

referring to some of the salient discoveries during this period, he pointed out that each decade since has witnessed a lengthening of the course, an increase in the number of subjects of examination, and a greater stringency in the standard required. The modern curriculum is an attempt to realise a scientific ideal. At every stage practical work goes hand in hand with the teaching of theory. The result is that, even with the present five years' minimal course, anatomy, instead of being, as it used to be, the one dominant subject of drill, has to take its place as one out of five sciences in which laboratory work has to be done. He then made some remarks on the mystery of life, holding that the physicochemical hypothesis of life which has come into vogue is inadequate. Evolution is the name we give to the modal process of growth, but we are left where we were as regards the mystery of origins, or of the forces by which this process is brought about and directed. But if the physicochemical hypothesis is incompetent to account for the mysteries of organisation, it is still more inefficient as an explanation of the psychological processes of consciousness.

Prof. Myers also delivered an introductory lecture on the aims and position of experimental psychology, at the close of which he dealt with what he described as the inadequate provision of the University of London for the teaching of psychology. The subject is recognised in six separate courses of study in the University; this distribution is harmful to its progress. It is an independent science with methods which are distinctly its own. Yet there is no body of professed psychologists within the University. He pleaded for the institution of a board of studies in psychology in order that the teaching of the subject may be reorganised and coordinated. Describing the provision made for the teaching of psychology on the Continent and in the United States, Dr. Myers showed that London is conspicuously backward, and he said there are not more than half a dozen medical men in the country who could carry out such observations upon a patient as would satisfy a psychologist.

The Huxley lecture, on recent advances in science and their bearing on medicine and surgery, was delivered at Charing Cross Hospital by Sir Patrick Manson, F.R.S. The lecturer dealt first with the geographical limitation of disease and the factors causing it—local and climatic conditions, the presence of other forms of life which act as intermediaries for the germ, &c. The principal tropical diseases are caused either by protozoa or by helminths. So far as we accurately know, none of the disease germs of strictly tropical diseases is bacterial. Several bacterial diseases which are often classed as tropical—for example, cholera, certain kinds of dysentery, leprosy, plague, Mediterranean fever, &c.—are not really tropical. Experience has shown that these diseases can flourish in any climate. It is only because those hygienic and social conditions most favourable to their spread are met with at the present day in greatest perfection in the tropics that they are conventionally regarded as tropical.

At St. George's Hospital Dr. Slater took as the subject for his address the laboratory in medical education and practice, in which he demonstrated the growth of knowledge of morbid states consequent on investigations carried out in the laboratory. It is quite certain that if the maximum benefit is to be derived from the laboratories, consultations between the clinician and the laboratory will have to be more resorted to.

At the Middlesex Hospital Mr. Rudyard Kipling presided, and Dr. Kellas delivered an address on the development of medicine as a science, giving an interesting account of the history of medicine from the earliest times.

At St. Mary's Sir John Broadbent remarked on the great advances that have been made in medicine, as in surgery, in recent years, and deplored the tendency of modern times to fly to the so-called remedies for every ill now advertised widely in the daily Press.

Addresses were also delivered at the London School of Medicine for Women by Dr. Sainsbury; at University College, Bristol, by Sir Rubert Boyce; at the University of Manchester by Sir Clifford Allbutt; and at the Pharmaceutical Society by Mr. Harwood Lescher.

THE BRITISH ASSOCIATION.

SECTION L.

EDUCATION.

OPENING ADDRESS BY PROF. L. C. MIALI, D.Sc., F.R.S.,
PRESIDENT OF THE SECTION.

Useful Knowledge.

I PROPOSE to speak to you about useful knowledge, and you will, I think, admit the importance and the appropriateness of the subject. But you may be surprised that I venture upon so wide a theme. For my part, I maintain that the extent of a subject gives no notion, however vague, of the time required to discuss it. If you have a quarter of an hour and a sheet of paper you may employ them with about equal probability of success in delineating a hand's breadth of greensward, or the British Isles, or the whole world. Bossuet handled universal history from his own point of view in a volume of no more than six hundred octavo pages, and Buffon¹ remarks, quite truly, that every subject, no matter how vast, can be treated in a single discourse. You will observe with satisfaction that I deny myself the commonest and most plausible excuse for an unduly prolonged address; that, I mean, which pleads the magnitude of the subject.

I do not wish to exaggerate the importance of useful knowledge. It is not everything, nor yet the highest thing in education. There are things which we rarely mention in a British Association section, and which are perhaps best left undiscussed, except where there is entire sympathy between speaker and hearer; some of these stand above useful knowledge of every kind. But the fact that useful knowledge occupies nearly all the school-time shows its practical importance, and disposes us to welcome any means of making it more effective.

*Book-learning.*²

The knowledge of books may be an excellent form of useful knowledge; it may also, when it strives merely to record and remember, be unproductive and stupefying. Let me give you an example, by no means an unfavourable one, of the book-learning which becomes sterile for lack of method and aim. My example shall be the elder Pliny, Pliny the naturalist, who lost his life in an eruption of Vesuvius, and whose many virtues were piously described by his nephew, Pliny the younger. The elder Pliny wrote a voluminous Natural History, and left behind him 160 books of unused extracts. His appetite for reading was insatiable. Reading filled all the hours which could be spared from public duties or snatched from sleep. Once, when a friend interrupted the reader to correct a mispronunciation, Pliny asked, "Did you not understand?" "Yes." "Then why did you interrupt? You have made us lose ten lines." The Natural History compiled during years of such reading is wholly uncritical; any testimony is good enough for the most improbable story. We look in vain for interpretation, combination, or inference. The facts are indeed rudely sorted, usually according to subjects, but sometimes alphabetically. The chief use of Pliny's Natural History has been to promote the fabrication of more books of the same kind.

Pliny, with his unlimited appetite for knowledge and his very limited power of using it, might seem to have been taken as a pattern by scholars. Like him, they have amassed knowledge in heaps. It has been the ambition of many scholars to read everything that was worth reading, and to fill great volumes with the imperfectly digested fragments.

In the ages of learning, the schoolmaster too became a pedant. His chief duty he supposed to consist in furnishing his boys with knowledge which they might some day

¹ "Discours à l'Académie."

² In the preparation of this Address I have been much embarrassed by the inexactness of the terms used to denote different studies. Some, such as science, literature, &c., include both process and product, which is as if we had but one name for weaving and cloth. The accepted names of the divisions of knowledge are neither exhaustive nor mutually exclusive; they are not so much logical terms as names of occupations, each of which might well occupy one man's time. We acquiesce in such anomalies because we feel the need of brief and comprehensive expressions, and find that bad definitions are not so intolerable as cumbersome and unfamiliar terms.

want. If it were not that Nature has endowed school-boys with a healthy power of resistance, their memories might have come to resemble the houses of those who believe that whenever they throw a thing away they are sure to want it again—houses in which room after room is so packed with antiquated lumber as to be uninhabitable.

The Renaissance called up men who made a vigorous protest against unused learning. Rabelais put into grotesque Latin his opinion that the most learned scholars may be far from the wisest of men.¹ Montaigne said over again in pointed phrases what common-sense people had been saying for ages, that he who knows most is not always he who knows best; that undigested food does not nourish; that memory-knowledge is not properly knowledge at all.² Erasmus wondered at the practical ignorance of the scholars of his own days—"Incredibile quam nihil intelligat litteratorum vulgus." Locke refused the name of knowledge to book-learning; real knowledge, he held, was mental vision. In the educated man he valued virtue, wisdom, and breeding (manners), ranking them in this order; learning came last of all.³

Happily for us, a great deal that we once knew and might foolishly wish to keep quickly fades from the memory. I picture to myself a stream gliding past, and bearing along a miscellany of facts any of which may possibly be useful at some future time. Now and then we stretch out a hand and grasp something which takes our fancy. In nine cases out of ten we drop it immediately. Only a small fraction of the knowledge which enters the mind of an inquisitive person is kept for so long as a month.

What we remember so greatly exceeds what we can use that we need not deeply regret the loss that is always going on. When people explain to us how much valuable substance is wasted by want of care in selecting and preparing our food, I reflect that all of us consume twice or thrice as much food as we can do any good with, and then I am consoled. It is not nearly so necessary to know more things as to know them better, to know what to do with them.

No doubt we often find it necessary to recall a multitude of small facts, in order, it may be, to elicit a general conclusion or to produce a telling argument. But is it wise to prepare years in advance by storing all the facts in the memory? I cannot think so. The study of the bodies of animals teaches us that muscle and nerve, which are easily fatigued and require an abundant blood-supply, are never employed in Nature where bone or tendon will serve. Exercise of the memory involves nervous strain, and after an early age a considerable nervous strain. It is more economical and more business-like to employ mechanical contrivances rather than brain-tissue for such purposes, to leave the vast mass of useful facts in grammars, dictionaries, and text-books, and to collect those for which we have a present use in the notebook or the card-index. There is another appliance which the serious student finds almost as useful as the notebook or the card-index—I mean the waste-paper basket.

The history of learning warns us that it is not good to lay up in our memories a great store of knowledge the use of which lies far in the future. Apply to knowledge what moralists tell us about money. It is only the money that you may expect to put to use within a reasonable time that does you any good, and the same holds true of knowledge. Unused knowledge, like unused money, becomes corrupt. Uncritical, ill-mastered knowledge is at its best a knowledge of useful things, which, as Hazlitt points out,⁴ is not to be confounded with useful knowledge.

If I felt it necessary to show that all book-learning is not futile, I might dwell upon the great subjects of languages and history. But you will gladly allow me to pass on to branches of useful knowledge with which I am more familiar.

Science.

It is the function of science to produce verifiable knowledge. Science achieved her earliest successes by investigating the simplest properties of tangible things—number, form, uniform motion. Here she learned how to combine the knowledge of many concrete facts into general statements, which (to the confusion of thought) we call scientific laws. Science applies her general statements to new cases, using facts to make general statements, and general statements to discover or verify facts, so that a considerable part of scientific knowledge is in perpetual use. Science is no longer content with the study of simple properties and tangible things. She will consider facts of every kind as soon as she can find the time. There is no hope of withdrawing from scientific treatment any kind of experience which the human senses or the operations of the human mind furnish; to be safe from the inroads of science you must betake yourself to some study which does not meddle with facts.

Generalisation involves incessant reference of effects to their causes. Facts can only be ill-classified and superficially generalised so long as the causes of the facts remain uninvestigated. Science of any good kind sets up, therefore, the habit of methodical inquiry and the habit of reasoning—productive reasoning, we might call it, to distinguish it from the reasoning of the schools. The best examples of productive reasoning are to be found in the investigations of science, and especially of those experimental sciences which deal with simple tangible objects the properties of which can be studied one at a time.

The virtues of science are exactness, impartiality, candour. Scientific impartiality means the determination to accept no authority as binding except the assent of all competent persons. Scientific candour means perpetual readiness to revise opinions which are held in respect. Loyalty, except of one kind, loyalty to herself, science has no use for and does not cultivate.

I think it is true, but you can judge as well as I, that during the last four centuries there has been no generator of useful knowledge at all comparable with science.

Spencer's Estimate of the Place of Science in Education.

Herbert Spencer has raised the question: What knowledge is of most worth? He considers knowledge in its bearing on life and health, on the gaining of a livelihood, on citizenship, on artistic production and enjoyment; lastly, as a means of discipline. The answer which he gives under each head is "Science"; that is his verdict on all the counts. A decision so clear, which is, moreover, powerfully and even eloquently supported, cannot fail to be impressive. It is naturally welcome to those who are devoted to the cause of science, and we can all see that, if accepted, it will simplify many troublesome questions. Will it not guide us in choosing a school staff, in drawing up a curriculum, in fixing the future occupations of our children?

But we must first scrutinise the verdict itself. Let us begin by putting a preliminary question so as to remove all risk of ambiguity. Who or what is to possess the knowledge the worth of which is to be estimated? Spencer seems to contend that for everybody and in all possible circumstances science is that knowledge which is most valuable, but this is a conclusion hard to receive. There are persons who are intellectually unfit to acquire the scientific habit of mind, or who follow an occupation incompatible with any but a light and recreative study of science. Suppose that a youth is wholly uninterested in science; or that after fair trial he shows no capacity for it; or that he is eager to become a poet; or that he will inherit a lucrative business in which science plays no part; would not these propensities and circumstances modify our choice? I cannot believe that Spencer was so impractical as to deny them any weight at all. Is it possible that he was thinking of mankind, of the British nation, or of some other large collection of men; that it is to the nation or the race that science will prove itself of most worth? If this is the right interpretation, we have some ground for blaming Spencer's neglect to mention so important a qualification. Those who admit that the nation requires scientific knowledge beyond knowledge of any other kind

¹ "Magis magnos clericos non sunt magis magnos sapientes" ("Frère Jean des Entommeurs in Gargantua," i. 39).

² "Essais," i. xxv.

³ Rabelais, Montaigne, and Locke have been collated by Quick in his edition of the "Thoughts concerning Education."

⁴ "Round Table," Classical Education.

are not compelled to maintain that the individual man must give his chief attention to science. A minute division of labour, intellectual as well as manual, is necessary in modern life, and we become every day more dependent upon other people's knowledge. An elementary knowledge of many sciences, such as Spencer valued and himself possessed, steadily becomes less attainable, and less applicable to real business; less attainable, because the standard is always rising; what was a respectable acquaintance with science in the days when Spencer was educating himself would now be thought no better than a smattering; less applicable, because business now requires and commands the science of experts. The instances which used to be quoted half a century ago of workmen who attended a course of chemistry in a mechanics' institute, and straightway suggested improvements in the manufacturing processes upon which they were engaged, have become rare, and will soon disappear altogether. Business demands the very best science that the age can supply, and it can afford to pay high enough to get it. Obviously the best knowledge of any kind can only be possessed by a few.

Spencer seems to expect that every intelligent mother should enjoy a knowledge of human physiology which will be a sufficient practical guide for the rearing of a family, but here, too, I have my doubts. Since the first publication of his essay the requirements of human physiology have risen in a surprising degree. The knowledge that can be got by reading even so admirable a text-book as Huxley's "*Lessons*" does not nearly suffice for the practical adviser. On this point I can speak with experience. When I was preparing for biological work I dissected the human body, took out courses in physiology, and walked the hospital. But this tincture of professional knowledge, though better than that which any elementary or secondary school could supply, has never proved applicable, except to the least serious of emergencies. A little knowledge may indeed be dangerous when it is applied to the diagnosis of disease or to sanitary construction.

Those who agree with me that the science which is applicable to industry or to public health is steadily growing harder of attainment will not, I hope, turn this into an argument for restricting the study of science to a few. The elementary science of the school, if good of its kind, is valuable for its effect upon the character and the intelligence; it is necessary for the timely discovery of young people who can be trained to carry on scientific discovery; and it engenders a sympathy with science which is of high importance to the State. If the science of the school does no more than make the phenomena of everyday life a little more comprehensible and a little more interesting, it will fully justify itself.

Spencer would, I feel sure, have admitted that even when science is to be the chief occupation of after-life, it should not occupy more than part of a well-ordered course of school-study. The chemist or physiologist often requires to express his own meaning by speech or writing; it will be highly advantageous that he should express it clearly and vigorously. He must get effective command of at least one foreign language. He ought to know enough mathematics and drawing to make his own calculations and sketches. He ought to have learned how to use books. Spencer does not exclude literature and the fine arts from education, but in his scheme they are not to claim very much. "As they occupy the leisure part of life, so should they occupy the leisure part of education."

I do not suppose for a moment that this passage was written with the intention of pouring contempt upon literature, and it is really appropriate to the current fiction which to-day is, and to-morrow is cast into the oven, but what insensibility to the claims of the higher literature it betrays! "On traite volontiers d'inutile," says Fontenelle, "ce qu'on ne sait point; c'est une espèce de vengeance."¹

These considerations move me to reject Spencer's verdict. There is not, and cannot be, a scale of usefulness by which everybody's choice can be at once determined. Before deciding what the schoolboy is to study we must inquire what are his aptitudes, inclinations, and oppor-

tunities. And the importance of science, which I do not think Spencer has exaggerated, will be fully recognised when every nation and city, every profession and trade, every person and interest, can be guided as often as need arises, not by their own scientific judgment, but by the judgment of scientific experts.

Preliminary Scientific Medical Studies.

Everyone agrees, in the abstract, that scientific information, the heap of scientific facts, is a small matter in comparison with scientific method and the scientific spirit. We do not, it is true, give effect to our convictions in practice. The teacher of science still loads the memory with facts; the examiner in science still passes or ploughs according to the quantity of facts that the candidates have got up. It requires an effort to keep hopeful, but we must go on steadily pointing out what we take to be the right way. The reformers of science-teaching are now bent upon such improvements as these: they wish to see a greatly improved synthesis of the student's knowledge, so that the things that he learns in one place and from one teacher should be intimately combined with what he learns in another place and from another teacher. Further, they wish to see a large extension of personal inquiry and personal verification of the fundamental scientific facts. It is thus, we think, that the future man of science will become possessed of a compact and harmonious body of useful knowledge, which may in favourable cases incorporate with itself the experience of after-life, and exhibit the incomparable virtue of healthy natural growth.

I will continue the discussion a little further with reference to the great problem of the scientific education of the medical practitioner, which has occupied the attention of the scientific world during the whole time of my long professorship, and still seems far from permanent settlement. Medicine is at present our one great scientific profession. It brings science into the daily life of every one of us, and employs it for the protection of some of our dearest interests. The scientific basis of medical knowledge should be sound, compact, well mastered, and, if possible, productive. I will go on to consider what it actually is, forming my opinion upon thirty years of experience in teaching elementary science to medical students.

Let me begin by making a concession to those who think that things are pretty well as they are. Remembering distinctly what the medical student was thirty years ago and more, I find that the first-year's university student of medicine at the present day is in all respects a better man, more serious, more enlightened, more capable. I find too that his preliminary scientific course seems to do him real good. It is far from perfect, but it is a great improvement upon anything that existed in the remote days when I was myself a first-year's medical student. The labours of the last thirty or forty years have not, in my opinion, been thrown away.

Nevertheless the preliminary scientific studies of the medical man are far from being as effective as they ought to be. Much of his time and effort are spent in laying up heaps of knowledge for which he is expected to find a use at some distant day. The items of scientific knowledge still require to be firmly bound together, and indissolubly associated with professional ideas and with professional exigencies. It is only close association with the work of the practitioner that can keep his knowledge alive.

The preliminary scientific course should give practice in the methods of chemistry, physics, and biology. It should prove by definite evidence characteristic scientific truths. Lastly, it should be closely related to medical practice. Looking round for an inquiry which will satisfy these conditions, one inevitably thinks of the teaching of Pasteur, which is now recognised as fundamental in medicine, surgery, and hygiene. Is it possible to give the future medical practitioner a firm grip of that teaching? I think it is. The first part of the preliminary scientific year I should treat as preparatory. It ought to acquaint the student with the methods which chemistry, physics, and biology employ for the establishment or the criticism of scientific statements. Methods of detecting and estimating; of observing small indications; of drawing; of

¹ Dr. Duncan's "*Life*" furnishes proof of the slightness of Spencer's obligations to literature.

recording results; of putting questions and bending the mind to their solution, should receive particular attention. The multifarious learning of the text-books should be put aside in order that undivided attention may be given to investigation and proof. I would leave it to the teachers concerned to supply the appropriate training, and to certify that it had been got. The latter part of the same year might be concentrated upon the close study of a very few of those agents which set up fermentation and putrefaction and contagion. A simple practical examination would test the reality of the knowledge of ferments actually gained; I can only hope that the examiners would not expect encyclopædic knowledge. This is not the place for the discussion of details.

Technical Education.

Of technical learning I must say but little, and that little must be said with reserve. For my only acquaintance with the subject is indirect, and arises from long connection with a city and university where technical education is prominent. I hope not to express presumptuous opinions on a kind of useful knowledge which I know so superficially.

Technical education may be pursued in at least three ways: (1) We may seek to qualify the pupil for his calling by a thorough training in some science or art, and then, by the application, under the guidance of an expert, of that science or art to a particular industry. The experience of at least two generations seems to show that this method is really effective; it does what it professes to do. (2) The second method aims at no more than supplying information directly applicable to the industry in question. Surely this is the least profitable of the three. The information is not accurately lodged, either in the memory or in the note-books of the students; it soon becomes obsolete in consequence of the advance of knowledge; and it does little to cultivate intelligence or the power of doing. Where intelligence and the power of doing already exist, more information may be valuable, but the best storehouse of information is the printed book. (3) Lastly, we may aim at nothing more than facility by repetition. Such practical arts as reading, writing, drawing, needlework, and cookery are largely acquired by imitation and constant practice. Skill in these arts is a tool, the profitable application of which depends much upon the intelligence and enterprise of the possessor. Independent attempts to meet difficulties, friendly criticism of these attempts, questioning about the causes of failure, are the expedients which a wise and experienced teacher, ever at hand, would employ. Such a teacher is of course rarely to be had, but is now and then found in a sensible mother. Perhaps the best substitute for the sensible mother would be plain, practical lessons on elementary science, such as the Edgeworths, Dawes, and Henslow used to give.

Literature.

Literature differs from most kinds of useful knowledge in having an immediate value. Like beautiful scenery, health, liberty, friendship, and other felicities of life, it is good in itself, apart from the advantages which it brings. Nevertheless, literature is not satisfied with delighting. Like architecture, it aims at utility as well as beauty, and employs its power of delighting to instruct and guide.

The benefits which we receive from literature are comparable with those which we receive from good society. We are expected to enjoy and appreciate; we are not to be for ever asking: "What have I got that I can carry away?" Literature may be more than good society; it may compare with the intimate talk on grave subjects of a wise and high-minded friend. Unfortunately those whose office it is to introduce us to literature often treat it as if it were only a particular sort of useful knowledge. They occupy our attention so completely with grammar, metre, etymology, and historical allusions that we have no leisure to enjoy and appreciate. Dr. Bain¹ tells us that we need to be indoctrinated in points of style before we begin to read on our own account, and discourages the reading of entire plays of Shakespeare because we

come across long passages which yield no marked examples of either grammar or rhetoric.

I have little fear that the scientific age which is now upon us will be permanently hurtful to literature. No new Lucretius, it may be, will write on the Universe, no new Milton on the Creation and the Fall. But contemplative and lyrical poetry will survive all changes in our philosophy. The higher criticism, which is the study of life as well as of letters, will survive too. One literary art, the art of rhetoric, may be weakened and lost when the scientific spirit becomes predominant—that sort of rhetoric, I mean, which may be fitly described as insincere eloquence. Rhetoric seeks above all to persuade, and in a completely scientific age men will only allow themselves to be persuaded by force of reason. Even in our imperfectly scientific age those men gain most by speech who have something important to say, who say no more than they know, and who use all possible plainness.

It will be enough for my present purpose if we can agree that literature has an aim and purpose of its own, and must not be treated simply as a branch of useful knowledge. Literature and science, for instance, are incommensurable.

The Necessity of Choosing.

It is an intellectual luxury to run over the kinds of useful knowledge that we should like to possess. Among them come languages, ancient and modern, some giving access to high literature, some yielding historical or scientific information, some acquainting us with communities or modes of thought very unlike our own. Then come a multitude of sciences, which perhaps show the engineer how to build railway bridges, or tell the navigator how to cross the Atlantic, or help us to improve our health and lengthen our lives. I barely mention history, geography, and innumerable practical arts. We seem to be led into a well-filled treasury, and invited to say what we will have. But one unpleasant condition is laid down; we may choose what we please, but we must pay for it. A new study generally means outlay of money, and always means outlay of time. We soon find ourselves forced to behave like the man whose wife has tempted him into a fine London shop; like him, we begin to ask: "How much can I afford to spend here?"

Every headmaster and headmistress is occupied with the eternal question how to make room for all the things that are demanded of the school. Theorisers, who have no responsibility for the time-table, insist from time to time upon new additions, and are happy if they can only express their own opinions with an emphasis which satisfies their sense of justice. It is my opinion that far too much has already been conceded to demands which, reasonable when taken separately, are unreasonable when taken together. I have known the time-table of a girls' school overloaded to such a point that in one form chemistry and English literature got no more than an hour a week between them. The headmistress no doubt hated the arrangement, but had to conform.

I have said that the grounds for introducing each separate subject are often perfectly reasonable. Thus by ancient usage Latin is made a necessary subject in certain schools. Then a claim is put in for Greek as more interesting and equally important. French and German demand admission, and put forward claims which can hardly be overstated. The result is that some boys in secondary schools attempt four languages, and many attempt three. Then we usually find that no foreign language, ancient or modern, is mastered to the point at which it can be used in reading, writing, or conversation. Our wish to be fair and consistent has landed us in an absurdity. The root of the whole difficulty lies in the fact that while there are perhaps fifteen or twenty branches of knowledge eminently fit to be taught in school, no pupil can profitably undertake more than five or six at a time. The man of business who is inveigled into a shop is better able to resist importunity than the schoolmaster. He will say: "If you insist upon the drawing-room table, you must go without the chest of drawers; if you insist upon the chest of drawers, you must go without the drawing-room table." I wish that the headmaster or headmistress might find courage and strength to require that every subject admitted

¹ "On Teaching English," p. 18.

to the curriculum should come round frequently, at least for two or three years; as nearly as may be once a day, but we cannot be rigid in these matters.

The sciences taught in school may spoil one another's chances in the same way. Not a few schools are convinced that they must have chemistry and physics because of their industrial importance, hygiene because of its relation to the health of the community, physiology to make the hygiene intelligible. The schoolboy is made to buy more sciences than he can pay for, and his time is gone before he reaps any of the advantages which are so much desired.

Too Much and too Long.

One inevitable result is that the school hours, including the preparation of lessons, are nearly always too long. Another result is that the schoolboy who is willing, but not very clever, is often overworked. I have known many such cases myself, and have also known cases in which excellent results have been attained in a good deal less than the customary time. If we could consent that our pupils should remain ignorant of many useful things, if we could materially shorten the lessons of very young pupils, and if we could bring the home-lessons into much smaller compass, I believe that the education which we offer would really be more valuable.

Natural and Artificial Education.

If we had a pupil put into our hands for solitary instruction, like the *mile* of Rousseau, we should find it wise to begin by studying him closely, and three things would particularly require attention—his aptitudes, his inclinations, his opportunities. The first two are self-explanatory, but the word *opportunities* may present some difficulties. It includes, of course, opportunity of learning, but the chief stress is to be laid upon opportunity of exercise in after-life. This is the opportunity which stimulates interest and rewards exertion. Moral character, intellectual character, curiosity, love of knowledge, equipment for practical life, and, so far as I can see, all considerations which ought to govern the choice of a study, come under one or other of the three requisites—aptitude, inclination, opportunity.

In school we have not so much solitary pupils as groups of pupils to consider, and this compels us to accept compromises, which are familiar to every teacher. We have often to study the wants of a school-form as well as the wants of an individual.

Some writers have given to the education which considers first of all aptitude, inclination, opportunity, the name of *Natural Education*, while that which makes its choice of studies on abstract or arbitrary grounds, with little reference to the needs of the pupil, they call *Artificial Education*.¹ We may be allowed to revive these terms for the sake of brevity. To me they seem appropriate as well as convenient in practice.

The advocates of natural education have sometimes reached absurdity by pressing the claims of one of the three requisites to the neglect of the rest. Tolstoy would make inclination supreme, even in early education. He exemplifies Quick's remark that writers on the school-course who are not schoolmasters are almost all revolutionary. Others have attended too exclusively to the opportunity of future exercise. The old grammar schools, thinking much of the future wants of the pupils who might wish to enter the Church, often added Hebrew to the compulsory Latin and Greek. Fortification was frequently taught to little boys. When the Berlin Realschule was founded (1747) it offered, among other things, instruction in the rearing of silkworms and the discrimination of ninety kinds of leather.

Nothing, I think, gives us a clearer notion of what natural education can accomplish in favourable circumstances than foreign travel, which is a form of self-education prescribed by grown-up people to themselves. Even the milder forms of compulsion are wanting here; aptitude, inclination, and opportunity are everything. The preparation, the actual journey, and the recollections yield

abundance of instruction to those who use them well. For weeks before setting out the traveller will turn over maps and conversation-books, inquire about handy cameras or collecting-boxes, and study the country which he is about to visit with an eagerness which he never felt before. The journey itself, if only it be such a journey as an active mind will frame, cannot but call forth many powers, physical, intellectual, and moral, that are rarely exercised at home. The love of science, the love of languages, the love of scenery, the love of adventure, the love of society, the love of poetry, all get a new stimulus. And the journey, already profitable in anticipation and in execution, is not exhausted when we return home. Our experiences in unfamiliar countries vivify many a page of history and many a scrap of useful knowledge which would have been otherwise languidly remarked or passed by altogether. Some years ago I had occasion to read the travels in the Levant of old Belon, a French naturalist of the sixteenth century. Though I had a purpose in reading them, they made no impression, and after a few months nothing survived but some pages of dry and unprofitable notes. Then I visited the Greek Archipelago myself, and one of the things that I made a point of doing when I came back was to read Belon again. I found it an entirely new book, full of curious and valuable observations. Now I dwell with keen interest on his account of the various nations which had made settlements in the Archipelago, on the Greek language, on the Cretan customs of wine-drinking, on the fishes and birds, and on a hundred other details which had seemed totally uninteresting before I visited the eastern end of the Mediterranean.

Let us suppose that all is done, not by the traveller, but for him, that routes are chosen, hotel-bills paid, carriages and boats hired, languages interpreted, information supplied, all without effort on his part. In a few months he will barely remember what places he has seen and what he has passed by. This may remind us that natural education is only kept alive by *doing*.

Of course the grown-up person is not like a child, and there is need of steady and impartial government, of drill, in short, if the child is to take all the pains that are indispensably necessary in school-work. All our teaching cannot be recreative. Does not this show, some of you will say, that your natural education is inadequate, and that a sterner thing, which takes little or no account of inclination, is demanded in school?

I think not. I think that inclination is a power that we ought to employ as often and as far as we can. No doubt it is inadequate; our very definition makes inclination only one of three requisites. The child at school may usefully remind us that the opportunity of future exercise in some cases becomes necessity, and will take no denial. Nevertheless, all three should be considered, and that teacher will prosper best who lets none of them drop out of sight. Do not forget, too, that inclination is the modifiable requisite; we can stimulate, and even create it; we can also fatally discourage it. It is only natural education, I still maintain, which can count upon the energetic cooperation of the child.

On the other hand, if we ignore aptitude, inclination, and opportunity—if we pour out information upon which the pupil does no work, merely because we think it ought to be good for him, then we have a dull, perhaps a sullen, mind to deal with, which neither will nor can learn to good purpose. The example for all time of artificial education is, or lately was, the setting of every boy in every grammar school to learn Latin, if not Latin and Greek.

Those who believe that natural education is at once the most formative and the most productive, that it helps to build up body and mind, that it encourages the acquisition of truly useful knowledge, should attend to one point which often escapes notice. Natural education demands leisure for the pupil. At the present moment the leisure of the pupil has been reduced to a very small amount indeed. We strive for efficiency, for good examination results, for knowledge of useful things. The negligence of the old race of schoolmasters, which winked at monstrous abuses but allowed a certain independent school-life, has been replaced by zeal and conscientiousness, which occupy every hour, and sometimes treat independent

¹ See, for example, Henry Sidgwick in "Essays on a Liberal Education" (1887).

occupations as mere idleness. Long rambles, such as were the delight of my boyhood, when we used to go miles in search of a wasp's nest, are in certain modern schools abolished by compulsory games. Some day or other (the reform will not come in my time) we shall recognise that the chief occupation of the young child should be spontaneous natural play.

That interesting book called "Public Education," now nearly a hundred years old, in which we find a description of the methods practised by Rowland Hill and his brothers at Hazelwood and Bruce Castle, is inspired by the desire to make education natural and not merely artificial; so is that older and still better book, "Edgeworth on Practical Education." There are modern English schools which give fair opportunity for natural education. I pass over some, perhaps many, out of mere ignorance; but I will name two which I happen to know—Bedales School and the Friends' School at Bootham, York, both of which have discovered how to combine natural education with efficiency.

Heuristic Methods.

Dr. Armstrong's heuristic method is well known in this section. He tells us that neither the name nor the thing is altogether new, and the same may be said of nearly every educational expedient. Promising schemes are proposed, tried perhaps on a small scale, and dropped, often for lack of enterprise on the part of the teachers, and years after someone discovers them again. Dr. Armstrong tells us¹ where he got the name, and quotes a passage from Edmund Burke, which clearly describes the method. It is now a good many years since I saw Mr. Heller give several lessons on this plan in elementary schools in London, and was then permanently convinced of the real value of the heuristic method. I only wish that we had a score of such, each worked out as carefully as Dr. Armstrong's model.

The method need not be confined to experimental science, nor to science at all. I have attempted something of the same kind in elementary biology. Why should not teachers of history carry out a little historical research with the help of an upper form? Suppose that the subject chosen was English town and country life in the sixteenth century. Harrison's Description of England, Shakespeare's plays, Walton's Lives, some of the modern books which collect the testimony of foreign visitors during the reigns of Elizabeth and James I., Spenser's View of the State of Ireland, and Hume Brown's Scotland before 1700 are, let us suppose, accessible to the class. Useful materials from these and any other sources might be arranged in a card-index. Cooperation is eminently desirable, and a little club of pupils might well make their index in common. Then the materials should be treated in literary form, every detail of literary workmanship receiving attention. I fully expect to be told that this plan has actually been tried in some school or other. The historical researches of the school may give opportunity for the use of foreign languages, for map-drawing, or for the handling of statistical information.

Mr. Greening Lamborn's "School History of Berkshire"² is interesting as an investigation carried out by and for the boys of an Oxford school. It will be read in a very different spirit from that with which the condensed school-history of England is received, and will no doubt suggest more work of the same kind. The share of the boys may well grow larger and larger.

The advocates of learning by inquiry and learning by doing will descend even into the nursery. What an opportunity is afforded by toys!—an opportunity that those who purchase all their children's toys throw away. Surely every little girl ought to be encouraged to make plausible dolls out of the rag-bag, every little boy to make his own menagerie, his own boats and whistles and sledges. Even the bought toy gives opportunity for inquiry. Ask any child if he has noticed that the animals of the Noah's Ark are always thicker at one end, usually the hinder end. There is a reason for this, and a curious reason, which the child may be helped to discover.

Mastery of Something.

Let us indulge less than we do the passion of intellectual avarice, if only because avarice blinds us to the relative values of things. The old French anatomist, Méry, said of himself and his colleagues that they were like the rag-pickers of Paris, who knew every street and alley, but had no notion of what went on in the houses. The accumulation of miscellaneous knowledge of useful things, copious, inexact, inapplicable, may, like rag-picking, leave us ignorant of the world in which we live. Let us try to reach the inner life of something, great or small. The truly useful knowledge is mastery. Mastery does not come by listening while somebody explains; it is the reward of effort. Effort, again, is inspired by interest and sense of duty. Interest alone may tire too quickly; sense of duty alone may grow formal and unintelligent. Mastery comes by attending long to a particular thing—by inquiring, by looking hard at things, by handling and doing, by contriving and trying, by forming good habits of work, and especially the habit of distinguishing between the things that signify and those that do not.

It is too much to expect that mastery will often be attained in school. School is but a preparation, not I think for promiscuous learning, but for the business of life. The school will have done its part if in favourable cases it has set a pattern which will afterwards develop itself naturally and harmoniously.

CHEMISTRY AT THE BRITISH ASSOCIATION.

AN unusually large number of chemists attended the meeting, and in consequence very many papers, some of considerable importance, were read before the section. Chief interest attached to the discussions, which were well supported and of real value; it is worthy of consideration whether it be not advisable to devote the programme almost entirely to these. On no other occasion is it possible to have what may be termed "borderland problems" discussed conjointly with representatives of other sciences.

The most novel contribution to the section was that made on behalf of Dr. Mond, describing the preparation and properties of cobalt carbonyl. The preparation of this substance has hitherto been attempted in vain, though the remarkable compounds of carbon monoxide with nickel or iron have been known since 1890. It is now obtained by acting on finely divided cobalt with carbon monoxide at 100 atmospheres pressure between 150° and 200°. It forms large orange crystals, which decompose in the air, yielding a deep violet substance.

Sir William Ramsay related in popular terms the well-known story of the discovery of argon, helium and other gases in the atmosphere. Following him, Prof. Hartley described his researches on the detection of lithium in radio-active minerals, which are of importance in connection with the assumed transmutation of copper contained in solution into lithium, neon and possibly other substances. He adduced much experimental work to show that it is impossible to corroborate Sir William Ramsay's statements that potassium is a more widely distributed element than lithium, or that lithium is an unlikely constituent of dust, glass, copper, &c.

Prof. Rutherford described experimental work showing that the amount of neon in 1/15 c.c. of air readily gives the neon spectrum, and can so be detected. He attributed Sir William Ramsay's assumed formation of neon by the action of the emanations on water to a slight leakage of air during the experiment, and claimed that when air is excluded no neon is formed. Sir William Ramsay, replying, upheld his experiments, but agreed that the formation of lithium from copper was of a less degree of certainty than the other transmutations he has observed.

Sir James Dewar communicated a paper from Dr. Kamerlingh Onnes describing the apparatus used to liquefy helium. From the study of the isothermals of helium the critical temperature was found to lie between 5° and 6° absolute, indicating that the gas must be cooled below 30° absolute before it will cool on expansion. By boiling

¹ "The Teaching of Scientific Method, &c.," 1903, p. 235.

² Clarendon Press, 1908.