

SCIENCE

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EDUCATION, SCIENCE AND LEADERSHIP¹

THE British Science Guild has sustained a grievous loss by the sudden death of Sir Alexander Pedler, who for eleven years was its valued honorary secretary. To all the work of the guild he brought wide experience and ripe knowledge. He gave his time freely to its service, and he has been a wise counsellor and a true friend during its early years. He died, as he would have wished, while engaged in work for his country.

Professor Gregory has dealt with our annual report and the objects at which we have aimed in the past year; but there is one matter to which I wish to direct special attention. The war has forced upon us the necessity for efforts to establish the manufacture of many articles formerly obtained mainly or entirely from abroad. Among such products and appliances are synthetic dyes, pharmaceutical and medicinal preparations, glassware and optical instruments, medical and surgical apparatus, and other important requirements alike of peace and of war. The fiction, if it existed, that German science was an essential factor in manufactures of this kind has been permanently dispelled. The guild is organizing an exhibition of British scientific products in order to show what has recently been accomplished by British science and industry. His Majesty the King has graciously consented to be patron of this exhibition and Lord Crewe is its president. The exhibition will be open at King's College next August, and we hope that it will effectively demonstrate the successful application of British scientific research and ingenuity brought into play to meet the needs of the war, as well as prove conclusively that our dependency on Germany in certain departments of industry can be overcome.

¹ Presidential address to the Annual Meeting of the British Science Guild, June 19, 1918.

Last year I endeavored to direct attention to some of the conditions which post-war reconstruction demands, and to indicate the direction in which we must move if we are not only to rebuild our national prosperity, but also to base it on broader foundations, so that it may be shared by every honest worker with hand or brain. Much has happened on sea and land since April of last year, and the war still dominates our activities and absorbs our thoughts. It has now been made plain to us all that the fate of the world will be determined on the western front, as was inevitable. And to the vast majority of the English-speaking peoples it has become clear that no enduring peace—no peace compatible with honor and such as would enable us to begin our great task of reconstruction—is possible until Germany accepts defeat. The Allies have frequently disavowed all desire to crush Germany out of national existence. That idea is a fiction invented, like many others, by her Prussian rulers to induce the masses to bear their growing burdens and to acquiesce in the reckless squandering of their manhood. It is in the general interest that Germany should remain a great power; but the accursed spirit which has been deliberately instilled into the German people—the spirit which is responsible for the greatest catastrophe the world has known, and for the infamies committed by the German navy and army—must be destroyed. Otherwise there can be no rest for mankind, and civilization will perish. The war, with all its cruel losses, sorrows and suffering, must continue until the menace of German militarism has ended and the nations of the world, small and great, are left free to develop in security on their own chosen lines. If ever there were doubts as to the issue, they have been dispelled by the splendid resistance which the Allies are offering to the German masses and by the gigantic efforts which America is making to bear her full share in the battle for human freedom.

In the year that has passed, our plans for reconstruction have made some progress, and we have gained more insight into our national needs. Always, as we seek to weigh our past

methods in the balance and to find remedies for the blemishes in our national, political and industrial life, the task before us seems to grow in magnitude and difficulty. And always, if we try to trace the ultimate cause of some failure, blunder, or sign of weakness, we arrive at errors of judgment due either to lack of knowledge or to neglect to apply knowledge that was available if sought. Two of the outstanding tragedies of the war—the operations in the Gallipoli Peninsula and the breakdown in Mesopotamia—have been exhaustively examined, with the result of proving that necessary knowledge was either ignored or not ascertained by the individuals responsible. In other cases, similar investigations must have led to the same verdicts.

The stern necessities of the war have forced upon successive governments the employment of trained non-officials in many capacities. The work accomplished under conditions of extemporization has been marvelous in amount, and it supplies evidence of our innate organizing capacities; but there has been lamentable waste. Government has not always succeeded in using experts to the best advantage. Square men have been too frequently placed in round holes, and in the building up of new departments of state the coordination of effort and the essential principles of sound administration have been palpably lacking. The foresight required to convert a peace-loving people into an armed nation and to fulfil on a sudden all the vast and various demands of the greatest of all wars is necessarily rare; but it can not be said that the best use has been made of the trained intelligence at our disposal, and our political methods have not proved well adapted to a supreme national emergency.

Meanwhile, we have been brought face to face with German efficiency, deadly in some aspects, because concentrated during many years upon deliberate preparation for world conquest. We are only now beginning to understand the meticulous care with which every requirement that could possibly be foreseen had been studied and provided for in advance. In the years before the war, we had often been warned of growing competition in

trade, and it was certainly true that German exports of home production to European countries were rapidly mounting and tending to supplant our own. This was due alike to advantages of position and of communications as well as to the far-sighted policy of the German government. In the general markets of the world outside Europe, however, we were more than holding our own, and Mr. H. H. O'Farrell has shown that in the periods from 1895-99 to 1910-13 we had nearly doubled our superiority to the Germans, owing largely to the magnitude and efficiency of our mercantile marine.

What we failed to recognize was that German peaceful penetration was directed to obtain financial control of certain key industries and vital raw materials in order that, when it was decided to light the fires of war we should be placed in a position of grave difficulty in the manufacture of munitions. A further object was, I am now convinced, involved. It was desired that as many influential persons as possible should be closely entangled in financial interests of which Germany held control, so that during and after war Germans in this country might obtain protection. In no other way can the amazing tenderness shown to Germans, which has given rise to strong resentment, be explained. The treatment of British subjects in Germany, and the liberty accorded to Germans among us offers a most startling contrast.

As little did we realize the strenuous German propaganda stealthily at work all over the world before August, 1911, and since develop with lavish expenditure. Every country of the Allies and of neutrals has felt this malignant influence. Mainly by its agency, Russia has been brought to ruin, and the fair hopes of victory last summer, which we were justified in cherishing, have been deferred. Italy was brought close to disaster by the same means, but has nobly rallied. France is still dealing with the unseen hand, and America has been forced to take drastic measures. Here, as in Ireland and in India, the effects of the most insidious weapons of the German government

have been felt, and they have not yet disappeared.

I mention this as a typical example of German efficiency and forethought of a kind which the British nation would rightly have scorned, but which have told heavily in the war and must be guarded against in the future. In the higher regions of statesmanship, that efficiency has inevitably failed. A government which confidently believed that it had the right, by reason of the alleged inherent superiority of the German nation, to force its will upon all other peoples, was naturally unable to understand their mentality; and the arrogance bred of the consciousness of military strength entailed serious miscalculations for which Germany will pay heavily. Impressed with the baseless idea that atrocities, if sufficiently revolting, would intimidate her enemies, the kaiser and his accomplices have succeeded in arraying against themselves all the free nations in the vanguard of progress. They have made the German name and Kultur by words and synonyms of barbarism. They will find that the moral reprobation of the civilized world will dog their footsteps in the years to come, and that the final overthrow of the power of their present governing classes will be the necessary first condition of their readmission to the family of nations. We can learn from German methods what to avoid.

In our projects for national reconstruction there is perhaps a tendency to regard increased industrial and commercial efficiency as paramount. This may be natural, because nothing but a great development of economic production within the empire can restore our heavily burdened financial resources. But, if we read the lessons of this war aright, we must see that this alone can not suffice, and that our industries might be paralyzed by antagonistic forces arising from want of other than purely technical efficiency. Peace will find us face to face with new problems of democracy still unsolved. A huge new electorate will convey political power to masses of men and women for the most part slenderly equipped for the responsibilities which they must assume. Democracy is still on its trial,

and its limitations are frequently forgotten. The masses can never build; but they can always and easily destroy, as the wrecking of Russia, following historical precedents, plainly shows. They can, however, for good or for evil, choose their rulers and displace them when they please. The theory that the intensely complex and vastly important work of modern governments can be continuously inspired by the will of the people is untenable. The hopes of the future depend upon the trained and disinterested leadership of a minority, in the workshop as in the cabinet, and upon the intelligent acquiescence of the majority.

During the war, the duties normally undertaken by government have been immensely extended and not always satisfactorily discharged. It has become more than ever clear that private enterprise and initiative, by which the trade and commerce of the empire were built up, are far more efficient than the agency of government. But there is work to be done which must be entrusted to government and to elected local authorities; and private enterprise will need assistance in certain directions, and some measure of wise control in others. When peace comes, more will be demanded from our governments than they have been accustomed to undertake in the past, and trained intelligence in our departments of state and wherever leadership and direction are required will be the essential condition of successful reconstruction. Of the future of democracy, nothing is certain except that it must inexorably depend upon the character of the acquired knowledge of the leaders whom the enfranchised masses elect to follow. And as the choice of leaders will be decided largely by the moral and intellectual equipment of the masses, the importance of sound and widely diffused education must be vastly enhanced in the years to come. Germany has shown to the world the appalling results of an education directed to Prussianize a great people and to concentrate their minds upon materialistic ideals to be enforced by arms on other nations. Our education must seek to inspire ideals of another kind—the true patriotism

which places the national welfare in the forefront of its efforts, which desires nothing at the expense of other peoples, which regards peace as the greatest of blessings and the sure safeguard of the progress of mankind, and relegates force to the righting of wrongs in the last resort.

Since the last annual meeting of the guild, all questions of education have been under discussion, and we now know better where our weakness lies and the entent and nature of our needs. In the number of our institutions providing higher education America alone stands ahead of us. Sir Robert Hadfield has pointed out that Great Britain and Ireland have one university per two and one half millions of population as compared with one million in America. In the dominions, on the other hand, where the population is relatively sparse and the distances great, the proportion is one university to two thirds of a million of people. This numerical comparison is, however, misleading, except that it indicates educational centers capable of extending their activities. The true criterion is the number of students who undergo a complete course of training. Of full time students only 4,400 entered our universities in 1913-14, and of them several hundred were foreigners who would subsequently leave this country. Putting the output of university and technically trained men and women in another way, it appears that per 10,000 of population there were 16 full time students in Scotland, 13 in Germany, 10 in the United States, 6 in Ireland, 5 in England and 5 in Wales. The figure given for the United States includes only students at universities and technical schools of recognized standing. If all students taking four-year courses at such institutions were included the rate per 10,000 of population would be doubled. It is impossible not to believe that these figures help to account for the high standard of intelligence in Scotland and America and for the success of the Scottish and American peoples in many spheres of activity, while the relative backwardness of England, Ireland and Wales must exercise an influence in public life.

The financial test shows a deplorable inferiority to the United States and Germany, and must indicate roughly the relative importance attached to higher education in these countries and our own. Thus the total incomes of state-aided modern universities and university colleges in England and Wales is about £700,000, of which 34 per cent. is derived from parliamentary grants. The corresponding figures for Germany are nearly £2,000,000 and 80 per cent., and the University of Berlin alone receives from the state an annual grant nearly equal to that given to all the university institutions of England and Wales. The annual income of the American universities and colleges is £20,000,000, of which £7,000,000 is at the disposal of the colleges of agriculture and mechanical arts. Private benefactions towards higher education in the United States amounts to more than £5,000,000 a year. With us they do not reach one twentieth part of this sum.

The only possible inference from these figures is that, as compared with the United States and Germany, our higher education is lamentably inferior in quantity. We are not producing trained leadership sufficient for our needs, and the diffusion of knowledge is pitifully inadequate to the requirements of a modern state. If an analysis of the kind of training received by our governing classes were possible, it would be found that scientific knowledge was exceedingly rare and even non-existent in some quarters, where it is essential. Sir Robert Hadfield states that in one important government institution devoted to educational work, about 90 per cent. of the principal officials have received a classical training, and only 5 per cent. have been educated in science. Mistakes and inertia in the direction of public policy and in administration are thus explained. There is not enough knowledge of the right kind in governments, departments of state, or parliaments, while, in the world of industry, a sufficient supply of trained research workers can not at present be obtained. Until this requirement is fulfilled, the development of new industries on a large scale must be impracticable.

The excellent report of Sir Joseph Thomson's committee on the position of natural science in education throws a flood of light on our national deficiencies, and points the way to educational reconstruction. The committee justly claim for sound science teaching that:

It quickens and cultivates directly the faculty of observation. It teaches the learner to reason from facts which come to his notice. By it the power of rapid and accurate generalization is strengthened. Without it there is real danger of the mental habit of method and arrangement being never acquired.

All thoughtful students of our public affairs must admit that, alike in peace and in war, our leaders in all classes have shown a certain lack of the qualities which science training can impart, and that national interests have suffered grievously for this reason. The power of reasoning from facts and of "rapid and accurate generalization," combined with the habit of "method and arrangement," is the best possible qualification for cabinet ministers as well as for all leadership on lower planes; and the British Science Guild has persistently urged that science should take a prominent place in the education of our public servants.

The committee recall the fact that the neglect of science was noted by a Royal Commission on the public schools more than half a century ago. The position of scientific instruction in the United Kingdom was also surveyed in detail in 1872-75 by a royal commission, of which the Duke of Devonshire was president and Sir Norman Lockyer, the founder of this guild, secretary. But although there has been advance in recent years, it has required the shock of a world war to make us broad to our shortcomings. The champions of classical learning are now moderate in their claims. The Council for Humanistic Studies declares that the future citizen should possess knowledge, not only of the physical structure of the world, but of "the deeper interests and problems of politics, thought and human life," and that he needs "scientific method and a belief in knowledge even more than physical science." This marks a change of attitude, and the advocates of the dominance of science in

education would agree, with the proviso that applications of science unknown to the ancients determine the conditions of health and of economic stability in modern life, and that a "belief in knowledge" and "method" in pursuing it are best inculcated by the study of law in the natural world.

The great merit of Sir Joseph Thomson's Report is that it discloses the present causes of the weakness of science in our education. The universities as a whole now show a bias in favor of science teaching, but there is a deplorable lack of students due partly to weakness in the schools and partly to the influence of scholarship examinations in which classics predominate. Thus the old universities, by their scholarship systems, tend to discourage science teaching in the public schools, and the public schools react upon the preparatory schools. It follows that many of the most intelligent boys are deterred from entering upon a scientific career. It is also possible that some class prejudice, based upon long tradition, dating back to the Renaissance, may still operate against science training. The recommendations of the committee are wise and far reaching; but I can only give the barest indication of their objects and scope. Nature study in primary schools up to the age of twelve is to be the foundation, and instruction in science up to the age of sixteen is enjoined upon all secondary schools, physics and chemistry to be taught, because all other sciences, to which they should be treated as passports, require some knowledge of them. Mathematics should be connected with science at an early period. The general aims of a science course at school age are defined with a view to secure two educational objects of primary importance: (1) To train the mind to reason about things the boy observes himself, and to develop powers of weighing and interpreting evidence. (2) To develop acquaintance with broad scientific principles and their application in the lives of men and women.

No better foundation for the training alike of the statesman, the leader of commerce and industry, and the manual worker, can be laid down. The committee were strongly im-

pressed with the importance of manual work at school age, and speaking from personal experience I am certain that I owe much to the handling of the file and the lathe before I entered the army, although mechanical pursuits at one time caused me to neglect other studies. I believe that if all classes underwent some manual training there would be a better understanding of the dignity of labor. Rightly distrusting examination tests of conventional type, the committee recommend the inspection of all schools.

Higher standards of teaching power, coordinated training from the primary school to the university and to the post-graduate stage, with a lowering of fees and a liberal allocation of scholarships to be awarded for "intellectual merit and promise," and not in accordance with the results of set examinations—such are the educational ideals which are set before the country. By these means we may hope in time to develop intelligence now wasted, as the committee point out, to supply our present deficiency of experts in all branches of science, and to secure more orderly methods of administration and a higher standard of leadership.

The American Declaration of Independence unfortunately proclaimed without qualification that all men are born "equal," and this theory has proved very harmful. In physical, as in intellectual capacity, men show the extremes of inequality. From the technically entitled "feeble-minded" to the intellectual giant there is an infinitely graduated range of ability in all classes. Heredity may confer some advantage; but genius generally mocks at heredity, and the frequent rise by sheer ability of men from the ranks of manual workers seems to prove that brain power in the case of a fairly homogenous race exists in due proportion in all classes. The object of national education must be to provide, so far as possible, equal chances for natural talent wherever it is to be found. Otherwise, there must be loss of national efficiency. At the same time, it must be remembered that marked intellectual power will always be the possession of a minority, that real leadership will always be rare, and that training in all classes may be wasted if

carried beyond the inherent capacity of the individual boy or girl.

Mass education will at best only approximate roughly to the ideals we set before us; but it can do much by stimulating the available intelligence, and by not only disseminating, but instilling the desire for knowledge, which is the essential foundation of sound judgment and the vehicle of truth. Thus the great education bill which awaits the sanction of parliament will have far-reaching effects upon the national life in the future. Continuity till the age of fourteen at least will provide an increase of school time which can be turned to good account, and will put all boys and girls on one equality; compulsory further part-time training to sixteen and later to eighteen will ensure a minimum of teaching to the whole of our youth, and it will have the great advantage that the state will be able to watch over a critical period during which careers can be made or marred. It is a sad fact that at present many more than two and one half millions of our boys and girls between twelve and eighteen have no opportunity of education and may be neglected in body and soul. Mr. Fisher has made wise provision for physical training, which will help to raise the standard of national health, and if the churches and denominations could arrive at some agreement, it should be possible to inculcate duty and discipline, honor and true patriotism, based on the eternal principles of righteousness.

Whether the bill will secure higher training for the children who show special ability must depend upon numerous scholarships awarded only to those who show fitness, and upon the reduction of university fees in special cases. Of about 600,000 children who now leave the elementary schools annually, only about 1 per 1,000 reaches a university. This is far too low a proportion, and it indicates the denial of that equality of opportunity which must be our ideal. I believe that education attained at some self-sacrifice is enhanced in value to the recipient; but, where there is absolute necessity, it is for the state to ensure that the gifted boy or girl shall not lose the chance of distinction. If the recommendations of Sir Joseph

Thomson's Committee are grafted upon the machinery of the education bill, there should be a great increase in the number of science students. The manual workers will not only have no bias against science as a career, but are likely to be attracted towards it. We may hope in future to draw from them a valuable reinforcement to the trained research workers, who will be more and more needed in every department of industry, while they will strengthen the ranks of the leaders of thought in all branches of public and private activity. Education will always depend upon the character, personality and enthusiasm of the teacher, and one great merit of Mr. Fisher's Bill is that it will raise the importance and dignity of the great profession of teaching.

The war has changed the whole outlook of the nation, swept away many prejudices and revealed alike our strength and our weakness. Our fighting men on sea and land and in the air have given to us inspiring examples of patriotism, gallantry and cheerful endurance. In spite of some unpleasant symptoms, the heart of the British people has proved sound and true when tried in the furnace. "The former things have passed away," and our country can never again be as it was four years ago. The reconstruction which lies before us involves political, social and economic changes for which the lessons of the war, if we turn them to full account, can smooth the way. The strenuous work of all classes with hand and brain is the essential condition of industrial regeneration. For well-known reasons, among which want of trust between employers and employed is prominent, our production has been far below that of America. This grave defect must now be removed by shared counsels and frank mutual understanding. Capital and labor are indissolubly bound together by common interests, which are also the interests of the nation as a whole. Nothing except harmonious cooperation, based on good-will and directed by trained intelligence, can ensure the increased and well-ordered production upon which good wages and the social reforms which we all desire absolutely depend. A more equable distribution of wealth will be

a national advantage; but unless wealth is continuously created we can not make good the huge wastage of resources which the war has entailed, and we shall be faced with bankruptcy. Much more is, however, required of us. In the cleansing fires of war, the gold and the dross have been thrown into sharp contrast. If we are to rebuild our national life on purer and healthier lines, so that it may be worthy of the heroes who have fought and died to save Britain from the greatest peril she has ever encountered, the gold must be cherished and the dross must be discarded. The whole future of the empire will be determined by leadership in all classes alike—leadership inspired by self-less motives and based upon patriotism and knowledge.

In the "Wisdom of Solomon" there are words which democracy must take to heart if it is not to prove a disastrous failure. "Neither will I go with consuming envy; for such a man shall have no fellowship with wisdom. But the multitude of the wise is the welfare of the world."

SYDENHAM

AGRICULTURAL TEXT-BOOKS FOR OUR PUBLIC SCHOOLS

ONE of the results of the activities of the agricultural colleges and the experiment stations is the production of an immense quantity of both general and special literature on agriculture. In this literature we find an increasing number of text-books intended for the use in our public schools. This, in itself, may have been influential in stimulating the modern public demand for agricultural instruction in the public schools of both the country and the towns—a demand which is very sane.

It is a matter of common observation of those who have had the opportunity to observe, that nowhere in the old world do we find that interest in the soil and its products among the non-farming classes, or as great a respect among them for the tilling and the tiller of the soil as in America. In many places of Europe, there yet lingers the prejudice of the city dweller against the peasant,

who once was tied to the soil and owned by the owner of the soil, for whose support it had pleased God to allow him to exist.

In this country, it is a frequent occurrence to find business and professional men of the city, not only to pride themselves on their skill and experience as cultivators of the soil, but to carry that skill and experience into actual operation in their management of rural affairs. Hence, the teaching of agriculture in all of our public schools of both city and country is an increasing demand. The exact scope of this teaching and to what classes, or what maturity of pupils it is to be applied, seems yet to be an unsettled question, judging from the nature of a large part of the many text-books published for this purpose.

Some of these text-books seem by their style of language to cater to the tended minds of the primary grades, but in their scope and the nature of the topics to be intended as guides for the professional farmer in his practical operations. Agriculture, as a subject in our public schools will fail to educate and entertain the minds of the pupils, if heavily burdened with dry recipes for increasing the number of dollars, or lectures upon mere physical operations of running a farm. The highly interesting biological, chemical and physical principles underlying these operations would, however, not fail to stimulate and elevate the young mind, as adding interest to the operations in themselves. The language, too, in which these subjects are taught, should be in a simple, yet good virile English, and not in the blabber of the baby; for no ambitious boy or girl is willing to stoop to a lower level of intelligence, but anxious to reach out for a higher.

In several of these text-books on agriculture, we find some very strange incongruities; for example, matters requiring a well developed intellect and considerable maturity of judgment for their comprehension are discussed in a language suitable to the kindergarden tot. One author, in describing the nitrogen-generating bacteria on the roots of the legumes, regrets that he has to use the big word, *tubercle*; but admonishes his pupils to learn