EDUCATION OF THE MAN OF SCIENCE

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LARGELY as a result of the War, there is now wider recognition of the possibilities of science and the powers of the trained man of science. This is reflected in the growing interest of contemporary literature in scientific affairs and in the frequency with which the opinion of scientific workers is sought on major matters of State. This improved status of science can only be maintained if men of science adopt a greater sense of responsibility; for the searchlight which is focused on them will necessarily expose their limitations as well as their strength. It is fitting, therefore, that at this time men of science should subject themselves to a searching inquiry of their training and qualifications. No place could be more appropriate as a forum for such a discussion than a meeting of the British Association, where all branches of science are represented and where so many sections of the scientific community assemble. At the recent meeting at Dundee a general discussion, supported by all the sections, took place on "The Education of the Man of Science" and attracted a large and representative audience.

The importance which the British Association attached to the discussion was indicated by the presence of the president, Sir Henry Dale, in the chair. The principal contributors included the headmaster of one of the best-known day schools of Britain, a university professor of the first rank, an eminent industrial scientific worker, and a vice-chancellor of a university famous as a centre of culture and learning.

As often happens in a discussion of such a broad topic as the education of men of science, there was no precise definition of many of the terms used. The term 'man of science' is often used to connote a member of that small but highly distinguished band of investigators who lead in the paths of discovery. To others it means one of that large body of scientific craftsmen, who, having had a university training in science, earn their livelihood by the pursuit of science or the application of science, whether in the universities, or in industry, or in Government laboratories, or elsewhere. It is necessary to distinguish clearly between the needs of the specialist, and the needs of the average scientific worker. The methods in use at the schools and universities of Britain have in the past created scientific leaders of the first magnitude, and the virtues of such a system cannot be lightly discarded. On the other hand, it may well be argued that the courses designed primarily for specialists are not necessarily well suited to the needs of the body of scientific workers of more average ability.

Scientific workers of the first rank are usually men of wide interests and cultural attainments. Nothing could be more specialized than the present training of mathematicians, and yet the ablest of them are often men of great literary ability. Eddington and Jeans were outstanding examples. In every branch of science there have been leaders who have attained distinction, not only in their subject, but also in the art of lucid and concise exposition.

It may be instructive to inquire why it is that the man of science of the most gifted kind is also usually a man of culture, for this may help in considering the education of those of more limited talents.

Having ability of an unusually high order, with all that that implies of alertness of mind, quick understanding and capacious memory, he develops as a rule wide and intense interests. It may be that these are associated with, or arise from, his predominant life's work, but all life, all Nature, arouses his penetrating curiosity. Finally, being quick in thought and efficient in action, the greatest scientific worker contrives also to have leisure. The qualities of ability and interest, together with leisure, lead to a fund of general knowledge and culture which we describe as education; and perhaps it is the gift of ever-widening interest which matters most.

Implicit throughout the discussion was, however, the assumption that it is the education of the good, competent, but not exceptionally brilliant man of science which gives cause for concern. In this category we may include all who are professionally engaged in the pursuit of science, whether in teaching, or in research, or in the manifold applications of science to industry.

Education is a more difficult term to define. It is easier to say what it is not. It is not simply the acquirement of knowledge or the filling of the mind with facts, or even familiarity with a particular culture. It may be more an attitude of mind or the habits of thought engendered by study, or again it may be a cultivation of personal aptitudes and abilities to enable a man to live a useful and satisfying life. Sir Henry Dale in his opening remarks said that education should provide not only a training adequate for the technical needs of a man of science in his profession, but also should fit him for his part as a good citizen and an acceptable member of a cultured community. He stressed also the importance of the power of communicating thought and the discipline of lucid and accurate composition.

The point of view of the schoolmaster was expressed by Dr. Eric James, the High Master of Manchester Grammar School, who said that the task of the schools is a threefold one: first, to maintain the quality of the specialist knowledge of our potential scientific workers; second, to see to it that they are aware of the social relevance of their work; and third, to ensure that they are people with the fullest general education. He was of the opinion that a man who has specialized in one science at a university, and perhaps done some research in it, is usually a better teacher not only of that but also of other subjects than one who has attempted to bring several subjects to degree standard. Moreover, he has often had leisure for interest in other subjects, which have contributed to his wider education. He thought it was no answer to the problem of providing a general education to insist that all men of science should reach a certain standard in a literary subject; in, for example, a modern language. What is required is imaginative teaching of such subjects as history, divinity, or even elementary philosophy, so that the boy or girl should be led to think and read and argue for himself.

Sir Lawrence Bragg described the kind of training which science students receive at present in British universities and said that, while a large proportion of science students leave the university at the completion of a three- or four-year course, many of those adopting science as a profession now spend a further three years in research, so that the total time spent at a university may be six or seven years. The object of the university course should be to train a

student in certain fundamental mental disciplines, so that when later in his career he is confronted with new problems, he may fall back on the old lines of thought and use the conceptions he has acquired, even though most of the factual information he learned may have been forgotten. In many respects university courses had in the past been successful, particularly in providing leaders in pure science, but serious criticism has been advanced that the present generation of scientific workers has had too narrow and specialized an education. It is also a frequent complaint of the industrialist that scientific recruits are unco-operative and intolerant and lacking in a knowledge of the world.

Sir James Irvine thought that some of the defects of the present method of training could be overcome, or at any rate mitigated, during the post-graduate years, particularly if there was the right relation between student and supervisor. It was a time to fill in gaps in education both on the scientific and literary sides. The writing of scientific reports could be made an important part of the education of a scientific worker. He favoured the study of a language, preferably Latin, to assist in the art of writing and speaking the English language. He also advocated an interest in poetry as a stimulus to the imagination and a counterweight against materialism.

The point of view of a man of science in industry was expressed by Sir Arthur Fleming, who dwelt on the qualities of mind and character which, in addition to technical proficiency, are necessary for success in industry. He mentioned qualities of sound judgment, courage and the capacity for leadership. He made the point that a considerable number of science graduates who enter industry ultimately change from purely technical work to other tasks, where their scientific training, while still of importance, becomes secondary to other qualities. Reference was made to a recent survey of more than a thousand science graduates who had passed through the post-graduate training scheme of a large engineering firm. It was found that at the age of thirty-five, fifty per cent of the men were no longer engaged primarily in technical work, while at the age of forty-five the proportion had risen to more than seventy-five per cent. This means that it is important for the ordinary science graduate to possess, or to develop, the qualities which will enable him to fit into the important and responsible positions, open to scientific workers, offered by a large industrial organisation.

In the open discussion which followed, a representative of the Scottish Branch of the Science Masters' Association stressed the importance of training character as well as developing technical skill. He said that since ideals are more readily caught than taught, it is necessary that university science graduates of the highest quality should enter the teaching profession. Universities should encourage a proper balance in schools by limiting the knowledge demanded of entrants and should take character into consideration.

Reference was made by Dr. Maxwell Garnett to the work of a committee of the British Association on university education and to the need for an inquiry in Britain similar to that which had produced the Harvard report on "General Education in a Free Society".

There seemed general agreement among all those who contributed to the discussion that all is not well with the education of the man of science; but where precisely the defects lie, or what the remedies should

be, are matters on which there are conflicting opinions. If the objectives were agreed, the means would not be lacking to attain them. Part of the difficulty arises from the differing views as to what constitutes education. There is often confusion between education and the acquirement of knowledge. As was pointed out by Dr. Eric James, there is a tendency to assume that a general education can be obtained by a suitable arrangement of the school time-table. He was surely on the right lines in stating that the aim should be to introduce to boys at school some of the problems of life and society in such a way that they will want to read and think and argue for themselves. In other words, we should try to promote their interest in the wider field of knowledge by using as a central nucleus the scientific knowledge they already possess. Could not history—and in some cases literature—be taught from this angle? Social history is as fascinating to the scientific worker as to the historian, and in this respect Trevelyan's recent book provides an admirable example of what can be done. This approach to history provides contacts with daily life and experience, and shows the effect of discoveries in science on the daily lives of mankind.

Everyone seemed agreed that a reasonable competence in the art of self-expression, both of an oral and a written kind, should be regarded as a necessary qualification of a man of science. This implies wide reading and a rich vocabulary, so that ideas may be expressed clearly and vividly in simple language without an excessive use of technical jargon. But, as Sir Henry Dale said, before we put too exclusive a faith in extra scientific studies as the means to this end, we ought to consider whether present faults may not be mainly in the teaching of science itself. The power to give clear and simple expression to a result or a conception requires, in the first place, the ability to think clearly about it; and teachers of science have admirable opportunities of training their pupils in the art of expressing what scientific knowledge they possess. Science can provide many examples of men who without the advantages of a formal education have produced writings on science which are none the less admirable as literature. The teaching of science can be made in itself cultural.

The discussion brought out that other traits of mind and character are necessary for success in the active and developing fields of scientific endeavour. How are qualities of sound judgment, courage or leadership to be developed in the course of education? To some extent they are probably innate and can only be developed and fostered by training. Judgment involves experience and the capacity to profit by experience. Leadership involves self-confidence and the ability to inspire others. These qualities are not likely to be engendered by study but more by contact with affairs and association with one's fellows.

Education must accordingly provide for social contacts on an adequate scale. Schools and universities cater in differing degrees and with differing success for these requirements. There is a widespread feeling that fuller facilities for residence in the universities are a necessary development to meet this need. The severe selective competition of the class-room tends to produce intense individualism. This often becomes more pronounced in post-graduate work, when there is an understandable eagerness to make individual contributions to the field of knowledge and a corresponding desire for

personal recognition. It is all the more necessary that there should be counterbalancing influences in a well-ordered communal life for undergraduates and post-graduate students. We have to reconcile the virtues of individualism with a spirit of co-operation, for excessive individualism may lead to difficulties in a large organisation.

The education of the man of science must be such that it gives him points of contact and common interest with his fellow men, and at the same time permits him to reach forward to the limits of knowledge in his own field. In this sense it must provide ever-widening expansion in the horizontal plane, the plane of general experience, and at the same time provide the path to the heights of specialist knowledge.

The discussion directed attention to important problems. It raised more questions than it answered, and these are the concern of school teachers, university teachers and industrial scientific workers alike. There is need for closer consultation between all the principal parties concerned. The discussion arranged by the British Association will have achieved its purpose if it stimulates further exchange of views and leads to the setting up of competent, representative bodies to study the problems involved. Thus may we hope to advance along the road of educational progress for the benefit of the next generation of men of science.

UNIVERSITIES OF GREAT BRITAIN

THE "Conference of Home Universities", which met in the Senate House of the University of London on September 26 and 27, was the second which had been called together at the initiative of the Vice-Chancellors' Committee. The first conference, which took place in 1946, was of a tentative nature (a report has just been issued: Universities Bureau, 8 Park Street, London, W.1. Pp. 76. 1s.); but the present meeting was on a larger scale and had a wider range. Its purpose was to test the value of discussions between the administrative authorities of the universities and the representatives of the teaching staffs, on questions affecting the policy and the development of university education. It was attended by pro-chancellors, vice-chancellors, principals and by representative professors and lecturers from all the universities and university colleges of the United Kingdom, by members of the University Grants Committee and by representatives of the Association of University Teachers and the Scottish Association of University Teachers.

Such a gathering may legitimately claim to be a model or blue-print, or whatever the current phrase is, of a university parliament. When one considers the independent origins of the universities of the United Kingdom, their diversity of age and constitution and their jealously guarded tradition of autonomy, it is a step of no small importance to higher education that they should thus assemble the various elements in their hierarchies to discuss problems of the day which affect them all in common and may influence their future.

Some may be tempted to regard such an undertaking as another manifestation of the passion for planning, from which few interests are to-day immune, but that would be a complete misunderstanding of the spirit and intention of the Conference. There

was no suggestion of any move towards uniformity, nor even of any special expectation or wish for unanimity. Everyone concerned recognizes that each university must continue, as in the past, to work out its own salvation in its own way, but these conferences may enable it to take advantage of the benefits of consultation and the pooling of experience, in which lie the true strength of democracy.

The first session was devoted to the question of "The Expansion of the Universities". The chairman was, appropriately, Sir Alan Barlow, second secretary of the Treasury and recently chairman of a Government committee the report of which, urging an increase in the output of scientific workers by 100 per cent in the next ten years, has aroused so much interest and controversy. The vice-chancellors have themselves issued a commentary on this report, demonstrating the difficulties which stand in the way of expansion on such a scale, and Dr. R. V. Southwell, rector of the Imperial College of Science and Technology, dealt with some of these in his address. He believed, he said, that the two major questions around which most of the discussions on the Barlow Report had centred were at present insoluble. These were: (a) the extent of the demand from industry for university graduates; and (b) the reserve of intelligence of university level available to increase the number of graduates. He considered that material shortages would, in any event, preclude undue expansion in the immediate future, and that we might beneficially confine our discussions to certain non-material questions with which a policy of expansion confronts us, and which must be resolved if expansion is to take place. He instanced the maintenance of academic standards, the balance of subjects in the faculties and the task of the universities in technology.

The discussion which followed tended to emphasize the present material difficulties; but Lord Simon of Wythenshawe and other speakers agreed with Dr. Southwell's conviction that university training of men of science and technologists is an essential part of the production drive and that it must rank among the highest priorities if production is to flourish. Lord Eustace Percy (Durham) pointed out that some universities have already gone so far in permitting expansion that unless greater Government support be forthcoming they would be forced to reverse the movement.

Prof. R. Pascal (Birmingham) directed attention to the importance of the balance of studies, and urged that expansion in the arts faculties should be governed by an authoritative estimate of the demand for their graduates, if we are to avoid the evils of over-production in that direction.

The second session turned to the question of "The Basis of Selection of Students", under the chairmanship of Prof. F. C. Bartlett, professor of experimental psychology at Cambridge. The discussion was opened by Prof. Godfrey Thomson of Edinburgh, who brought forward arguments based upon intelligence tests, which tended to show that the university population could be doubled without a fall in standards, provided that all those of adequate intelligence outside the universities could, in fact, be brought in, and that efficient selection were operative. He presented the detailed results of a number of investigations; but was careful to emphasize the somewhat precarious nature of the data. He also recognized that there is a fairly large percentage, among those of adequate intelligence, who do not want a university education