THE FUNCTIONS OF LECTURES AND TEXT-BOOKS IN SCIENCE TEACHING.[1]

I WISH to-day to speak of a tendency in education which I think is increasing, and in my opinion is mischievous; it is one, however, which is much more rampant with us at the universities than it is at schools—I mean the practice of attempting to teach everything by lectures; of making to a continually increasing extent the lecture supply the place of the text-book; of learning everything by being told it instead of reading it for oneself.

Now I should be the last to maintain that the reading of text-books is in many branches of study sufficient by itself to give a man a real grasp of his subject. The lecture, or something equivalent to the lecture, is in many subjects, notably in science, an essential part of the educational apparatus, perhaps more essential in science than in anything else. By means of the experiments in the lectures (though these by themselves are by no means all that is required) the students see the phenomena they are studying; the experiments make them realise that they are dealing with definite phenomena, and help towards one of the most important results which the teacher has to aim at to make their acquaintance with these facts as intimate and vivid as possible.

The position I am taking this morning is not new. Let me quote here from Boswell's "Johnson":—

"People have nowadays," said he, "got a strange opinion that everything should be taught by lectures. Now I cannot see that lectures can do so much good as reading the books from which the lectures are taken. I know nothing that can best be taught by lectures, except where experiments are to be shown."

As those of you who are acquainted with that inexhaustible book are, I am sure, longing to hurl another quotation from it at me, I will disarm them by quoting it myself. It relates to an occasion when an Oxford don, Dr. Scott, was present. Johnson lectures were once useful, but now, when all can read and books are so numerous, lectures are unnecessary. If your attention fails and you miss a part of the lecture, it is lost. "You cannot go back as you do upon a book. Dr. Scott agreed with him. 'But yet,' said I, 'Dr. Scott, you yourself gave lectures at Oxford.' He smiled."

I object to the lecture usurping so largely the function of the text-book, because I think when this is done the study of a subject has not the same educational value—is not such good intellectual gymnastics, to use the cant phrase, as when a student reads it for himself. This is especially true when a student is new to the subject; with a book he can confine himself to the consideration of the new ideas, and can take his own time, while in a lecture he has to take in these ideas at the pace presented by the lecturer, and, in addition, has to put them in writing as fast as his pen can travel; as a matter of fact, in many cases he takes little trouble to understand, but confines himself to taking down as many of the words of the lecturer as is possible in the time, and trusts to finding out later on what they mean. This practically amounts to substituting a manuscript, and I think it would not be an unfair description of many such notes to say a very corrupt manuscript, for a text-book. Now it is possible that in some cases there is an advantage in doing this; the lecture may be so good that even the imperfect notes of those that heard it may be better than the best text-book available. I am assuming, of course, that there is a text-book on the subject. This, no doubt, is sometimes the case; but I think those who have read lecture notes as they are taken down will agree with me that a text-book must be quite exceptionally bad if it is not more intelligible than the majority of the notes taken even in good lectures.

Another consideration which I think is of greater weight is that if the student rewrites his rough notes, the task of reducing them to sense and logical order is an excellent mental training. I quite agree that it is, and if the student attended only one such set of lectures a term I think he might greatly benefit by doing this; but when, as he often does under present conditions, he attends three or four such courses, it is impossible for him to treat them all in this way. Consider, for example, a case that came under my observation last term. A student came to me with his time-table; he had lectures or practical work in the laboratory every morning from nine to one, and on three afternoons in the week from two to five. His object in coming to me was to find if I could not help him to find lectures to fill up the three afternoons which he had vacant.

Even though the student attends lectures, it is, I think, important that he should have training in learning for himself, and not be encouraged to think that all he need know about a subject will be told to him in lecture. In after life he will have to acquire most of his learning from books. He will not always find lectures available; it is possible, indeed, that he will have no passion for lectures, and if he has not acquired the art—for there is an art of learning from books—he will be at a serious disadvantage. Is not an excessive reliance on lectures likely to leave us open to the reproach that we teach our students everything except how to learn? I sometimes wonder when I see the extent to which some students rely on their notes, and the appallingly long list of lectures which appears at the beginning of each term, whether the importance of the invention of printing has not been overrated.

Now I must express an opinion with which I think it quite possible that many here will not agree. The view is often expressed nowadays that students should be examined by their teachers, and not by outside examiners. I cannot agree with this; so far as my experience goes, the practice leads to one of the worst kinds of cramming—the cramming of note-books—and not always the student's own note-book. I think the teacher ought to have the fullest power over the syllabus, and not to have his method of teaching hampered by external authority; but when he is given this freedom I think he may be expected to produce results which need not fear the tests imposed by any sensible examiner.

But although I am urging a freer use of text-books and more independent reading by the students, the last thing I would do would be to abolish lectures, though I should like to see them reduced in number, and in some cases their objective changed. To my mind, the proper function of a lecture is not to give the student all the information he is supposed to require on the subject of the lecture, but to arouse his enthusiasm so that he will be eager to get that information for himself. A lecture ought to be interesting and to arouse interest; dullness should be the unpardonable sin. The lecturer should avail himself of the "purple patches" of the subject to supply the momentum which will carry his students over the less exciting parts. Again, in a lecture it is possible to emphasise the fundamental parts of the subject, to discuss at length the ideas and assumptions involved, and to illustrate them by a multitude of illustrations and examples which would be impossible in a text-book of moderate size.

If lectures were limited to these objects there need not be so many of them, and there would be more time available for what I regard as the most important part of teaching—the part when the teacher comes in contact with his pupils, not as a class, but as individuals. If the teacher could talk with his pupils, even for half an hour a week, cross-examine them to see that they really understand their work, make suggestions as to what they should read, suggest points of view, sometimes even point out that things are not quite so clear as they seem to appear to the student, then I think he would have far greater influence over his pupils—would educate them better than would be done by any amount of lecturing alone. I am aware that what I am advocating is done by many teachers already, but I think there is still room for expansion of a method which the collegiate system and the large educational staff at many of our colleges make especially feasible at Oxford and Cambridge. I would like to utter a word of warning against allowing this kind of tuition to degenerate into an explanation of difficulties brought to the teacher by the student; puzzling over a difficulty is often a very good way of getting clearer ideas on a subject, and a good teacher will not solve these difficulties until he feels sure that the student will not, perhaps with

[1] Presidential address delivered to the Association of Public School Science Masters on January 11 by Sir J. J. Thomson, F.R.S.

the help of a hint or two to put him on the right track, solve them for himself.

I am told that at a school which of late years has been one of the most successful in turning out good mathematicians, the older boys are under the impression that they get very little teaching in the higher parts of mathematics; they work in a class-room together at the text-book, abuse its obscurity, argue out with each other what it really means, while the master appears to take very little part in the proceedings; as a matter of fact, if he sees that a wrong conclusion is likely to be come to by the little parliament, by an apparently casual remark he gives the argument a push in the right direction. This seems to me the very best kind of education when the boys are of fairly equal ability.

Work of this kind, when the student tries to puzzle out his own difficulties, takes time, and the student cannot cover the ground so quickly as when his difficulties are solved for him by his teacher as fast as they arise. If the examination for which he is preparing covers a wide range of subjects, he is almost compelled, or at any rate he is very strongly tempted, to adopt the quicker and easier methods. The temptation is especially strong in the case of students of science. For the Natural Sciences Tripos at Cambridge, for example, the majority of the students take four subjects in part i.; there is really no need for them to do so, and the better students are in many cases strongly advised by their tutors to take only three; if they did so I feel sure they would not prejudice their chance of getting a first class. They think, however, that it is safer to take four, and as playing for safety is a very characteristic feature of the modern undergraduate, the majority of them take this course. As they have now to do a very large amount of practical work in each subject, the study of four subjects means if they take the first part of the tripos in the second year that the whole of their mornings and many of their afternoons are spent in lecture-rooms and laboratories, and that they have very little time to spend in thinking quietly over their subject. It may be said that they have the vacations in which to do this. But, as a matter of experience, it is found, I think, that this habit is either continuous or else non-existent; it is not one that can be flung aside in term time and then resumed as soon as term is over. We cannot all emulate the heroes in the Bab Ballads:—

> These men were men who could
> Hold liberal opinions,
> On Sundays they were good,
> On week days they were minions.

It is, I think, most important that they should form this habit of independent thought at school, for if they have not done so the conditions are not very favourable for them to do so at the university.

The popularity of science, the great increase in the numbers attending lessons, lectures, and laboratories makes it more and more difficult to arrange that our students shall have the opportunity of thinking out their own difficulties and developing their independence and power of relying on their own resources. Let me contrast the conditions under which I began in the 'seventies the study of practical physics at the Owens College, Manchester, with those which prevail at the Cavendish Laboratory at the present time. When I was a student there were perhaps a dozen working at practical physics in the laboratory; there was no need for any elaborate organisation; we used to work at an experiment until we were satisfied we had done as much as we could, by what we thought, generally erroneously, were improvements on the methods shown to us, and acquired in this way a lively interest in our subject and some facility in devising experiments to test various points which arose in the course of our work. This, I think, is the best kind of laboratory training it is possible to have, but it is only available when the number of students is small. If we adopted it at the Cavendish Laboratory, where last term there were above three hundred students doing practical physics, the result would be chaos; while the students would not learn physics, independence, or anything except proficiency in free fighting. With such numbers elaborate organisation and preparation are unavoidable, and we have necessarily to limit ourselves to trying to make the elementary demonstrations teach the students how to make accurate measurements, to give them a knowledge of methods, and to make the experiments as illustrative as possible of the fundamental principles of physics.

I think, however, that in some of our schools the number of boys taking practical work is small enough to make the other method possible, and when this is the case I would urge as strongly as I can the danger of excessive organisation and the importance of developing as much as possible the independence and self-reliance of their pupils, and I think they might do so with safety to a small number of subjects.

I cannot refrain from alluding to the remarkable and very gratifying increase which has taken place in the last few years in mathematical knowledge possessed by the students of science sent up from the schools, and is growing rapidly from year to year. When I first went to the Cavendish Laboratory the knowledge of mathematics possessed by many of the students was so meagre that I had to start classes to teach them the elements of the differential calculus; that class has gone on until the present year; but the number who required such teaching has diminished so rapidly during the last few years that I have decided it will not be necessary to continue these classes any longer.

In conclusion, I would like to offer a suggestion, which I make with great diffidence, but it is one which, if it were possible to carry out, would increase the efficiency of the student, especially in after life, to a very considerable extent. I mean, would it be possible to teach science students enough German to enable them to translate an ordinary text-book or paper? I do not ask that they should all know German—that I realise is, at present, impracticable. I do not ask that they should be able to write German, or even pronounce it, but merely that they should be able to make sense of a straightforward sentence.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

IT is announced in *The Jewish Chronicle* that a wealthy Jew, a native of India, has bequeathed a sum of 80,000*l.* for the endowment of a Jewish college in Jerusalem. This sum is likely to form the nucleus of an endowment for a university in Palestine.

PROF. J. G. HIBBEN has been elected president of Princeton University in succession to Dr. Woodrow Wilson. Prof. Hibben has been professor of logic at Princeton University since 1893, and is known as the author of works on logic and philosophy.

IT is announced that Sir Charles Chadwyck-Healey, K.C., who is a member of the governing body of Cranleigh School, has expressed his desire to present a laboratory to the school, and the offer has been accepted by the governors. The work has been put in hand, and it is expected that the cost will be about 4000*l.*

A REUTER telegram from Cape Town on January 13 states that, speaking at Moorresburg, Mr. F. S. Malan, Minister of Education, said he hoped to introduce and pass in the forthcoming session of Parliament a Bill dealing with higher education and the foundation of a university. Mr. Malan expects shortly to receive from Messrs. Wernher, Beit and Co., who have given half a million sterling towards the university scheme, a notification of their acceptance of the Bill, which will then be published.

AT a meeting of the executive committee of the governing body of the Imperial College of Science and Technology, held on Friday last, Prof. W. A. Bone, F.R.S., professor of applied chemistry (fuel and metallurgy), University of Leeds, was appointed professor of fuel and refractory materials in a new department of chemical technology now being established in the Imperial College at South Kensington. He will take up his new duties at the Imperial College about September of this year.

IN connection with the Francis Galton Laboratory for National Eugenics, a course of eight lectures will be given