PHYSICS IN THE SECONDARY SCHOOL.

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The experience of many schools has demonstrated the fact that it is impractical to attempt to prepare boys for the College Entrance Examination in Physics in one year. Even to do the work in a cramming sort of fashion with certainty of good results takes more time than ought to be given to a single subject. But, what is of still greater importance, to mature the new conceptions involved, requires in the mind of the average boy of sixteen to eighteen more than a single year. Mental development is a growth, and cannot be forced without bad effects on mind or health. It may not yet be scientifically demonstrated, but certainly it has proved the case in numberless instances, that for growing boys, too highly specialized mental exercise, as well as too heavy physical exercise, intereferes with a normal, well-rounded development.

From the psychological standpoint, the order of presentation of new conceptions is also of importance, and in a one-year course it is not possible adequately to take this into consideration. It seems now to be a generally accepted conclusion that an unconscious, but very real, organizing and harmonizing process goes on in the brain, which tends to establish orderly associations between all experiences, educational and otherwise. In some branches, such as history, this idea has been put into practice by giving, in the lower grades, first mythology and legend, then historic or biographical stories; and finally, after a rest period of one or two years, full-fledged college entrance courses in Greek and Roman, and in English and American history, with note-books, outlines, and outside reading. In English, only the simplest ideas of the structure of a sentence can be taught to advantage in the early years; later all the parts of speech and their use are taken up, together with the analysis of sentences, and so forth; and finally, after a period of comparative rest, during which there is only practice in applying the principles already learned, rhetoric is studied in connection with the work of preparation for college entrance examinations.

In science, also, the same attention should be given to this fundamental principle. My own teaching experience of ten

years has shown me that it takes time, repetition, and many concrete examples to build up in the mind anything approaching to a sound conception of a law or a principle. It must be remembered, too, that while activity is an essential characteristic of youth; variety is the soul of activity. Therefore, remaining too long on one phase of a subject should be avoided. Yet, in going from one phase to another, it is of the utmost importance, especially on the first presentation, that the two phases be naturally and obviously related, or else be so presented that the previously acquired general experience of the boy is a sufficient foundation for the new conception.

If the data be presented by laboratory experiments or demonstrations, we must insist that time is required for absorption, assimilation, and incorporation into the mind, otherwise confusion is sure to result; and confused conceptions and blurred reasoning processes are the bane of our present varied and spread-thin education, and an almost certain bar to future success.

Prof. Woodhull has said that in the Horace Mann School they had found it necessary, in preparing boys for the college entrance examinations in physics, to have a separate division with extra work added after the completion of the high school course. They give more periods a week to physics than most schools do, if I am not much mistaken. (Three double periods, *i. e.* six ordinary periods per week.)

Granting then that more than one year is necessary to properly prepare the average boy in physics, of what shall the work of the preliminary year consist? Evidently, some practice in making accurate measurements, and a working familiarity with the metric system is necessary. The English have "Physiography," an outgrowth, I suspect, of the natural philosophy of our grandfathers' school days. A good deal might be said in favor of this plan; for, on the one hand, it is the logical next step after the ordinary physical geography course, as it carries this on in a somewhat more scientific manner, and into a broader field. This course discusses: 1st, The earth from the astronomical point of view; next, the earth from the geological point of view; and, finally, some of the fundamentals of physics and chemistry. The purpose of such a course is the development of interest in the processes of nature going on around the boy, and of the feeling that science is not, as far as he is concerned, something

remote, abstract, useless, and impractical, but rather that it is very vital and definite. When he has in this way surveyed the field occupied by each of the sciences named, he should have some inkling of the care and accuracy they require, of the methods they employ, and of the principles they have evolved. He should have acquired some idea of the relatedness of things, and should not be left without a notion of what it is all about, and of what it all amounts to; as is sure to be the case if he plunges into the forty experiments in the usual way; where he is dragged along and left dangling, only to be seized and dragged again to some dizzy height or stupid detail, being left finally without any adequate conception of the connection between the two. The abstract principle is too thin air for him, and the detail is too prosaic, in the usual disconnected form of presentation.

To overcome these difficulties as far as possible, the following six year course has been adopted in the Morristown School with good results: 1st year, geography, drawing and manual training; 2d year, commercial geography, design and manual training; 3d year, physical geography; 4th year, elementary physics, with drill in the rudiments of chemistry; 5th year, chemistry (if both physics and chemistry be taken); 6th year, physics (the forty experiments).

As to the correlation of studies, some mutual benefit has been derived by co-operation between the English and geography teachers during the first and second years; and the drawing teacher renders much service by instruction and practice in map drawing. These aids also apply to the physical geography of the third year. The manual training course of two years is also a great help to the physics which comes later; and those boys who take mechanical drawing and special manual training work, of course, find these of great assistance in their laboratory work. The mutual assistance between the mathematics and physics courses is almost too obvious to mention.