

general literary acquaintance with scientific facts, and the more minute and accurate knowledge that may be gained by studying the facts and methods at first hand, under the guidance of a competent teacher. Both of those are valuable; it is very desirable, for example, that boys should have some general information about the ordinary phenomena of nature, such as the simple facts of Astronomy, of Geology, of Physical Geography, and of elementary Physiology. On the other hand, the scientific habit of mind, which is the principal benefit resulting from scientific training, and which is of incalculable value, whatever be the pursuits of after life, can better be attained by a thorough knowledge of the facts and principles of one science, than by a general acquaintance with what has been said or written about many. Both of these should co-exist, we think, at any school which professes to offer the highest liberal education."

With these remarks I need hardly say that I most heartily concur.

There may be used in the lower part of the school, some work on Physical Geography, embracing the elements of the subjects above-named; and it will be found extremely convenient to introduce short courses of lectures on such subjects as these, even in the higher parts of the school. For since new boys are perpetually coming, and it is impossible that a new course of lectures on Botany, or on Mechanics, should be started in every division of the school at the beginning of every term, without requiring the number of natural science masters to be almost indefinitely increased, there must be some collecting place, a class in which the new boys shall accumulate until they are numerous enough to form a body to enter on the regular course. This must be a class in which physical Geography, including, if the master likes, the elements of Geology and Astronomy, is taught. In such classes as these the ideas of boys are expanded; fresh books are opened to them; and some will avail themselves of the opening, and learn a good deal about the subjects spoken of: but the value is more literary than scientific; and even after the most careful teaching will be found disappointing. In lecturing on such subjects as Geology, Astronomy, or Physical Geography, the master never can be sure that the ideas he has so clearly in his own mind are seized by all his boys. There seems to be a deficiency in powers of conception on the part of very many boys. Theorists may say what they please, but it is true that the act of the mind in forming a conception is difficult to excite. There is a marvellous, truly marvellous, want of imagination in many minds, a want of power to form and keep in view a distinct image of the thing reasoned or spoken about. It is not only want of attention, but there seems to be a total separation in some minds between words and things, perhaps the result, in part, of early teaching; so that the knowledge apparently gained is sometimes wholly unsound. I will instance what I mean. I once gave three lectures on coal, in such a course of Geology. During those three lectures, every individual in the class handled and examined some scores of specimens, to illustrate the vegetable origin of coal; no part of the subject was left unillustrated. One, however, in an examination paper, in reply to a question about coal, answered exactly as follows: "Coal is supposed by some persons to be a kind of inflammable substance, and must therefore be classed among the igneous rocks." And another once told me that nummulitic limestone (after handling and examining it), was made by little fishes, who lived in the limestone and carried limestone to the mountains from the sea; and answers that show the same total want of conception are common. So it will be seen that something else is meant when men of science and writers on education urge, that instruction in science should form part of all liberal education.

The mental training to be got from the study of science is the main reason for its introduction into schools. It is with reference to this that the subjects of instruction, and the methods of instruction, must be chosen. It is important, therefore, that what is meant by *mental training* should be distinctly understood. Training is the cultivation bestowed on any set of facul-

ties with the object of developing them. It is possible to train the body, and to train the mind, for a great variety of purposes, some very foolish ones. But in all cases the training consists in *doing*. If you wish to swim, you must go into the water and swim as best you can: if you wish to box, there is no way of learning but by boxing: if you wish to study music or drawing, you must play and sing or draw: and thus in educating others you must make them *do* whatever you intend them to learn to do, and select subjects and circumstances in which *doing* is most facilitated. Now, laying aside out of consideration the mere accumulation of statistical information, and all kinds of education except intellectual, it is clear that this ultimately divides itself into the training of the artistic and logical faculties. And the logical faculties are of two kinds. It is by a logical faculty that we are able to understand other men's thoughts and apprehend new ideas. The cultivated, intelligent, imaginative mind is one in which this receptive faculty is strong. Nothing so marks the uneducated man as his dulness, his incapacity, in understanding what you say to him, if you depart in the slightest degree from the range of his daily thoughts. For the ordinary intercourse of men of education, for the spread and fertility of active thought, this faculty of intelligence is invaluable. Again, it is by a logical faculty that the mind deals with things and the relations of things. The mind which is thoughtful rather than receptive or imaginative, which studies phenomena, be they in mental philosophy, in politics, or in natural science, with a view to elicit and establish the true relations that exist among these phenomena, is the type of the mind in which the logical faculty of investigation is well trained. Nothing so marks the imperfectly educated man as his helplessness when dealing with facts instead of men, and his insecurity both in arriving at truth from them, and in judging of the validity of the conclusions of others. For the advance of thought, on all subjects which require thought, this faculty of investigation is indispensable. Probably no study will cultivate one of these faculties and wholly neglect the others, but all studies aim principally at one or other of these. A study of the classical languages, for example, is an artistic exercise, and moreover it educates the receptive faculties in a manner in which no other study educates them. The study of a language and literature not our own is the best preparation for entering into the thoughts of others; but even when best taught and best learned it can only be a very imperfect exercise in logic, for it omits nearly the whole of the logic of induction. The study of science, on the other hand, while not without its influence on even the artistic powers, and exercising in a remarkable degree the powers of intelligence of a certain kind, deals mainly with the faculty of investigation, and trains the mind to ponder and reflect on the significance of facts. And the methods of these studies are in many respects precisely the same. Models and exercises are given by the one; models and exercises by the other. Thucydides must be read, and Latin prose must be written, by the student of form and style; and the man who would cultivate his powers of thought must read his Newton, and study Experimental Physics. And as the student of Thucydides and Plato is likely to gain in clearness and brilliance of expression, and an insight into history and humanity, in intelligent and ready apprehension of the thoughts of others, in versatility, and in polish; so the student of natural science is likely to bring with him to the study of philosophy, or politics, or business, or his profession, whatever it may be, a more active and original mind, a sounder judgment and a clearer head, in consequence of his study. A good style perhaps may be got by reading and writing; thinking is learnt by thinking. And therefore that method of giving scientific instruction is best which most stimulates *thought*; and those subjects which afford the best method ought to be selected for instruction in schools.

Now there are two different methods of teaching science: one, the method of investigation; the other, the method of authority. The first starts with the concrete and works up the abstract; starts with facts and ends with laws: begins with the known, and pro-