positions; the former determining a boy's place in the school, and the latter forming a regular system of instruction for the first eight or ten classes, including about 120 boys.

I beg to subjoin a table, containing a list of the upper classes of this department, with (1) the average ages, and the highest and lowest ages of the boys in each class during the last half year, (2) the subjects in experimental and physical science studied in each; and (3) the mathematical subjects for each class presented for examination in June last. I also beg to send herewith a school list, which may possibly supply some information, which I have accidentally omitted. All these mathematical subjects, I should remark, are studied on what I may call the "Woolwich" as distinguished from the "Cambridge" system, *i. e.* with constant reference to practice, and with great care to promote practical accuracy and facility.

Throughout the whole of this department geometrical and free-hand drawing form a regular part of the work, and in the highest classes plain drawing is brought to a considerable degree of excellence.

It will, therefore, not surprise the Committee, when I add that, except for the actual manual training required, we do not purpose, in our competition for the Whitworth scholarships, to depart in any important point from the regular course of our instruction for the candidates whom the College will send in*.

The boys of the first (or highest) class usually leave at the age of 18, but I have subjoined the average of age (somewhat roughly, but I think accurately estimated) of the various classes, in order that the Committee may judge of the degree of knowledge which a boy should carry with him, if he leaves at an earlier age. Those who do so leave, are usually boys intended for commercial life, whose parents care little for the scientific training, or boys who are exceptionally backward, and who, if intended for scientific professions, require to be brought on by some special and individual tuition.

In this part of our school, modern languages (French and German) are studied throughout; English has always been "classically" studied in the highest classes, and we have just introduced a

regular system of such study through the school; and the rudiments of Latin are taught in the lower classes, and (exceptionally) to certain boys in the higher (generally in lieu of German) who show special aptitude for it, or have special need of it. Our experience here is, that as a rule the success attained in these linguistic studies is considerably less than that which is reached on the classical side of the school, although in the latter the boys devote far less time to the systematic study, either of English or of modern languages. But, if we can only get teachers of French and German, who are competent to teach them, as Latin and Greek are taught by our classical masters, I am sure that we may obtain far greater linguistic results than have been obtained hitherto in our Military and Civil Department. I may remark that, in order to do this, I think we must endeavour to have both Englishmen and foreigners in our modern language staff; the former, if well versed in the language they teach, have incomparable advantage in the systematic and grammatical training, while we look to the latter for skill and vigour in composition, and extensive acquaintance with foreign literature.

It is (I conceive) no part of my duty to institute a comparison between the results of the classical and the "modern" teaching, although the fact, that our two departments are co-ordinate in numbers (about 300 in each) and in age, gives the opportunity of some very interesting comparisons and contrasts.

But it may be to the purpose to remark, that there is no difference whatever in the classes from which the boys of our two divisions are drawn, and that, except in friendly rivalry, there is no division whatever between them.

The Committee may be aware that in Cheltenham College, there is a power vested in the council to accept or refuse any boy nominated, of the working of this rule I have had (for the last six years) little or no experience, but the practical effect has been to exclude the sons of retail tradesmen from the school and to confine it chiefly to the sons of professional men, or those of independent fortune. This rule (of which, personally, I entirely disapprove) may possibly affect the result above noted, but I am inclined to think that it does not affect it materially, for the range of boys, as to class, is still sufficiently extensive to give scope for any variation in respect of class between the two systems, if any variation existed.

The college is also expressly a Church school; *i. e.*, its boys are instructed in the doctrines of the Church of England, and, if boarders, regularly attend its services on Sundays. But we have a considerable number of Dissenters in the school, and also of members of the Church of Scotland; in fact, I believe, of all denominations except Roman Catholics; we ask no questions upon the subject, and I should not now refuse any "conscience clause," if it were asked for by any parent.

* It is my intention to recommend to the Council the establishment of a "Workshop," where boys might be taught the use of carpenters' tools, lathes, and easy iron work. I have long wished for such a shop for its educational influence on the mind, and should like to make all young boys enter it; but the Whitworth competition will naturally give it a more visible and immediate value.

parent. But, again, I do not find that any variation in religious matters affects the destination of a boy to one or other of the departments. I infer that, if all restrictions were removed, the result on this subject would remain unchanged.

I may also add that I find no material difficulty in working the two departments (the classical and military and civil departments) together, on the contrary, I think that their co-existence is most useful. Not only does it enable us to divide boys, after they emerge from the lower or junior school according as their minds or their destinations demand a culture, predominantly "literary" or "scientific"; but the effect is (I think) that the studies of the two departments interpenetrate each other. There is certainly more time given to mathematics and modern languages by the boys of the classical department than in almost any other public school; and the boys of the military and civil department have greater value for and progress in literary culture than would be the case if their connexion with the other part of the school were severed.

I come, therefore, to the conclusion, that there should be no difficulty (although the Public School Commissioners appear to hold the contrary opinion) in affiliating to our ordinary public schools a scientific department, in order to prepare for the schools of technical education, which are the main subjects of the Committee's investigation.

I prefer to look at the question with a view to a liberal education, as such, rather than a technical one, considering (that is) the development of the mind rather than the training for any special profession; and, as it appears that no man is thoroughly educated who has not studied language, mathematical reasoning, inductive science, and some form of (fine) art, as it is clear that these great subjects cannot be all studied to exactly the same extent, without an inevitable danger of smat-

tering and superficiality, as it is equally clear that for different minds different subjects must predominate, especially if the consideration of ultimate destination in life here comes in; I think that, even in the interests of a liberal education, such "bifurcations" are valuable, and I prefer them on the whole to the separate establishment of purely classical and purely scientific schools.

Our own military department, contains about 300 boys, each paying for tuition about 20 £. or 25 £. per year. The salaries of masters (one class master to about 30 boys, besides the superintending masters, and the masters in special subjects) amount to about 4,500 £. per year. Our whole staff numbers 18, and the salaries are not higher than they should be, in fact some are lower than I could desire, for a school of this class. It would be easy to reduce the scale of expense, either by lowering the class of master, or by decreasing their number in comparison with the number of boys, but either of these plans would impair efficiency, and I do not see any other which could greatly diminish cost.

I do not know whether I need trouble the Committee with any further remarks, I have thought it right to confine myself to that aspect of the subject which regards liberal education, and especially the class of boys who go to our "Public Schools," because on this aspect alone have I any knowledge which gives me a claim to speak.

But I beg to add that I shall be most glad to answer any definite questions, or to supply any other information, which may be useful to the Committee in their important investigation.

I have, &c
(signed) *Alfred Barry, D.D.*,
Principal of Cheltenham College,
late Fellow of Trinity College, Cambridge.

B. Samuelson, Esq., M.P.

TABLE referred to on preceding page.

	Age of Boys.	Experimental Science Subjects.	Mathematical Subjects.
CLASS I. - - - - (About 16 boys.)	Average, 17. Highest, 18. Lowest, 16.	Geology. Chemistry. Heat. Magnetism. Galvanism. Electricity.	Euclid Arithmetica. Algebra Trigonometry. Elementary Statistics Dynamics. Differential and Integral Calculus
CLASS II. - - - - (About 21 boys.)	Average, 16½. Highest, 19. Lowest, 14.	Electricity. Heat.	Euclid. Arithmetica. Algebra. Trigonometry. Mensuration. Theory of Equations.
CLASS III. (A. & B.) - - (About 30 boys.)	Average, 16. Highest, 18. Lowest, 14.	Voltic Electricity. Geology. Technology.	Euclid. Arithmetic. Algebra. Plain Trigonometry. Mensuration
CLASS III. (C. & D) - - (About 30 boys.)	Average, 16. Highest, 18. Lowest, 13½.	Electricity. Pneumatics.	Euclid, I IV. VI. Arithmetica. Algebra.
Sandhuist and "Direct" Classes* (About 26 boys.)	Average, 17. Highest, 19. Lowest, 14.	Electricity.	Various, according to the necessities of the case.

* These classes are not included in the regular graduation of school-work, but contain boys who need special tuition, and who work more individually than in other classes.

Note.—It will be observed that subjects are often repeated in various classes, from the necessity of revision.

App. No. 21-

LETTER from Mr. *Thomas Bloxam*, Science Master of Cheltenham College, to Dr. *Barry*.

Dear Dr. Barry,

THE following is a brief outline of the method of study which I have found, from now some seven years' experience, to succeed the best in the Science Department of Cheltenham College

We commence in the lowest division, 3 D, with the introductory matter of science, such as the general properties of matter, the difference between studying a body chemically and physically. Then we proceed to elementary pneumatics, which includes a chemical consideration of the air.

We next pass in 3 C division to an elementary consideration of statical electricity; in 3 B, the subject of geology, and its bearings upon other branches of knowledge is considered. In 3 A division, voltaic electricity forms the subject.

We now pass to 2 B, in which the subject of heat is minutely treated, and in 2 A, frictional and voltaic electricity similarly considered.

In 1 B, our attention is devoted to the study of the non-metallic elements and their chief compounds. 1 A, practical chemistry, where each pupil is taught to detect the more common metals and acids, working for himself at 1st practical table, a written paper (of two hours) upon various parts of chemistry, chemical physics, has to be answered by each pupil of this division every

week; these answers are corrected in red ink, and the whole made matter of discussion once in each week, when the papers are returned, so that every pupil has his errors pointed out to him.

From the above sketch it will be seen that our aim is to impart the elementary consideration of the various branches of science from div. 3 C to 3 A; in 2 A and B, to give the advanced work of chemical physics, and in 1 A and B, to complete the course of study in chemistry.

A pupil having passed through these various divisions will be in a fit state to go up to the several competitive examinations.

We have found a short course of elementary technology of great use; such as manufacture of paper, iron, &c., illustrated by specimens and experiments, where possible. In conclusion, all lectures are experimental; *visa voce* examinations are held upon the subject of the previous lecture always; notes carefully taken, and all pupils invited to attend after hours, should they wish any special explanation.

I shall be happy to furnish any information not contained in the above.

I am, &c.
(signed) *Thomas Bloxam.*

Appendix, No. 22.

PAPER handed in by Mr. Field.

LIST of some ARTICLES made in¹ Birmingham and the Hardware District which are largely Replaced in Common Markets of the World by the Productions of other Countries.

App N:

This List might be immensely extended by further investigation, which the shortness of time has not permitted

Articles, or Class of Articles.	Country whose Products are believed to have Replaced those of this District, in whole or in part.
Carpenters' Tools :	
As Hammers - - - - -	} Germany chiefly.
Pliers - - - - -	
Files - - - - -	
Compasses - - - - -	
Hand and bench vices - - - - -	
Chains :	
Of light description, where the cost is more in labour than in material - - - - -	} Germany.
As halter chains and bow ties, and such like - - - - -	
Frying-pans, of fine finish. + + + - -	France.
Wood-handled spades and shovels, an article of very large consumption - - - - -	} United States export them to all our colonies.
Hoes :	
For cotton and other purposes, an article of large consumption - - - - -	} United States compete with us for their own use, and to some extent for export.
Axes :	
For felling trees, &c., an article of large consumption - - - - -	} United States supply our colonies and the world with the best article
Carpenters' broad axes - - - - -	} Germany and the United States.
Carpenters' and coopers' adzes - - - - -	
Coopers' tools, various sorts - - - - -	
Shoemakers' hammers and tools - - - - -	
Matchets .	
For cutting sugar canes, an important article - - - - -	} Believed to be now Germany.
Nails :	
Cut - - - - -	} United States export to South America and our colonies.
Wrought - - - - -	} Belgium
Point de Paris (wire nails) - - - - -	} French and Belgian largely supersede English
Horse nails - - - - -	} Beautifully made by machinery in the United States.
Pumps .	
Of various sorts - - - - -	} Largely exported by United States. [Note.—An American pump, finding water for the Abyssinian expedition.]
Agricultural Implements :	
Ploughs, cotton gins, cultivators, kibbling machines, corn crushers, churns, rice hullers, mowing-machines, hay rakes - - - - -	} Many articles similar to these are exported by United States to common markets.

App. No 22.

Articles, or Class of Articles.	Country whose Products are believed to have Replaced those of this District, in whole or in part.
Sewing machines - - - - -	United States.
Lamps:	
For use with petroleum, now an article of very large consumption - - - - -	The United States Petroleum lamps supplant the English in India and China.
Lamps for the table - - - - -	French even imported to England.
Tin Ware.	
Tin'd spoons, cooks' ladles, and various culinary articles, of fine manufacture and finish - - - - -	France.
Locks:	
Door locks, chest locks - - - - -	United States, France, and Germany.
Draw locks, cupboard locks - - - - - in great variety.	
Door latches, in great variety - - - - -	United States export to Canada.
Curry combs - - - - -	United States and France.
Traps:	
Rat, beaver, and fox - - - - -	United States export to Canada.
Gimlets and augurs (twisted). - - - - -	United States export to Canada, and probably elsewhere.
Brassfoundry (cast):	
As hinges, brass hooks, and castors (in great variety) - - - - -	These articles, in great variety, are now extensively exported from France and Germany.
Door buttons - - - - -	
Sash fasteners, and a great variety of other articles - - - - -	
Brassfoundry (stamped)	
As curtain pins, and bands, cornices, gilt heading, and a great variety of other brassfoundry - - - - -	These articles, in great variety, are now extensively exported from Germany and France.
Needles:	
An article of large consumption - - - - -	Mostly Germany (Rhenish Prussia), even imported to England.
Fish hooks - - - - -	Believed Germany.
Guns.	
A great variety of sporting guns, articles of large consumption, formerly entirely from Birmingham. - - - - -	Now exported largely from Liege, Belgium, and Etienne, France.
Breechloading muskets and revolver pistols	United States.
Watches and clocks - - - - -	Switzerland and France import into England, United States, and France. Note.—Watches made in United States unchangeable, by machinery.
Iron - - - - -	Belgium.
Glass:	
For windows, an article of large consumption, spectacles and all other glass - - - - -	Belgium supplants ours in our own colonies.
Table glass - - - - -	Believed to be Belgium and France.
Swords - - - - -	Prussia and Belgium.
Jewellery:	
Gold, gilt, and fancy steel, in very great variety - - - - -	France and Germany. These articles are even imported into England.
Small Steel Trinkets:	
As bag and purse clasps - - - - -	
Steel buttons, chains, key rings, and other fastenings, and many others in great variety - - - - -	France and Germany. Many of these even imported into England.

Articles, or Class of Articles.	Country whose Products are believed to have Replaced those of this District, in whole or in part.
Leather bags, with clasps, purses, and courier bags, &c	Austria, France, and Russia We believe about all these articles sold in England are imported.
Buttons .	
Mother o' Pearl	Vienna, imported to England
Horn	France
Porcelain (formerly Minton's, of Stoke)	France entirely superseded English, and imported to England largely.
Steel buttons (formerly Bolton & Watts)	France.
Florentine or lasting boat buttons	Germany.
Steel pens	
Penholders	} France.
Brass scales and weights	
Cutlery	
In great variety; scissors, light edge tools, such as chisels, &c	} Germany.
Pins for piano strings and other small fittings for pianos	
Silver wire for binding the bars, strings of pianos, &c.	} France.
Iron gas tubing	Germany.
Elastic belts, with metal fastenings	Germany
Brass chandeliers and gas fittings	
Harness buckles, and furniture	} France and Prussia.
German silver spoons, forks, &c	France, Austria, and Prussia.
Locks; best trunk, door, and cabinet locks	Prussia and France.
Umbrella furniture	France and Prussia.
Horn combs	Prussia.
Pearl and tortoiseshell articles	France and Austria.
Iron wire	Prussia and Belgium.
Iron and brass hooks and eyes	Prussia and France.
Bronzed articles	Prussia and France.
Hollowares, enamelled	France and Prussia.
Optical instruments	
Mathematical instruments	} France, Austria, and Bavaria.
Japanned wares	Germany and France.
Bits and stirrups	Belgium and France.
Coach springs and axletrees	France.
Electro-plated wares (customers preferring French goods)	} France.
Gas fittings	United States.
Weighing machines	" "
Plumbers' brass foundry	" "
Table glass ware	" "
Door locks	" "
Machines for domestic purposes, as sausage machines, coffee mills, and washing machines	} " "
Nuts and bolts	" "
Penknives and scissors	" "
Stamped brass ware (certain kinds)	" "
American "Notions," as buckets, clothes pegs, washing, and agricultural machines	} " "

I N D E X

TO THE

R E P O R T

FROM THE

SELECT COMMITTEE.

ON

SCIENTIFIC INSTRUCTION.

Ordered, by The House of Commons, to be Printed,
15 July 1868.

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Cochrane, William. (Analysis of his Evidence)—Is a partner in the firm of Cochrane & Co, owners of collieries and iron works, represents the Northern Institute of Mining Engineers, 7128-7131—Want of facilities for a scientific education of foremen, managers, &c. of collieries, it being necessary to bring such education home to the collieries by means of travelling teachers, 7132-7134. 7153-7160—Steps taken for the promotion of primary education in the colliery districts in Staffordshire and the north of England, so that the children of those engaged in mines are generally sufficiently advanced for receiving scientific instruction, 7135-7152.

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Satisfactory instruction now given in elementary science at a considerable number of schools, owing to the matriculation examination of the University, *Carpenter* 2038, 2039. 2100, 2101. 2158-2160—Instances of sons of artisans coming up for matriculation, *ib.* 2092-2094—Total of about 500 matriculated students yearly, the minimum age being sixteen, and the average age about eighteen, *ib.* 2096-2098.

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Statement showing the special need of the Manchester district for a high-class of scientific culture, *Roscoe* 5509-5515—Frequent employment hitherto of Germans in alkali and other works in the district on account of their scientific attainments; increasing supply of Englishmen from Owens' College for these works, *ib.* 5511-5525—Appointment of one of witness's students as science master at Manchester Grammar School, where science is being carried on upon an extensive scale, *ib.* 5534-5536—Slight prospect of municipal aid being forthcoming for Owens' College and similar institutions, *ib.* 5732-5736.

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educated, *Chance* 6674-6688 6702-6707—Advantages of large capitalists and manufacturers having a university education, *ib.* 6674-6676—Great want of scientific education of manufacturers as well as of foremen and managers, *Lloyd* 6821.

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Mathematics. Approval of a certain amount of mathematical culture as an essential element in any system of education, *Tyndall* 2214, 2215—Undue amount of mathematical knowledge required by the examination papers, of Mr. Cowie; improvement through the appointment of Mr. Anderson in lieu of Mr. Cowie, *Coomber* 3904-3920

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MECHANICAL ENGINEERING.

1. *Generally.*
2. *Whitworth Scholarships and Exhibitions.*

1 *Generally:*

Very limited means at present for obtaining theoretical knowledge in mechanical engineering, *Whitworth* 1625-1628—Outline of the instruction desirable to be given in connection with mechanical engineering in such places as Owens' College, Manchester, *ib.* 1637-1648—Conclusion as to Manchester being the best place for a college of mechanical engineering, *ib.* 1649, 1650.

Advantage derived by witness, when a pupil at Mr. Fairbairn's, from the scientific education which he had previously received, very unprepared state generally of the pupils at Mr. Fairbairn's and at Messrs. Penn's, in mechanical engineering, *Jenkins* 2254-2271.

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1. Generally—continued.

2522-2524—Very little information imparted by masters or foremen to the pupils or apprentices in the workshops, *Jenkin* 2271-2276. 2454-2456 2490-2494. 2500-2502—Reception of twenty-five pupils, who pay premiums at Messrs. Easton's factory, there being about 800 workmen, *ib.* 2277-2279—Better technical education of artisan apprentices in engineers' workshops, than of pupils who pay premiums, *ib.* 2516-2520—Instances of very eminent engineers who possessed no scientific knowledge, *ib.* 2527-2531—Obstacles to engineering pupils receiving professorial instruction in the works, *ib.* 2599, 2600.

Illustrations, in the case of mechanics, of the importance of an amended system of science teaching, *Moseley* 3737, 3738—Statement showing the expediency of teaching what is termed the theory of work, as specially required to be understood by mechanical engineers, *ib.* 3739-3744—Suggestions as to the course of instruction desirable for engineers and machinists, *Platt* 5816-5820—Advantage of a knowledge of chemistry in engineers, *ib.* 5823-5825.

List of schools having day classes in science, and showing the number of students in theoretical mechanics and in applied mechanics, *App.* 436-438.

2 Whitworth Scholarships and Exhibitions :

Apprehension lest the scholarships about to be established by Mr. Whitworth in mechanical science will be gained almost entirely by the artisan classes, to the exclusion of theoretical men, *Cole* 387-491.

Explanation that the provision of better foremen and managers in the works of mechanical engineers, is the main object of the endowments proposed to be founded by witness, *Whitworth* 1622—Intention to secure by the endowments the combination of scientific knowledge with practical skill, *ib.* 1622-1624. 1656—Details in explanation of the arrangements proposed by witness for the practical working of his scheme of endowment in the shape of scholarships and exhibitions for mechanical science, *ib.* 1657 *et seq.* 1800-1805—Arrangement as to the examinations for the scholarships being undertaken by the Committee of Council on Education, *ib.* 1666-1671. 1800-1805—Suggestion with a view to honorary degrees being conferred on those who succeed in obtaining scholarships, *ib.* 1666-1668.

Explanation of the action to be taken by the Education Department, in connection with Mr. Whitworth's scholarships and exhibitions, and with the examination of the students, *Cole* 1680-1691.

Probability of the scholarships being gained chiefly by artisans who qualify themselves for the theoretical examination, *Whitworth* 1692. 1694—Prospect of some of the scholarships being gained by young men taken by mechanical engineers as pupils or apprentices, *ib.* 1692, 1693 1733-1743.

Prospect of students in the workshop at King's College competing successfully for the Whitworth scholarships, *Cunningham* 3336-3338—Importance attached to the Whitworth scholarships, *Platt* 5845

Communication from Mr. Whitworth to the Secretary of the Science and Art Department, dated 4th May 1868, together with a memorandum containing sundry explanations and suggestions relative to his scholarships for mechanical science, *App.* 433-435.

See also *Civil and Mechanical Engineers. France.*

Mechanics' Institutes. Great convenience of mechanics' institutes in connection with the holding of evening classes, *Dannelly* 521-527—Facility given to mechanics' institutes to hold classes in mechanical drawing in connection with the South Kensington Department, *Cole* 850, 851.

Entire inadequacy of instruction in connection with mechanics' institutes, as compared with the scientific instruction abroad, *Mundella* 4635. 4785—Belief that mechanics' institutions could be easily adapted for the teaching of the body of the working classes in elementary science, *Sales* 5052—Grounds for objecting, in the case of mechanics' institutions, to the restriction with regard to payment on results in night classes, where there are no day schools, *ib.* 5060-5063. 5088-5091.

Prominent part taken by witness in introducing consecutive science teaching into the mechanics' institutes in Lancashire and Cheshire, *Watts* 5106-5112—Details relative to the system of scientific instruction in these institutions, the examinations in connection with the Society of Arts, and the Science and Art Department, and the beneficial results produced, *ib.* 5108 *et seq.* 5202-5208. 5238-5243. 5252-5257—Successful operation of science classes in connection with mechanics' institutes in Manchester, &c., *Rumney* 6032. 6054. 6055. 6085-6087.

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Mechanics' Institutes—continued.

Existence of mechanics' institutes in several towns in Scotland, by means of which an impetus is given to the study of science, *Macadam* 7493—Machinery afforded by mechanics' institutes in connection with a systematic teaching of science, *ib.* 7493-7496—Suggestions as to the mode of scientific instruction desirable in connection with mechanics' institutes, *ib.* 7616-7620.

See also *Lancashire and Cheshire*. *Manchester*.

Medical Students. Statement as to the inferior state of education of students who present themselves for medical examinations, expediency of the medical council raising their standard of requirements, *Carpenter* 2051-2065—Character of the theoretical studies desirable for medical students previously to the study of the art itself, *Huxley* 7989-7992.

Merthyr Tydvil. Prospect of success of a mining school, if established at Merthyr Tydvil, *Coomer* 3885, 3886.

Metallurgy. The instruction in metallurgy at Jermyn-street is given in connection with the general course of the school, *Percy* 1415—There are also several students who come to witness for instruction, without attending the general course, *ib.* 1415-1419—Fees are payable by the students in respect of the laboratory instruction, irrespectively of its being a portion of the regular course, *ib.* 1420-1424—Details explanatory of the instruction given by witness, practical knowledge conveyed in addition to the principles of the science, *ib.* 1424-1438.

Particulars relative to the number and class of students who attend witness's lectures, or are instructed in the laboratory, improbability of any large number of students in metallurgy, *Percy* 1448-1459 1520-1525 154E-1558. 1552-1558—Degree of scientific knowledge possessed by the students when they first attend, the instruction given enabling many of them to obtain situations as assayers, &c, in manufactories, *ib.* 1450-1464 1526, 1527—Great advantage if there were a school like that in Jermyn-street, in Birmingham and other metallurgical districts, for the scientific instruction of foremen and managers, *ib.* 1468-1477. 1518, 1519. 1555-1558. 1591-1600.

Very useful operation of the science classes in connection with the Science and Art Department, as regards instruction in metallurgy, *Percy* 1478-1494 1564-1569 1604-1609—Expediency of teaching not only the principles of the science of metallurgy, but its application to the smelting of metals, *ib.* 1530-1536—Doubt as to many Englishmen now going abroad to study mining or metallurgy, *ib.* 1570-1574—Satisfactory progress being made generally in the knowledge of metallurgy within witness's experience, *ib.* 1602-1609. 1611-1616—Improvement in the operations of mining and metallurgy in this country, *Hunt* 1822-1825 1827.

See also *Iron Manufacture*.

Metropolitan College of Science See *Central College of Science*

Middle and Upper Classes. Explanation as to its being the policy of the Science and Art Department, to aid the education of the artisan class mainly, though inducements are also held out to the middle and upper classes to attend the schools and to pay school fees, *Cole* 4-8 266-271. 277-299—Statement of the aid given by Government to science instruction at the universities of London, Aberdeen, Glasgow, &c, such instruction having reference mainly to the middle and upper classes, *ib.* 258-268. 290, 291.

Grounds for concluding that the middle and upper classes should pay fees for their instruction in science schools and colleges; advantage in such cases of their having facilities for instruction, *Donnelly* 441-451 460. 467-471 496-503 538 570—Approval of the middle classes being allowed to compete for scholarships in science, *ib.* 461-463—Doubt as to any better teaching of the artisan class in science, if the middle classes were excluded from such teaching, *ib.* 496. 503. 538

Special want of science instruction in the case of the middle and wealthier classes, *Cole* 907—Doubt as to an extended system of schools of science being taken advantage of by the middle classes almost exclusively, and not by the artisan class as well, *ib.* 961-971

Limitations subject to which witness approves of Government aid towards the scientific instruction of the middle classes, *Playfair* 1123-1125. 1134-1137 1167-1171—Advantage of encouraging scientific instruction in schools for the middle and upper classes by means of exhibitions, scholarships, fellowships, and endowments, *Moseley* 3751, 3752—Indirect educational aid received by the upper classes from the State, through existing endowments under its control, *ib.* 3789. 3792, 3793.

Argument as to the expediency of the State contributing towards the scientific instruction not only of the artisan class, but of the middle class, on account of the benefits thereby to the national industries and to the country at large, *Watts* 5215-5237. 5258, 5259—Advantage if science were comprised in the teaching at many intermediate schools, 432-1.

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schools, and at such colleges as those at Framlingham, Crawley, Dulwich, &c., *Buchmaster* 8274, 8275.

Statement of Parliamentary votes for science for the middle and upper classes in 1867-68, exclusive of the cost of the Queen's Colleges, Ireland, *App.* 462.

See also *Owens' College. Payment on Results. Secondary Schools.*

Middlesborough Chamber of Commerce Witness submits a memorandum received from the Middlesborough Chamber of Commerce as to the importance of Government aid in the formation of a school of science in the Cleveland iron district, *Sir C. Lanyon* 6936, 6937.

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MINING SCHOOLS AND COLLEGES.

1. *State of Education of Working Miners; Suggestions on the Subject.*
2. *Suggestions relative to the Scientific Education of Foremen and Managers.*
3. *Question of Establishing Local Mining Colleges*
4. *Question of Local Mining Schools like the School in Cornwall.*

1. *State of Education of Working Miners, Suggestion on the Subject.*

Increasing desire amongst working miners for scientific instruction, owners, and managers, however, not generally attaching advantage to such instruction in the men, and being frequently prejudiced against it, *Hunt* 1818, 1826 1867, 1882, 1883 1892. 1922. 1925 — Diminished number of colliery accidents if the men were better educated, *ib.* 1873 — Difficulty of any scientific instruction of miners through the want of primary education, advantage on this score of applying the half-time system to mines, *ib.* 1878-1881. 1907. 1909, 1910. 1937-1994 1995-2000 — Want of facilities for the circulation and interchange of information amongst miners in different districts, *ib.* 1927-1932 — Circulation and receipt of mining statistics through means of witness's office, *ib.* 1933-1936.

Suggestions for improving primary education in the mining districts, and for combining with it some elementary knowledge of science, as preparatory to increased scientific instruction after the age of fourteen, *Hunt* 1937-1949 — Proposed attendance at evening classes in science in the case of boys at work in the mines after the age of fourteen; course of instruction suggested, *ib.* 1946-1951.

Steps taken for the promotion of primary education in the colliery districts in Staffordshire and the North of England, so that the children of those engaged in mines are generally sufficiently advanced for receiving scientific instruction, *Cochrane* 7135-7153 — Necessity of science classes in the colliery districts around Newcastle being held in the evening; the same teachers could have day classes in the towns for the iron works *ib.* 7176-7179.

Establishment of several colliery schools by Earl Vane, fees being required from the children attending, and the average attendance being very good, *Daglish* 7302-7312. 7373-7378 — Necessity of itinerant teaching, in order to reach the mining population, *ib.* 7339. 7400 — Considerable difficulty in carrying out evening classes in connection with the day schools at Earl Vane's collieries, *ib.* 7391-7400

2. *Suggestions relative to the Scientific Education of Foremen and Managers :*

Approval of a certain amount of scientific knowledge being insisted upon in the case of those in charge of mining operations, *Roscoe* 5715-5719 — Want of facilities for a scientific education of foremen, managers, &c. of collieries, it being necessary to bring such education home to the collieries by means of travelling teachers, *Cochrane* 7132-7134 7153-7160.

Tendency to increased safety in the working of mines, if the foremen had scientific training, *Daglish* 7325. 7389, 7390 — Sufficiency of the primary education of those selected for foremen as a basis of scientific instruction, *ib.* 7326-7335. 7369-7371. 7379-7385 — Advantage of the managers of mines being educated in collegiate schools of science, *ib.* 7371, 7372 — Doubt as to the expediency of making it compulsory for overmen or foremen of mines to pass an examination, *ib.* 7403, 7404.

3. *Question of Establishing Local Mining Colleges :*

Opinion as to the sufficiency of one mining college in London, with several secondary mining schools in the provinces, *Cole* 894-896. 941, 942. 908-923. 992 — Conclusion as to the working of the Jermyn-street School of Mines being no encouragement to Government to found local mining colleges, *ib.* 908-923 — Opinion that there is not sufficient demand for another college or school of mines in the provinces, *Reeks* 1298-1300. 1308-1310.

Explanation

Report, 1868—continued.

MINING SCHOOLS AND COLLEGES—continued.

3. Question of Establishing Local Mining Colleges—continued.

Explanation of witness's views as to the scientific studies desirable in reference to mining in the case of young men attending the Jermyn-street Institution, or local schools or colleges of a similar kind, *Hunt* 1952 *et seq*—Difficulty as to local mining students attending the Jermyn-street course, convenience and increased attendance if there were colleges in Newcastle and other mining centres, *ib.* 1977-1981 1986-1991.

Representation as to the want of institutions similar to the Jermyn-street School of Mines in the chief mining districts, *Cochrane* 7197-7203. 7276-7293—Expectation that large fees would readily be paid by students at colleges established by Government in mining centres, *ib.* 7277-7286

4. Question of Local Mining Schools like the Schools in Cornwall.

Importance of mining schools similar to that in Cornwall were established in the several colliery districts, benefit thereby to employers as well as employed, *Hunt* 1846-1873—Expediency of Government aiding the localities in establishing and maintaining mining schools, *ib.* 1863-1867. 1886-1888. 1894-1903

With regards to the organisation in Cornwall for the instruction of the miners in science, witness was not aware of it till recently, and considers that some similar plan might be adopted in the North of England; difficulty as to the colliery owners subscribing, except in providing the accommodation required, *Cochrane*, 7174, 7175.

Expediency of the mining districts in the north being better informed as to the aid receivable through the Science and Art Department, it being important that the department should organise local science schools, and should maintain inspection over them, *Daglish* 7336-7351 7401, 7402.

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2. *Scholarships and Exhibitions*
3. *Funds required for an Extension of the College, local action in the matter*
4. *Character and Remuneration of the Professors.*
5. *Successful operation of the College*
6. *Connection of the College with London University.*
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1. Origin and Operation of the System of Payment of Teachers according to the Results produced

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