School Science

VOL. II]

MAY, 1902.

[No. 3

PROFESSOR REMSEN ON THE TEACHING OF SCIENCE.

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The Twentieth Century Club of Boston, Mass., provides a course of lectures each winter for the benefit of the teachers of that city and vicinity. President Ira Remsen of Johns Hopkins University recently delivered a lecture in this course on "The Place and Function of Science in Popular Education." The lecture was a lucid exposition of this teacher's views on science teaching in general and on the teaching of chemistry in particular.

In answer to his first question, "What distinguishes science studies from other studies?" he said:

"Science studies are, or ought to be, distinguished from other kinds of studies by the fact that they bring the pupil into direct contact with the things or phenomena he is studying. He is called upon to use his own eyes and his own mind. There is a direct connection between statements he may make and facts that he knows to be true as a result of his own experience. In their first stages, in their simplest forms, this should be the most prominent feature of science studies. Any course of study that depends largely upon what a lecturer may say or upon what a pupil may read in a book can never be a science course, no matter what the subject, no matter how good the lecturer, or how good the book. The essential feature of direct contact is lacking. So also the emphasizing of the theories of a science, no matter how important those theories may be or how well they may be established, should not play an important part in a science course in its early study. As far as this fact is lost sight of, the course is not scientific. It is not scientific, for example, to present and discuss the atomic theory in an elementary

course in chemistry, or the electro-magnetic theory of light in an elementary course in physics, or the nebular hypothesis in any course. The pupil must first learn how knowledge is acquired by direct contact. This lesson must be impressed upon his mind before he can profitably take up the profound thoughts to which scientific investigators have gradually been led—thoughts which are based upon an immense accumulation of facts learned by direct contact.”

He then showed how language, mathematics, and history do not meet these tests, and are therefore not science studies. Much to the amusement of his hearers, he then said that many science courses—so-called—would not meet this simple requirement, viz., the element of direct contact. “They are mere masquerades,” he said.

In answer to his second question, “What ought science studies to accomplish?” he said in substance:

“It is often stated that the object of science studies is to develop the power of observation. This is true, but it is far from being the whole truth. There are other ways of developing this power, perhaps better than by pursuing elementary courses in science. Life on a farm or life out of doors tends in this direction. The savage probably has the keenest powers of observation possessed by any member of the human race. He gets his knowledge and his power, not by studying books, but by direct contact with the things around him; that is, by the scientific method. Science courses should teach more than the power to observe. They should teach how to draw conclusions. They should lead to a scientific state of mind. By this is meant a state of mind that enables the possessor of it to take the most direct course in dealing with any problem that may be submitted to him; that enables him to see through the mere talker, through the shams, and go back to the facts and draw his conclusions from them; that enables him to discriminate between what is known and what is imagined. That state of mind called *unscientific* might be described as the average state of mind, that state of mind which accepts popular superstition or which has undue willingness to talk much on topics little understood.”

As to how far science courses accomplish what they are designed to accomplish, he said: "Not far, but it is better to get a glimpse than no look at all. Probably the average course of science does comparatively little toward putting the pupil in a scientific state of mind. Still, if this kind of study is right in principle, and in regard to this there can probably be no doubt, the pupil ought to have at least a taste of it. Some pupils will, of course, be much more benefited than others. Some will be inspired by this kind of work. No one can be harmed by it. If the courses were what they ought to be, then all the pupils ought to be, and probably would be, benefited by them. The ideal course is one in which the pupil makes daily observations, spends a certain amount of time in reflecting upon what he has observed, and then from time to time is led to see the connection between his own observations and some of the important generalizations that have been reached, which, taken together, form the ground-work of the sciences. The usual results of a year's work in chemistry are meagre." He then illustrated this point by some answers received by him from entering students.

He gave many practical suggestions in answer to the question, "How can science courses be improved?" saying substantially:

"The greatest need is that the courses be made more scientific. Everything that is labeled scientific is not necessarily scientific. Indeed, some of the most unscientific courses I have ever known have been called scientific. Studying chemistry by listening to a lecturer and seeing him do things, or by reading a book, may be scientific as far as it goes, but is more likely to be more unscientific. Even experimenting in a laboratory is not necessarily scientific. Imperfect observations of complex phenomena, and the writing of statements supposed to be based upon what has been seen, but really drawn largely from the printed laboratory guide—these processes are not scientific, and they cannot lead to good results. They are more likely to do harm than good, as they involve waste of time and give false impressions in regard to scientific methods. Nor can the best work be accomplished by turning the pupil loose in the laboratory and letting him experiment without supervision. The questioning teacher is necessary in order that

good results may be reached. The teacher has here a splendid opportunity. Questions in regard to work done in the laboratory are of much more value than questions on matters studied from books or heard in a lecture room. The proper guidance in the laboratory demands the constant attention of the teacher; and, further, the teacher must have a full appreciation of what is meant by the scientific method. Such teachers are rare, whether in school, or college, or university. Undoubtedly the teachers of languages and mathematics are, in general, better fitted for their work than the teachers of science. It seems to me that what is most needed in our science courses is greater simplicity. The simpler phenomena should be studied so that the pupil's mind may be able to cope with the things he sees. The thoughts presented to him should be simple. He should be made to understand what he is doing and what he is talking about. If he shows a tendency to use words or symbols without being able to explain what he means, he should be corrected, just as if the subject were language or mathematics.

In regard to the laboratory work, which must be the basis of science courses, more care should be given by the teacher to secure *good* work. The pupil should be compelled to avoid slovenliness. A bad piece of apparatus is as bad as a bad piece of grammar or a bad mathematical demonstration. And in telling the story of his work, orally or in writing, the pupil should be held responsible for faults in language as well as in observation. Accuracy is an important feature of scientific work, and this the pupil should be led to feel."

The lecture was enlivened by many witty remarks. For example, "atoms are not fit food for infant minds," "some people don't suppose you have to have any facts to get up a theory," "a book with no reference to the atomic theory would never sell," "let the pupil observe and then observe him," "the most accurate language is the most scientific," "once it was all atoms, now it is all ions," "pupils are too ready to say 'haven't had that yet.'"

These thoughts have been reproduced from very brief notes in the belief that the readers of SCHOOL SCIENCE may find them helpful in daily work.