## THE VALUE OF RESEARCH IN SCIENCE.[1]

SCIENCE of some sort is now being very widely taught at all stages of education, and so far from its progress being impeded as used to be the case by disadvantages of a public kind, most Governments are more or less alive to the importance of devoting public funds in furtherance of scientific work, and almost every honours list now contains the names of men distinguished in science. In India the various Governments have made a very fair beginning in the matter of funds.

It is impossible, and would be of little value for our purposes, to estimate the amount devoted to scientific teaching in schools and colleges by the various education departments. I have, however, endeavoured, with the kind assistance of the Hon. Mr. Davidson and the Financial Department of the Government of Madras, to form some idea of the amount being spent upon original research and other higher scientific work throughout India.

On the nature and essence of "research" I propose to offer a few observations later on, but it is not without interest to note at this point the connections in which the word occurs in the various Budget estimates. The Government of India supports a Forest Research Institute and College at Dehra Dun, and devotes about 4 lakhs a year to it; it contributes 5 lakhs a year to the Indian Research Fund, about 5½ lakhs to the Agricultural Research Institute at Pusa, and a lakh to the Central Research Institute at Kasauli.

Some of the local Governments have entertained, or propose to entertain, what they call in the Budget forest research officers. The Agricultural College in the Madras Presidency has for part of its title that of Research Institute. The Government of Bengal gives research scholarships. The Punjab Government enters a small portion of its contribution to Government colleges as research grant. In Burma a small sum is devoted to what are called leprosy researches.

The Budgets however, provide for many other forms of scientific activity in connection with which the word "research" does not happen to have been used, such as: further experimental work in connection with agriculture, bacteriological work as affecting man and animals, other investigations of a medical nature, and work relating to fisheries and other industries.

Further, various Governments support museums, in some of which, at any rate, scientific work is carried on, and our institute here at Bangalore receives an annual grant of Rs.87,500 from the Government of India, which has promised, should any private individual be willing to subscribe, to provide a like amount so long as its total grant does not exceed Rs. 1,50,000.

There are also the various Imperial surveys; in some of these the expenditure must, of course, be mainly debited to administrative work, but in the majority of them the funds do something towards the progress of science.

Without taking the surveys into account, the annual expenditure from public funds on scientific work in British India is somewhere in the neighbourhood of Rs.70–80 lakhs—that is to say, 500,000*l*.—and to this must, of course, be added large capital sums invested in buildings. This expenditure is supplemented to some extent by the more progressive of the native States, including, I need scarcely say, the State in which we have the pleasure to be at present. Lastly, private sources have contributed, but to a lamentably small extent. In this last respect there have been a few striking exceptions, and perhaps the foremost of these was the projected gift of the late Mr. Tata, to the carrying out of which by his sons our institute owes its existence.

Now I propose to deal with the question of research. Research is often alluded to as a perfectly simple operation; one even hears of men being "taught to research"; newspapers speak of it in the lightest manner, whereas in even my student days it was spoken of with almost bated breath as indicating something to which only the best of us could look forward, something which few of us were ever likely to carry on with any hope of success.

It is probably impossible to find a classification of research work devoid of considerable overlapping, and in many cases the motives are undoubtedly mixed, but it seems possible to recognise three classes: that carried on with the single purpose of ascertaining the truth in regard to the causes of things; that which has for its immediate object a specific utilitarian purpose, but still without any expectation whatever of a pecuniarily remunerative result; and research with the avowed object of making money out of it sooner or later.

The first and second classes would come under the head of scientific research in the sense in which the term is used by the Privy Council Department of Scientific and Industrial Research, while the third class is industrial research; but what I want to emphasise is the fact that the first class alone is research in pure science, while the second and third classes are both research in applied science—that is, science put to practical use; practical as distinguished from abstract or theoretical.

Huxley said that what people call applied science is nothing but the application of pure science to particular problems. The Advisory Council says that this no doubt is so; there are not two different kinds of science; at the same time it realises that it has to deal with the practical business world, in the eyes of which a real distinction seems to exist between pure and applied science. There are, however, men in the business world who see more clearly. An American manufacturer pointed out only the other day that "there are no sharp lines to separate pure from applied, scientific from practical, useful from useless. If one attempts to divide past research in such a manner he finds that time entirely rubs out the lines of demarcation."

But whatever terms have been used, the application of scientific knowledge for the good of mankind is as old as that knowledge itself, and one may safely say that the majority of those who have attempted this application have not been swayed by any pecuniary motive. The scientific agriculturist is not in most cases the person into whose pockets comes the money secured by the use of better methods. Medical science in all its branches is applied science, and although the doctor may earn his living by means of fees, medical research is not undertaken from pecuniary motives. It has been for the most part the application to a particular problem of the scientific knowledge of the day, and there has, of course, been no such application with a more noble purpose. Still, it is not pure science, and there have often been medical men who have left further application to others, while they have reverted to purely scientific problems.

What utilitarian research would have discovered the fundamental facts in regard to electricity or have led to the framing of the atomic theory? Who can say how many profound truths await discovery because some utilitarian who happened upon a glimmering of them did not think it worth while to pause and investigate the apparently irrelevant?

[1] From the presidential address delivered before the Indian Science Congress, Bangalore, January, 1917, by Sir Alfred Gibbs Bourne, F.R.S., K.C.I.E.

How much research has been undertaken by the student of pure science which he would have frankly admitted to be apparently useless? How much patient work and loving care have been bestowed upon investigations seemingly impossible of application to any of the specific problems of the day? Upon research of this kind no utilitarian would have been at all likely to embark, yet sooner or later such research has either proved capable of direct application or—and this has more often been the case—has unexpectedly formed a corner-stone, or occupied a more humble but still useful position, in building up some far-reaching generalisation capable of being seized upon at once by the worker in applied science, thus in turn perhaps stimulating further scientific research.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

CAMBRIDGE.—The subject proposed for the Adams prize essay for the period 1917–18 is "The Diffraction of Sound Waves." The solution of a typical problem or problems, such as that of diffraction by a circular or rectilinear aperture in a plane screen or by a circular disc, is desired free from approximations or restriction to relatively long waves. Treatment of the corresponding problems in electric waves is also suggested.

The question of compulsory Greek in the Previous examination has been very prominent during the present term. The case for the abolition of compulsory Greek has advanced greatly since 1905, when it was put to the vote and defeated. A syndicate appointed in 1913 to consider the regulations for the Previous examination reported that it was unable to recommend that Greek should continue to be a compulsory subject, and a new scheme was drawn up for the examination in which Greek was made alternative to French or German. Had it not been for the outbreak of war, this reform would probably by this time have become an accomplished fact, but, as it was, the discussion of the report was delayed until last year, and afterwards the syndicate expressed the opinion that it was inexpedient to bring the scheme before the Senate while so many members of the Senate were absent on war service.

Early in the present term the council of the Senate issued a report on the subject. The council agreed that it was inadvisable to proceed at once with the whole question of the reform of the Previous examination, since this should be considered together with the considerable modification and reconstruction of the educational system of the University which was likely to take place after the war; but it held that the question of Greek was of practical urgency at the present time, and it was of opinion that, as a temporary provision, the papers at present set in French and German (which are easier than those proposed by the syndicate) should be alternative to Greek. However, the council had ascertained that if a discussion were held and a vote taken in the existing circumstances, it would be greatly resented by some members of the Senate absent on war service, and it had accordingly decided not to take action at the present time. This aroused widespread disappointment in the University, and a memorial bearing a long and influential list of signatures was presented to the council asking it to reconsider its decision. A counter-memorial was presented; strong protests were also issued by a small number of residents now engaged on war service in various Government offices. The result has been that the council adheres to its decision to take no action at present, but the constitution of the Previous examination is to be considered further, so that it may be possible to take action immediately upon the conclusion of the war.

THE third conference of the Committee for the Development of Regional Survey will be held at Newbury on April 7–17, and it is proposed to make a detailed study of the town and region. No formal classes will be held or lectures given, but there will be daily conferences for the purposes of study. The committee hopes that sufficient workers will be able to attend the conference to make all aspects of the regional survey possible, physical, historical, and social. Members are asked to communicate with the hon. local secretary, Kingsbridge Road, Newbury.

THE governors of the Imperial College of Science and Technology have recently considered the conditions to be fulfilled in the case of students of the Royal School of Mines whose associateship courses of study have been interrupted by their undertaking service with the Forces of the Crown or other approved war-work, precedent to the award to them of the diploma of associateship of the Royal School of Mines in Mining or in Metallurgy or in Oil Technology. Instead of insisting upon the full four-year course, the opportunity is offered for a student to complete in three years the tests ordinarily imposed, having regard to experience gained during the war, and, in that case, the reduction is contemplated of the requirement as regards practical work (shifts) by one-third, and the possibility of a man making good in certain arrears of subjects during vacations, but it is considered inadvisable to make any curtailment of the work of the first and second years.

AT a representative and largely attended conference of examining bodies in Great Britain held on March 15 at the Board of Education under the presidency of Mr. A. T. Davies, chairman of the British Prisoners of War Book Scheme (Educational), it was unanimously decided, on the motion of Sir Edward Busk (University of London), to approve certain proposals for the encouragement and recognition of the studies pursued by prisoners during their internment. Steps are being taken to give effect to these proposals, and various examining bodies (including most of the universities) have already intimated their willingness to recognise work done and examinations passed in the camps, and to extend to the men on their return facilities for sitting for examinations under conditions which will take account both of their special circumstances and their needs. A message was read from the President of the Board of Education in which Mr. Fisher expressed sympathy with the objects of the conference and his belief that the result of its efforts would prove a great encouragement to the men to use wisely and well the time of their captivity, and, further, would be of material assistance to them on their return to this country. It is intended that the decision arrived at shall be communicated, as soon as possible, as "a message of encouragement and hope" to the various internment camps in enemy and neutral countries. In the meantime it was suggested that friends and relatives of student prisoners might do them a service if, when writing to them, they will direct their attention to the steps in this connection which are being taken on their behalf.

THE issue of the Journal of the Royal Society of Arts for March 9 contains a paper on "German Methods" by Mr. J. H. Vickery, read before the society on March 7. In it Mr. Vickery deals, among other matters, with German education and science. He points out that it is the habit of the Germans to refer to the English as being a "practical" people. But he urges that, in point of fact, the German has