ON SCIENCE TEACHING. (V).

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In this article we shall mention some of the questions that bear on the problem of choice of subject matter for the course. As in the last article the point of view is that of a physics teacher, though most of the suggestions must apply equally well to other branches of science.

It is of course manifest that the selection of subject matter is dependent on the choice of a conscious teaching purpose,—in fact that the two are so closely interrelated that the solution of the one problem generally means the more or less complete solution of the other. Hence the following remarks may in a way be considered as a continuation of those of the last article.

In the first place we must not forget that the students come to us supplied with a great amount of qualitative information obtained from their general experience. In this scientific age, the daily life of every one is so closely in touch with the practical results of scientific work, that it is impossible for anyone not to have formed numerous more or less distinct concepts of the “go” of things in the world about him. To ignore this vital knowledge is surely a mistake: and to found the discussion of the principles of science on strange and unnatural laboratory experiments must seem to the student both unnecessary and uninteresting. Therefore the teacher must endeavor to use as much of these materials at hand as is possible; not as illustrations of “laws” derived from abstractions, but as means of building up the concepts expressed and related by the laws, and as the material that serves as the basis of the abstraction.

The decision as to which of the youthful experiences to use will depend on a number of factors. Primarily, however, on the teacher’s teaching aim. For if that aim is to make up-to-date scientific encyclopedias of the students, the experiences selected will be as numerous and will bear on as many different topics as possible. But if that aim is to develop thinking power and incidentally to ram home some of the most general and fundamental principles of science, the experiences chosen, though varied, will be as simple and as closely related as can be found. And this problem is a large one, because at present the mass of scientific

material is so great that we are all guilty of cramming the beginner's memory pouches so full that he cannot swallow. How shall we settle it?

May we not be guided in making our decision as we would be in the corresponding case of the physical boy? Shall we not try to find out what the student needs for healthy, mental growth, what he can assimilate, and what nourishes him? Should not the course be framed from the point of view of the student's best development rather than from that of the physicist? By this is not meant that he should be fed only on the things which he likes—he might then try to live on candy and oranges. Rather, he should be given the most nourishing and above all the simplest diet, not be overfed, and have time to assimilate one meal before he is given the next. This is a question that cannot be settled by guess-work. It involves at least as careful an analysis of the essentials of boy mentality and its growth as has been given to the related physical problem.

The teacher has probably often been told this in the form of requirements in the study of psychology. But from the point of view of science teaching it means more than a mere study of this valuable subject. For psychology is a very young science, and the wide differences of opinion among its masters on vital points show that it has not yet attained those general and fundamental principles from which deductions may be made. And especially if the teacher's aim is to foster the scientific habit of thought, is psychology unable as yet to give very definite answers to his queries, since the modern logic has fortunately as yet defied our efforts toward formulation and systematization. It therefore follows that in this field the teacher must be something of an investigator and experimenter for himself. He must try different subject matter and different methods of presenting that matter on different classes and attempt to discover which serves best in carrying out his own conscious teaching aim.

This must not be taken to mean that the study of the various manuals of psychology and that of other similar works is to be neglected. Far from it. The science student is particularly culpable if he ignores such study. For he knows that one of the first steps in any really valuable investigation is the acquirement of a knowledge of what has already been accomplished in the solution of the problem. Hence he should assiduously study such works; he should read and ponder carefully the classics of peda-

gogy from Plato down; and he should also consider the educational development which they portray and which is depicted in some of the good histories of education, like those of Painter, Davidson, Laurie, etc. Above all he must apply the scientific method to this problem—must question conclusions, compare them, sift out those that appear less valid, and try to make new combinations, to suggest new ideas, and to draw new conclusions.

In opposition to what has just been said it may be urged that little is to be gained by the man who wishes to teach modern science from a study of the works of those who wrote before science appeared to play an important role in education. The use of natural science as an active educative factor in the schools appears to date back only fifty or a hundred years. But it must be clear on careful thought that no subject,—and especially not science, modern though it appear to be,—can sever its connection with the rest of the mental man without greatest injury primarily to itself.

Yet it would almost seem that the fact that science does not at present occupy in the educational system the important place which it is capable of taking is due to an implicit belief in some sort of exclusiveness on its part. If we science teachers understood better the relations that exist between our subject and the others, would we not be better able to make our science teaching play as important a part in education as science has played and is even now playing in civilization? May we not derive many hints as to the part science should play in the development of the individual, by a study of its activities in the growth of the whole of society?

But to return to the immediate problem, what further hints can we find that will assist us in choosing the subject matter of the course? Several will be found in Hanus's book on *Educational Aims and Educational Values*. The main one is, perhaps, "to connect the school interests with the life interests; in other words to so construct the school programs that stress is laid throughout on the boy's vocational and social interests." This point is probably so well understood nowadays that a passing mention of it will suffice.

Other important suggestions will be found in *Adolescence*, by G. Stanley Hall, especially in Vol. II, chapters X, XII, XV, XVI. We are particularly urged in this valuable work to dwell on practical applications of science first—on the things that go—

on toys of various sorts. All of these can be used as starting points from which to develop an understanding of principles even better than the finest apparatus, which usually presents the bare principle indecently stripped of its use and its vitality. On page 168 of the volume is sketched very briefly an outline of a course in elementary astronomy—a subject now almost extinct in the secondary schools. This may be taken as a sample of what may be accomplished in other lines. Every science teacher should read and ponder well at least these four chapters of this monumental work.

We may perhaps sum up what has been said as follows. The teacher must know his pupils and their dominant interests; he must try to find out what stimulates and nourishes them; and he must use practical things with “go” in them just as much as he possibly can.

The practical difficulties presented in carrying out such a plan are very great. For we have fallen heir to a set of arid, parched, and lifeless experiments, and to a stock of laboratory apparatus for performing the same, which few school boards would consent to have scrapped. The whole thing resembles more a mummy than a living man, and its only just place is in a museum. Yet is it not far better that we stock a few museums with this sort of thing, and then, with the help of the more enthusiastic pupils, make a few toy machines and engines, than that we go on killing off the budding scientists and stifling the enthusiastic love of Nature and her works, a love that is inherent in every normal child?