THE BRITISH ASSOCIATION.

SECTION L.

EDUCATIONAL SCIENCE.

OPENING ADDRESS BY SIR WILLIAM DE W. ABNEY, K.C.B., D.C.L., D.Sc., F.R.S., PRESIDENT OF THE SECTION.

THE Section over which I have the honour to preside deals with every branch of education. It is manifest that in an Address your President cannot deal with all of them, and it remained for me to choose one on which I might remark with advantage. As my official work during the last thirty-three years has been connected with education in science, I think I cannot do better than take as my subject the action that the State has taken in encouraging this form of education, and to show that through such action there has been a development of scientific instruction amongst the artisan population and in secondary day schools. The development may not indeed have been to the extent hoped for, but it yet remains that solid progress has been made.

I have chosen the subject deliberately, as I find that there are very few of those who have the interests of education strongly at heart, or who freely criticise those who have borne the burden of the past, that have any knowledge of the trials and difficulties (some of its own creating, but others forced on it by public opinion) which the State, as represented by the now defunct Science and Art Department, had to contend with in its unceasing missionary efforts in the cause of scientific instruction. I shall not attempt to do more than show that whatever its defect may have been in tact, whatever its shortcomings in method, that Department still deserved well of the country for the work that it did in regard to the fostering of scientific instruction in the country at large.

As far back as 1852 the Government of the day, influenced very largely by the Prince Consort, realised that it had an educational duty to perform to the industrial classes. Whether it was influenced by philanthropic motives or from the evidence before it that if Great Britain was to maintain its commercial and industrial supremacy scientific instruction was a necessity, it matters little. The fact remains that it determined that the industrial classes should have an opportunity of acquiring that particular kind of knowledge which would be of service to them as craftsmen. In this year 1852 the Speech from the Throne contained these words: "The advancement of Fine Arts and of Practical Science will be readily recognised by you as worthy of a great and enlightened nation. I have directed that a comprehensive scheme shall be laid before you, having in view the promotion of those objects towards which I invite your aid and co-operation."

It is somewhat remarkable that the then Ministry, of which Lord Derby was the chief and Mr. Disraeli the Chancellor of the Exchequer, did not survive to promulgate the scheme, which proposed theoretical rather than practical science, but that their successors, under Lord Aberdeen, issued it and commenced to carry it into effect. In 1853 the Department of Science and Art was established under the direction of Mr. Cole. Since 1835 so-called Schools of Design had been in being. These came under the new Department, and it was determined to establish science classes for instruction in science, Dr. Lyon Playfair, the well-known chemist, being charged with the duty. Playfair resigned in 1858, and in 1859 Mr. Cole induced a young Engineer officer, Lieut. Donnelly, to undertake the inspection and organisation of science instruction throughout the country. It was through this officer's untiring energy and zeal that the classes in science flourished and were added to at this early stage of the new Department's history. The same energy was displayed by Donnelly during the whole of his long career in the service of the State, and I feel that it was fortunate for myself to have served so many years as I did under one to whom the country at large owes a deep debt of gratitude.

Not long ago he passed away from us, and there will be no more lasting memorial to him than that which he himself erected during his lifetime in the fostering of that form of education which is of such vital importance to the national well-being.

To revert to history, I may record that the first science examinations conducted by the State took place in May, 1861, and, the system of grants being made on the results of examination having been authorised, the magnificent sum of 1300*l.* was spent on this occasion on the instruction of 650 candidates, that number having been examined. Thus early was the system of examination commenced in the Department's career, and the method of payments on the results of these examinations stereotyped for many years to come. There is reason to believe that the educational experts of that day considered that both were essential and of educational value, a value which has since been seriously discounted. Employers of labour in this country were not too quick in discerning the advantages that must ultimately ensue from this class of education if properly carried out and encouraged. Theoretically they gave encouragement, but practically very little, and this survives to some extent even to the present day. Some of the foremost employers, however, gave material encouragement to the formation of classes, insisting on their employees attending evening instruction; but conspicuous above all was Mr. Whitworth, who, in 1868, placed in the hands of the Department the sum of 100,000*l.*, to be devoted to the creation of scholarships, which were to be awarded at the annual May examinations. The proviso made by him was that all competitors were to have had experience in practical work in an engineering establishment. Such candidates, it was evident, must have found out their own weakness in education, and, by working in science classes, could make up their deficiencies, and the award of these scholarships would enable them to study further. Sir J. Whitworth was far-seeing and almost lived before his age, but the benefits that he has conferred, not only on individuals, but on science and industries, by his generosity will make his name to be remembered for generations to come. To have been a Whitworth scholar gives an *entrée* into various Government and engineering posts, and we have in the front rank of science men who have held these scholarships and whose names stand prominent in the development of engineering.

Incidentally, I may say that no country but this, for very many years, considered that instruction in science for the artisan was a large factor in maintaining and developing industry. The educational interests of the employer and the foreman were, in some countries, well provided for, but the mechanic was merely a hand, and a "hand" trained in merely practical work he was to remain. He could not aspire to rise beyond. We may congratulate ourselves that such a "caste" system does not exist amongst ourselves.

For the first twenty-five years of the Department of Science and Art the grants given by Parliament for science instruction were distributed almost entirely amongst those who were officially supposed to belong to the industrial classes, and no encouragement was offered to any higher class in the social scale.

It would take me too long to show that at first the industrial classes were very shy of seizing on the advantages offered them. Suffice it to say that they had to be bribed by the offer of prizes and certificates of success to attend instruction, and it was not for several years that the evening classes got acclimatised and became popular.

The evening instruction was then largely attended by adults. That this was the case may be judged by the fact that the average age of candidates who obtained successes in advanced chemistry was about twenty-five and in elementary chemistry about twenty-one. I have alluded to the apathy displayed by employers and by the artisans in the early days of the Department of Science and Art. The causes which dispelled it in both employers and employed, in regard to science instruction, will be found in the following extract from a report by the Department of Science and Art:—

"The Paris Exhibition (1867) caused the work of this country to be brought into close comparison with that of the rest of the Continent, and in many points both of manufacture and of skilled labour it was found England did not stand in such a good position as she had done a few years back. Dr. Playfair, in a letter to the *Times*, drew attention to this, attributing much if not all the evil to the deficiency of our technical education among the artisan class. The substance of this letter was taken up by many

persons of influence during the autumnal recess, and it led to a sort of educational panic, the cry for technical education becoming quite the absorbing topic among all circles and forming a considerable portion of the contents of all periodicals. Meetings were convened and addresses delivered all over the country, and the question was so much ventilated that important changes were anticipated in the educational arrangements of the country during the coming session of Parliament, which unfortunately were put off on account of the debates on the Reform Bill of 1868.

"The agitation necessarily brought forward the work of the Science Division of the Science and Art Department, and it is not a little remarkable how completely the system which had been growing up since 1860 seemed to meet all the requirements of the case, and at the same time how few persons had any idea of its provisions in spite of all that had been done to spread a knowledge of the scheme.

"There can be no doubt, however, but that this six years' work had silently, though materially, effected a change in the general tone of feeling on the subject of scientific education, and had been the means of preparing the country for the 1867 agitation. The different feeling among the working-classes on the subject is forcibly shown in the Annual Report of the Science and Art Department. From this it appears that in 1860 a pupil in one of the science classes in Manchester, a town usually looked upon as in advance of others, could hardly continue his attendance at the class owing to the taunts of, and ill-treatment by his companions. Nevertheless, in the autumn of this year, 1867, hardly enough could be said or done to satisfy the desire for science classes being formed for those very persons who, but six years before, had considered attendance at a Government science school as almost against the rules of their trade."

Such was the account of 1867 given by Mr. G. C. T. Bartley (now Sir G. Bartley, M.P.). The plan adopted by the Science and Art Department for encouraging instruction in science was perhaps the best that could be devised at the time, though we now know that it was capable of improvement. It may be mentioned that an improvement in it was made the next year by the introduction of a very large system of scholarships, scholarships which have enabled the possessors in some instances to continue their studies at universities, and several distinguished men owe their positions to this aid. It was in this same year that Mr. Whitworth established his scholarships, as before described.

I have endeavoured to give a brief *résumé* of what was done during the first fifteen years of the existence of the Science and Art Department, and it continued to expand its operations after 1868 on the same lines for another ten years. In 1876 your President became connected with the Department as a Science Inspector. I am sure the Section will forgive me if I am somewhat personal for a few moments. During the previous eight years I had had the honour of being a teacher of some branches of physical science at the School of Military Engineering, and my own training was such that I had formed a very definite opinion as to how science instruction should be imparted, both to those who had a good general education and also to those who had not. The method was the same in both cases: it should be taught practically. I may say that though I had not myself had the advantage of being taught it at school, I had learned all the science I knew practically, and I entered the Department fully impressed with this view. Whenever possible I have until the present time endeavoured to impress this view on all who were interested in the work of the Department. Much of the science that was taught in State-supported classes was largely book work and cram, and the theoretical instruction as a rule was unillustrated by experiment. This was undoubtedly due to the system of payments being based on success at the examinations. I must here say that there were honourable exceptions to this procedure. There were teachers, then as now, who knew the subjects they taught, and who were inspired by a genuine love of their calling. I can in my mind's eye recall many such some of whom have joined the majority and others who are still at work and as successful now as then in rousing the enthusiasm of their students.

I am not one of those who think, as some do, that cramming is entirely pernicious. A good deal of what used to be taught at public schools in my days was cram. It served its purpose at the time in sharpening the memory, and was a useful exercise, and it did not much matter if in after years much of it was forgotten. If the cramming is in science, a few facts called back to mind in after life are better than never having had the chance at all. In fact, as the faded beauty replied to the born plain friend, it is better to be one of the "have beens" than a "never wasn't."

It was determined to make a vigorous onslaught against teaching that was unillustrated by experiment and to encourage practical teaching as far as could be done. Proper apparatus for illustrating lectures was insisted upon, and, with aid from the Department, was eventually provided, though in some instances several years' pressure had to be exercised before it was obtained. I am bound to say that in many instances after it had been procured a surprise visit by the inspector during the hours of instruction often found that the lecture table was free from all encumbrance, and that the dust of weeks was upon the apparatus that should have been in use. This was sometimes due to the inability of the teacher to use the apparatus rather than to a wish to disregard the rules laid down by the Department; but usually it was due to the fact that the teacher found cram paid best. I should like to say here that this state of things does not exist at the present time, and that the training of science teachers by the Royal College of Science and by other institutions has completely broken down the excuses that were often offered at that time.

The first grants for practical teaching were paid for chemistry. The practical work had to be carried out in properly fitted laboratories. There were not half-a-dozen at the time which really answered our purpose, and one of the earliest pieces of work on which I was engaged was in assisting to get out plans for laboratory fittings. These were very similar to those which I had designed for the School of Military Engineering several years before. Thanks to the Education Act of 1870 (I speak thankfully of the work that some of the important School Boards have done in the past in taking an enlightened view of science instruction) there were some localities where the idea of fitting up laboratories was received with favour, and it was not long before several old ones were refitted, in which instruction to adults was given, and new ones established in Board Schools for the benefit of the Sixth Standard children. At that time an inspector's, like the policeman's, lot was not a happy one. We had to refuse to pass laboratories which did not fulfil conditions, though we left very few "hard cases."

Until after the passing of the Technical Instruction Act in 1887 the Department aided schools in the purchase of the fittings of laboratories (both chemical and others), and year after year this help, which stimulated local effort, caused large numbers of new laboratories to be added to the recognised list. After six or seven years we had a hundred or more laboratories at work of what I may call "sealed-pattern efficiency." I am not very partial to sealed patterns, but they are useful at times, for they tell people what is the least that is expected from them. The pattern was not without its defects; but laboratories, like other matters, follow the law of evolution, and the more recently fitted ones show that the experience gained whilst teaching or being taught in a sealed-pattern type has led to marked improvements. Personally I am of opinion that only necessaries should be required, and I rebel against luxuries; for a student trained by means of the latter will, as a rule, in after life fail to meet with anything beyond the mere essentials for carrying on his scientific work.

The sealed pattern is practically in abeyance, though it can be trotted out as a bogey, and any properly equipped laboratory is recognised so long as it meets the absolute necessities of instruction.

The half-dozen chemical laboratories which existed in 1877 have now expanded to 349 physical and 774 chemical laboratories. These are spread over all parts of England. I leave out Scotland and Ireland, as the science teaching is no longer under the English Board of Education.

It is only fair to say that many of this large number of laboratories are at present in secondary schools, regarding which I shall have to speak more at length. But the fact remains that in twenty-seven years there has been such a growth of practical science teaching that some 1120

laboratories have come into being. My predecessor in the Chair likes to call laboratories "workshops." I have no objection, but the reverse; for the word "laboratory," like "research," sounds too magnificent for what is really meant, and all education should more or less be carried out in workshops.

The increase is as satisfactory as it is remarkable. It was only possible to increase the numbers in early days by gentle pressure and prophesying smooth things which, happily, did eventually come to pass. In later days the increase has been almost automatic. The Technical Instruction Act has called into being technical instruction committees who in many cases have taken up science instruction in their districts in earnest. They, too, have had public money to allocate, and not a little has gone in the encouragement of practical education. It may, however, be remarked that had it not been for the preliminary work that had been done by the Science and Art Department it is more than probable that the Technical Instruction Act of 1887 would never have seen the light.

A reference must now be made to the removal of what anyone will see was a great bar to the spread of sound instruction in every class of school where science was taught. So long as the student's success in examination was the test which regulated the amount of the grant paid by the State, so long was it impossible to insist on all-round practical instruction. It was impracticable to hold practical examinations for tens of thousands of students in some twenty different subjects of science. The practical examination in chemistry told its tale of difficulties. It was only when the Duke of Devonshire and Sir John Gorst in 1898 substituted for the old scheme of payments payment for attendance, and in a large measure substituted inspection for examination, that the Department could still further press for practical instruction. For all elementary instruction the test of outside examination does more harm than good, and any examination in the work done by elementary students should be carried out by the teacher, and should be made on the absolute course that has been given. It seems to be useless or worse that an examination should cover more than this. Instruction in a set syllabus which for an outside examination has to be covered spoils the teaching and takes away the liberty of method which a good teacher should enjoy. The literary work involved of answering questions, for an outside examiner, is also against the elementary student's success, and cannot be equal to that which may properly be expected from him a couple of years later.

Advanced instruction appears to be on a different footing. The student in advanced science must have gradually obtained a knowledge of the elementary portions of the subject, and it is not too much to ask him beyond the inspection of his work to express himself in decent English and to submit to examination from the outside; but even here the payment for such instruction should be by an attendance grant tempered in some degree by the results of examination, since examiners are not always to be trusted.

The attendance grant was not viewed by some with great favour at first, and protests were received against its adoption, a favourite complaint being that it was sure to entail a loss of grant. One became suspicious that some of those who protested were aware that the last bulwark which defended the earning of grants by cram was being removed, and that inspection might prove more irksome than examination. This is past history now, and the new system works as smoothly as the old and with not more complaints than are to be always expected.

As I have said, grants were for very many years supposed to be confined to aiding the instruction of the industrial classes, but this limitation was more nominal than real. It might probably be imagined that it was no very difficult task to distinguish an artisan and his children from students who belonged to the middle classes. This was not the case, however. Children belonging to the industrial class were, on joining a science class, obliged to state the occupation of the father, and it was no uncommon thing for fathers to be given brevet-rank by their children. Thus, a bricklayer's son would describe his father as a "builder," which, if true, ought to have brought him into the ranks of the middle class. These unauthorised promotions were one of the difficulties the inspector had to face when judging as to the status of the parents. This difficulty was largely met by a rule that all those who attended evening classes were supposed to be of the industrial class; but as day classes increased the numbers of those who by no possibility could be of the artisan class also increased, and it became a very invidious duty of the inspector to put M.C. (Middle Class) against the names of many. It was determined by superior authority that only those students or their parents who could claim exemption from income-tax should be reckoned as coming within the category of industrial students. In early days the qualification for abatement on income-tax was a much lower figure than it is to-day, and almost each succeeding Chancellor of the Exchequer has raised the figure of the income on which the abatement could be claimed. To-day it is, I believe, 700*l*. a year, bringing the official definition as to membership of the industrial classes to an absurdity. It became evident to the official mind, which some people are good enough to say works but slowly, that the definition must be amended or the limitation abolished. The progress of events happily made the abolition the better plan, and was the means of allowing inroads of science instruction to be made into secondary day schools.

The history of these inroads I shall now give. Instruction given in so-called organised science schools was originally aided by the Department by means of a small Capitation Grant. These schools were supposed to give an organised course of science instruction, and the successes at examination determined the payment. They were not satisfactory as at first constituted, and they so dwindled away in numbers that in 1890 only some one or two were left. A small increase in Capitation Grant in 1892 revived some of them, and a fair number existed in the following year. There was no doubt, however, that the conditions under which they existed were most unfavourable for a sound education, which ought not only to include science but also literary instruction. The latter was, in many schools, wholly neglected, owing to the fact that the grants earned depended on the results of examination, and so all the school time was devoted to grant earning.

Mr. Acland, at this time Minister for Education, was made aware of this neglect to give a good general education, and as I was at that time responsible for science instruction I was directed to draw up a scheme for reorganising these schools and forcing a general as well as scientific education to be carried out. Baldly the scheme abolished almost entirely [1] payments on results of examination, and the rate of grant depended on inspection and attendance. Further, a certain minimum number of hours had to be given to literary subjects, and another minimum to science instruction, a great deal of it being practical and having to be carried out in the "workshop." The payments for science instruction were to be withheld unless the inspector was satisfied that the literary part of the education was given satisfactorily.

The scheme was accepted and promulgated whilst the Royal Commission on Secondary Education was sitting, and, if I may be allowed to say so, Mr. Acland's tenure of office would be long remembered for this innovation alone, since in it he took a wide departure from the traditional methods of the Department and created a class of secondary school which differed totally from those then existing. Needless to say the scheme was not received with favour on all sides, more especially by those who thought that serious damage would be done to secondary schools by the competition from this new development of secondary education. I am not ashamed to say that the disfavour shown on some sides made me rejoice, as it indicated that a move had been made in the right direction. At first it was principally the higher-grade Board Schools that came under the scheme, and in the first year there were twenty-four of them at work. This type of school gradually increased until about seventy of them, and chiefly of a most efficient character, were recognised in 1900. Their further increase was only arrested by the Cockerton judgment, now so well known that I need only name it. But here we come to a most interesting development. State aid, as already said, was at first limited to the instruction of the industrial classes, but no limitation as to the status of the pupil was made in this new scheme for the schools of science, and logically this freedom was extended in 1897 to all instruction aided by the Department—the date when all limitation

[1] Within the next four years they will entirely cease.

as to the status of the pupil was abolished, the only limitation being the status of the school itself. Thus, if a flourishing public school, charging high fees for tuition, were to apply to participate in the grant voted by Parliament, it may be presumed, it would have to be refused. The abolition of the restriction as to the status of the pupils left it open to poorly endowed secondary grammar schools to come under the new scheme. To a good many the additional income to be derived from the grant meant continuing their existence as efficient, and for this reason, and often, I fear, for this reason alone, some claimed recognition as eligible.

Such is an outline history of the invasion of science instruction into certain secondary schools—an invasion which ought to be of great national service. In my view no general education is complete without a knowledge of those simple truths of science which speak to everyone, but usually pass unheeded day by day. The expansion of the reasoning and observational powers of every child is as material to sound education as is the exercise of the memory or the acquisition of some smattering of a language. I am not going into the question of curricula in schools, as I hope, regarding them, we shall have a full discussion. But of this I am sure, that no curriculum will be adequate which does not include practical instruction in the elementary truths of science. The President of the Royal Society, in his last Annual Address, alluded to the mediæval education that was being given in a vast number of secondary schools. Those who planned the system of education of those times deserve infinite credit for including all that it was possible to include. Had there been a development of science in those days, one must believe that with the far-seeing wisdom they then displayed they would have included that which it is the desire of all modern educationists to include. Observational and experimental science would have assuredly found a place in the system.

One, however, cannot help being struck by the broadening of views in regard to modern education that has taken place in the minds of many who were certainly not friendly to its development. Perhaps in the Bishop of Hereford, when headmaster of Clifton, we have the most remarkable early example of breadth of view, which he carried out in a practical manner, surrounding himself with many of the ablest teachers of science of the day. There are other headmasters who, though trained on the classical side, have had the prescience to follow in his footsteps, and of free will; but others there are who have neither the desire nor the intention, if not compelled to do so, to move in the direction which modern necessities indicate is essential for national progress. I am inclined to think that the movement in favour of modernising education has been very largely quickened by the establishment of schools of science in connection with endowed schools and the desire for their foundation by the Technical Instruction Committees, who had the whisky money at their disposal, and who often more than supplemented the parliamentary grants which these schools were able to earn. It was the circumstance that the new scheme was issued when many endowed schools were in low water that made it as successful as it has been.

The number of schools of science increased so rapidly that it appeared there might be a danger of too many of this type being started on sufficient educational grounds. Science instruction was carried in them to such an advanced point and so many hours of the week were spent on it that they became in some degree specialised schools. At least eight hours a week had to be devoted to science, ten to literary instruction, and five to mathematics—any further time available could be spent on any section that was considered desirable. For some pupils the time devoted to science is barely enough, but for others who intend to follow careers in which the literary section should predominate it appeared that some curtailment of hours in the science section might be usefully allowed, and it became a question how far such instruction might be shortened without impairing its soundness. After much anxious thought it was considered that four hours per week, besides mathematics, was the very least time that ought to be devoted to such instruction, and that the latter part of it should be practical work. A scheme embodying this modification was approved by the Lord President and the Vice-President whilst I was Principal Assistant Secretary for Secondary Education, and smaller grants than those for schools of science were authorised in 1901 for those schools which were prepared to adopt it. By the scheme instruction has to be given only in such subjects and to such an extent as is really necessary to form part of that general education of ordinary students who might not have to follow in industrial pursuits. This modified and shortened course has met with unqualified success. Some 127 schools came under the scheme the first year, and I gather that there will be a considerable increase in numbers in the future. The establishment of schools of science and of these schools may be considered to be a great step taken in getting practical instruction in natural knowledge introduced into secondary schools. The leaven has been placed in some 300 of them, and we may expect that all schools which may be eligible for State aid will gradually adopt one scheme or the other. Though it is said that there is nothing in a name, I am a little doubtful as to whether the earmarking of science education as distinct from secondary education is not somewhat of a mistake at the present day. For my own part, I should like to think that the days have passed when such an earmarking was necessary or advisable. The science to be taught in secondary schools should be part and parcel of the secondary education, and it would be just as proper to talk of Latin and Greek instruction apart from secondary education as it is to talk of science instruction. One of the causes of the unpopularity of the Science and Art Department was its too distinctive name. At the same time it would be most unwise at the present time, when the new Education Committees are learning their work and looking to the central authority for a lead, for the State to alter the conditions on which it makes its grants to these schools. It will require at least a generation to pass before modernised education will be free from assault. If science instruction is not safeguarded for some time to come it runs a good chance of disappearing or being neglected in a good many schools. As to the schools which have no financial difficulties, it is hard to say what lines they may follow. Tradition may be too strong in them to allow any material change in their courses of study. If it be true that the modern side of many a public school is made a refuge for the "incapables," and is considered inferior to the classical side, as some say is the case, such a side is practically useless in representing modern education in its proper light. Again, one at least of the ancient universities has not shown much sympathy with modern ideas, and so long as she is content to receive her students ignorant of all else but what has been called mediæval lore, so long will the schools which feed her have no great inclination to change their educational schemes.

If we would only make the universities set the fashion the public schools would be bound to follow. The universities say that it is for the public schools to say what they want, and *vice versâ*, and so neither one nor the other change. It appears to me that we must look to the modern universities to lead the movement in favour of that kind of education which is best fitted for the after life of the large majority of the people of this country. If for no other reason, we must for this one hail the creation of two more universities where the localities will be able to impress on the authorities their needs. The large majority of those whose views I share in this matter are not opposed to or distrust the good effects of those parts of education which date from ancient times. The great men who have come under their sway are living proofs that they can be effective now as they have been in times past, but we look to the production of greater men by the removal of the limitations which tradition sets. I myself gratefully acknowledge what the public school at which I had my early education did for me, but I think my gratitude would be more intense had I been given some small elementary instruction in that natural knowledge which has had to be picked up here and there in after life.

There is one type of college which I have not alluded to before, and that is the technical institutes. These have been fostered by the localities in which they are situated, and been largely supported by the whisky money, supplemented by Government aid. I am glad to see that in the last regulations of the Board of Education these colleges will receive grants for higher scientific instruction, and I have no doubt that in the near future such institutions and schools of science will receive a block grant, which will

give them even still greater freedom than they now enjoy. These are colleges to which students from secondary schools will gradually find their way, where they wish for higher education of a type different from that to be gained at a university.

I have endeavoured to give a brief historical sketch of what the State has done in helping forward instruction in natural knowledge amongst the industrial classes, adults and children, and how gradually its financial aid has been extended to secondary schools. I have also endeavoured to indicate the steps by which practical instruction has been fostered by it. I have done this because I am confident that ninety-nine educationists out of every hundred have but little idea what the State has been doing for the last fifty years. Some connected with secondary schools—I have personal knowledge—were until lately ignorant that the State had offered advantages to them of a financial nature. I may say that the work of the late Science and Art Department was largely a missionary work. It was abused, sometimes rightly but more often wrongly, for this very work, and it had more abusers at one time probably than any other Government Department. Even friends to the movement of modernising education found fault with it as antiquated and slow, but I can assure you that no greater mistake can be made in pressing forward any movement by any hurried change of front or by endeavouring to push forward matters too rapidly. In the first place, the Treasury naturally views untried changes with suspicion, and this fact has to be dealt with more particularly when there is no great expression of public opinion to reckon with. At the same time it cannot be stated too strongly that the Treasury has in recent years dealt in a friendly and enlightened spirit with all matters which could affect the spread of science. Again, there is a hostility to great and rapid changes in the minds of those whom such changes affect.

The policy must always be to progress as much as is possible without rousing too great an opposition from any quarter, and I think it will be seen that the progress made during the last twenty-five years has, by the various annual increments, been perhaps more than could have been hoped for, and gives a promise for even more rapid advances in the future.

As an appendix to this Address I have given a brief epitome of the increases in students, in schools, in laboratories, and in grants which have taken place since 1861. If to the last be added the amount spent out of the whisky money an additional half million may be reckoned.

It will be seen that the progress made has been gradual, but satisfactory, and that, if we showed some of the results graphically, weighted according to the circumstances of their date, and dared make an extrapolation curve of future results, we should have a complete justification for prophesying hopefully.

The question of the supply of science teachers has already been referred to. My remarks I should like to supplement by saying that in the greater number of schools teachers are to be found who have been trained at the Royal College of Science, and mostly at public expense—some through scholarships gained by competition and some through training selected teachers. The success of the movement for the introduction of science instruction in schools depended on the proper supply of teachers, and even now the demand for men possessing the highest teaching qualifications in science is greater than the supply. It may be said, I think, that our science teachers from the college have one special qualification, and that is, that besides the knowledge of science, practical and theoretical, that they have acquired they have lived in an atmosphere of what is called research, and which might be called original investigation. Professors, assistants, and students alike are impregnated with it, and when the teacher so trained takes up his duties in his school he still retains the "reek" of it. True instruction in science should, as I have before said, be practical, and practical instruction should certainly include original inquiry into matters old or new. The teacher who retains the "reek" is the teacher who will prove most successful. It will thus be seen that the State had the task before it, not only of introducing instruction in science, but of training teachers to give such instruction. This problem is the same as now exists in Ireland, and the experience gained in England cannot but be of the greatest use to those at the head of Irish technical education.

Before concluding there is one subject that I must lightly touch upon, and that is the supply of teachers other than science teachers. The Education Act of 1870 gave the power to elementary schools to train pupil teachers, who in the process of time would become teachers, either by entering into a training college by means of a King's Scholarship or, less satisfactorily, by examination. In large towns the need of a proper training for pupil teachers has been felt, and gradually pupil teacher centres were established, principally by School Boards, where the training could be carried out more or less completely; but in the rural districts and smaller towns the pupil teacher has had to be more or less self-taught, and except in rare cases "self-taught" means badly taught. The Training College authorities make no secret of the fact that one of the two years during which the training of the teacher is carried out has to be devoted more or less to instructing the pupils in subjects they ought to have been taught before they entered the college. Thus all the essential and special instruction which is given has to be practically shortened, and the teacher leaves the college with less training than he should have.

The new Education Act has put it in the power of the educational authorities to rectify the defects in the training of pupil teachers. It is much to be hoped that Councils will separately or in combination either form special centres for the training of all pupil teachers or else give scholarships (perhaps aided by the State) to them, to be held at some secondary school receiving the grant for science and recognised by the Board of Education as efficient. The latter plan is one which commends itself, as it ensures that the student shall associate with others who are not preparing for the same calling in life, and will prevent that narrowness of mind which is inevitable where years are spent in the one atmosphere of pedagogy. The non-residential training college, where the training of the teacher is carried on at some university college, is an attempt to give breadth of view to him, but if attempted in the earliest years of a teacher's career it will be even more successful. All teaching requires to be improved, and the first step to take in this direction is to educate the pupil teacher from his earliest day's appointment, for his influence in after years will not only be felt in that elementary, but will also penetrate into secondary education. In regard to the additions which are required in elementary education, and which require the proper training of the pupil teacher, I must refer you to a report which will be presented to the Section. The task of training pupil teachers is one which requires the earnest and undivided thought of the new Education Committees.

In the earnest Address given by my predecessor in this Chair he brought forward the shortcomings of secondary education and of the requirements for a military career in a trenchant manner and with an ability which I cannot emulate. With much of what he said I agree heartily, but I cannot forget that, after all, the details of education are to some extent matters of opinion, though the main features are not. We must be content to see advances made in the directions on which the majority of men and women educational experts are agreed. Great strides have already been made in educating the public both in methods and subjects, but a good deal more remains to be done.

It may be expected, for instance, that the registration of teachers will lead to increased efficiency in secondary schools, and that the would-be teacher, fresh from college, will not get his training by practising on the unfortunate children he may be told off to teach. It may also be expected that such increased efficiency will have to be vouched for by the thorough inspection which is now made under the Board of Education Act, by the Board, by a university, or by some such recognised body. It again may be expected that parents will gradually waken up to the meaning of the teacher's register and the value of inspection, and that those schools will flourish best which can show that they too appreciate the advantages of each.

I have to crave pardon for having failed to give an Address which is in any way sensational. I have thought it better to review what has been done in the past within my own knowledge, and with this in my mind I cannot

but prophesy that the future is more than hopeful, now that the public is beginning to be educated in education. It will demand, and its wants will be supplied.

APPENDIX.

Number of Schools of Science and their Grants.

Year	Higher Grade Schools	Endowed Secondary Schools	Technical Institutes	Total Schools	Total Grants
					£
1895	53	30	29	112	39,163
1898	69	50	49	168	98,849
1901	63	106	43	212	118,833
1903	50	119	57	226	Not yet known[1]

Number of Schools teaching Shortened Course of Science.

Year	No.
1902	127
1903	184

Number of Laboratories recognised.

Year	Chemistry	Metallurgy	Physics	Biology	Mechanics
1880	133	—	—	—	—
1900	669	37	219	17	4
1901	722	37	291	26	10
1902	758	39	320	34	14

Grants paid for Science Instruction.

Year	Amount	Year	Amount
	£		£
1860	709	1890	103,453
1870	20,118	1895	142,543
1875	42,474	1901	212,982
1880	40,229	1902	240,822
1885	63,364		

THE GERMAN ASSOCIATION AT CASSEL.

THE seventy-fifth meeting of the German Association for the Advancement of Science and Medicine took place in brilliant weather in the picturesque town of Cassel. By Saturday evening, September 19, members and associates began to arrive, and on Sunday a large number of gaily coloured "rosettes" were visible in the streets. Advantage was taken of this gathering of men of science to present to Prof. Graebe, of Geneva, an address on the completion of the twenty-fifth year of occupancy of his chair of chemistry, and M. Moissan, of Paris, on behalf of the Chemical Society, conveyed to him the Lavoisier medal of the Institute of France. Prof. Graebe, who, in conjunction with Prof. Liebermann, of Berlin, achieved the first important chemical synthesis—that of artificial alizarine—was an old assistant of Prof. v. Baeyer, of Munich, who then occupied the chair of chemistry in the Gewerbe Akademie in Berlin. Prof. v. Baeyer, in his opening address, directed special attention to the cooperation of men of science with technologists, which was the fruit of this important synthesis—a cooperation which has had enormous influence on the development both of German science and industry. The rector of the University of Geneva followed, and he mentioned that, during the twenty-five years of Prof. Graebe's tenure of the chair, he had published 196 memoirs on chemical subjects, while more than 400 papers were published by workers in his laboratory. Prof. Moissan, who, as delegate of the Académie des Sciences, handed to Prof. Graebe the Lavoisier medal, referred in an eloquent speech to the great influence which Graebe's work has had in developing synthetical organic chemistry, and after the presentation of addresses from the Royal Academy of Sciences of Bavaria, from the German Chemical Society, from the Societies of Geneva and Frankfort, and from the University of Lausanne, Prof. Graebe received from the chairman a gold plaque, engraved with his portrait, and from M. Amé Pictet, on behalf of his old students, a bound copy of his own papers. Dr. Brunck, on behalf of the "Badische" Chemical Company, of which he is managing director, added a tribute to Graebe from the point of view of technology, and in an eloquent reply Prof. Graebe expressed his gratitude and thanks. About sixty of the audience remained to a dinner given in honour of Prof. Graebe, at which numerous toasts were drunk, and the proceedings were kept up until a late hour.

[1] In 1902 124,300*l.* was paid.

The members and associates met for the first time on Sunday evening, September 20, in the grounds of the Hessian Brewery, where a large hall had been adapted for the purpose of the general meetings, and on Monday morning, after words of welcome from Prof. Hornstein, of Cassel, the local secretary, from President von Trott zu Solz, from the mayor and others, the president of the Association, Prof. van 't Hoff, returned thanks in the name of the Association. An address was then delivered by Prof. Ladenburg on the influence of science on our views of life. The address treated of the gradual development of scientific knowledge and its opposition by the church; the necessity of education in the phenomena and laws of nature, and the insignificant position of man among natural phenomena; the doctrine of the immortality of the soul and the dicta of science on the subject. He contended that Christianity alone had been unable to induce mankind to accept the doctrine of liberty, equality, and fraternity, and that this doctrine, indispensable for our future progress, must be the future object of scientific endeavour. The general opinion of the audience appeared to be that Prof. Ladenburg's address was unnecessary, and that he had assumed for science an infallibility similar to that claimed by the Apostolic See. The second address, by Prof. Ziehen, of Utrecht, treated of impressions and sensations, and their connection with the surface of the brain. Sensations may be termed positive or negative, according as they produce pleasant or unpleasant emotions, and their intensity depends less on the degree of excitability of the regions of the brain affected than on the capacity for "discharge" or communication with other regions. "Negative" sensations are more numerous than positive; the lecturer attempted to prove this by the fact that, in German, words denoting unpleasant are more numerous than those which denote pleasant sensations. But up to now it had been impossible to bridge the gap between the mechanism of the brain and the sensations and perceptions.

In the afternoon the sections met, and in the evening the opera of "Tannhäuser" was well performed in the theatre. September 21 was devoted to sectional meetings, and in the evening the members and associates dined together in the "Festhalle," and many toasts were proposed. On the morning of the next day addresses were delivered by Prof. Penck, of Vienna, on geological time; by Prof. Schwalbe, of Strassburg, on the early history of man; and by Dr. Alsberg, of Cassel, on inherited degeneration as a consequence of social influences. On the morning of September 24 the medical side of the congress was represented by Dr. Allan Macfadyen, who gave an address on intercellular toxines; by Dr. Paul Jensen, on the physiological action of light; and by Dr. Rieder, on the curative results obtained by treatment with light.

Later in the morning, in order to open a discussion on the place of mechanics in our views of nature, papers were read by Dr. Schwarzschild, of Göttingen, on astronomical mechanics, by Prof. Sommerfeld on technical mechanics, and by Prof. Otto Fischer on physiological mechanics. Dr. Schwarzschild began by stating that Newton's law of gravitational attraction still remains the leading factor in astronomy, and every observation only serves as a confirmation of its correctness. It has been proved to be correct to two parts in one hundred millions. The chief aim of astronomical mechanics is to represent exactly the actual path of the planets. But the classical "Mechanics of the Heavens" fails, if it is applied to very long periods of time. The formulæ which are applied would, if extended, point to a destruction of the planetary system. There are, however, two reasons for believing that such a conclusion would be incorrect. The problem of "secular disturbances" was solved by Lagrange, and that of "commensurabilities"