

CURRENT TENDENCIES IN SCIENCE EDUCATION IN THE SECONDARY SCHOOLS

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The last meeting of this Academy was devoted largely to a most admirable and thorough discussion of the subject of science education, and under ordinary circumstances, it would be unnecessary to discuss the subject again so soon. But it is true that during the last twelve months, some things have happened, in connection with this important matter, which are quite new and which need to be reported.

I can present these new developments in better light, if I may first review briefly, the main features of the more or less blind struggle toward better things which the students of these problems have gone thru during the past fifteen years. Altho I have been more or less engaged in these struggles during these years, I shall endeavor on this occasion, to view the whole matter as objectively as possible.

Fifteen years ago, all was comparative peace and contentment in this field. Secondary school science was viewed as simply so much subject matter, which had been fairly well crystalized and standardized, and which was to be imparted bodily to young people, at least partly by the laboratory method. The standard high school curriculum in science, here in the middle west, consisted of half-year courses in physiology and physical geography in the first year; half-year courses in zoology and botany in the second year; and year courses in chemistry and physics in the third and fourth years, and most students took all the science offered. About the only evidences of unrest at the time consisted of a little jockeying on the part of the friends of the several sciences for a better position in the curriculum for the favored subject, the fourth year of the high school course, being the one most desired.

About this time, however, the agricultural colleges and schools of home economics, which had reached a high state of development in the universities began to scan the secondary field, and soon, some of those who had the clearest vision of the possibilities of and the urgent need for a more practical education for the young people in the high schools, began to insist that courses in agriculture and in home economics be offered in the high schools. Now, since the science curriculum was already full, this demand usually took the form of a proposal to substitute these new subjects for some of the sciences already in the curriculum. This situation soon divided the friends of science education into two camps, under the banners of pure science and applied science respectively and a bitter civil war ensued, involving many odious comparisons of the relative educational values of the two kinds of science. This warfare lasted for five or six years during which time, the High School Conference at the University of Illinois, the Central Association of Science and Mathematics Teachers and other similar organizations, staged annually, royal battles over these issues. Even this Academy was drawn into the fray, and the symposium at the Urbana meeting in 1910 on the subject: "The Relation of Pure and Applied Science to the Progress of Knowledge, and of Practical Affairs" did much to help clear the atmosphere.

It is pleasing to relate that this war ended definitely and as suddenly as it began. I recall definitely that the battle was going on with all its fury at the meeting of the High School Conference in November, 1909, and that a year later, all the smoke of battle had cleared away. Everything that was said and done at the 1910 meeting of the High School Conference was marked by a spirit of conciliation and mutual understanding and appreciation between the late belligerents. What had happened? Simply this: Discussion, and thought and fair and open mindedness had cleared away the misconceptions which had been the real cause of the war. The friends of the older sciences had discovered that there are some real possibilities for good in the new ones, and that they have a real claim to a place in the sun. The friends of the newer sciences had profited by the criticisms that had been hurled at them, had gained a clearer vision of the true mission and place of their subjects, and had also discovered that some knowledge of the

older and more fundamental sciences was a necessary prerequisite to theirs. The friends of the older sciences were ready to admit that an academic knowledge of fundamental science alone, is not a sufficient education for the masses of young people flocking into the high schools. The war was over, science education had taken a distinct step forward, and the friends of science education were once more united in the interests of the common cause.

Not all the problems of science education were solved, however, when this peace was declared, for two new sciences, each demanding more space than was demanded by any of the older sciences had been added to the list which must compete with other subjects for space in the brief four-year high school curriculum. Instead of crowding other subjects, which had the force of tradition and inertia behind them, out of the high school, the numerous sciences began to crowd each other out. The statistics collected by the Commissioner of Education, began to show a rapid decline in the percentages of high school students pursuing the older sciences, and especially of those which happened to occupy the first two years of the course. Botany, zoology, physiology, and physical geography soon began to verge toward the vanishing point, and some of them have almost reached this point in some parts of the country.

In the midst of this perplexing situation, there suddenly appeared above the horizon, what seemed to many of us, another menacing factor in the form of an exceedingly effective catch-phrase, and slogan: General Science. At first, this phrase meant many different things to different people, but it soon gathered under its banner all people to whom it meant anything good, no matter what that meaning happened to be, and so it soon became a formidable factor. To some of its early advocates, it meant merely samples of all the sciences done up in small packages. To some it meant a much more substantial thing, namely: environmental science materials, attacked from the standpoint of the child's immediate interests and needs. To some administrators, it meant an opportunity to put all science into a small space and thus a satisfactory solution of their administrative troubles. To some of the conservative students of science education, it meant simply an-

other science seeking space in the already overcrowded curriculum. Being thus capable of so many different interpretations, it has been an ideal topic for argument, for difference of opinion, and warfare between the friends of science education, and so another civil war has been in progress for the past five or six years.

Along with general science came the *Project Method*, and this to most of us was at least a vague and indefinite stranger, and possible enemy in the camp. We made urgent demands for his credentials but nothing in the form of a satisfactory definition, or even a good illustration was forthcoming, and so we were against him.

I believe that nearly all of the partizans on both sides in these internal wars among science teachers are earnestly and honestly seeking to help the cause of science education, and I believe that the wars themselves usually arise out of the shortcomings of science teachings, but it is usually the case that the reforms needed are at first felt, rather than seen clearly, and so it seems almost necessary that the issues be threshed out by a period of discussion and experiment. But the most unfortunate thing about such a method of progress, is the tendency of the partizans to criticize so unmercifully and often so unjustly, the things that are being done in the line of science education. The most severe and unjust criticism that I have ever heard of botany, for example, as a high school subject, has not come, as one might expect, from some teacher of the humanities, but rather from some science teacher, usually a physicist, or a geologist, who has espoused the cause of general science. Such a person usually takes up the botany of twenty or forty years ago, when he was in college, and shows what a miserable thing it is as a preparation for life in these modern times, and then tries to show by contrast what a superior thing this brand new modern general science is. If we were never heard by anyone but ourselves, this would not be so serious, but unfortunately, we have been influencing a lot of innocent bystanders. The non-scientific administrator, who is perplexed by the numerous sciences from which he must choose his science curriculum, and who gets such conflicting advice from science educators, finds plenty of argument to support him in giving science little space, in the

criticisms of the different sciences, and the different ways of teaching science, which he hears uttered by science educators. There is nothing that we have ever done or proposed to do that has not been scathingly criticised by some members of our own group.

As a matter of fact, I am convinced that the results accomplished by the teaching of science in the secondary schools during the past fifteen years, have been quite as satisfactory and valuable as have been those accomplished by the teaching of any other high school subject, but we have been losing ground while some of the others have been gaining, and I believe that this is largely because of the strife and conflict within our own camp. Some other subjects like Algebra and Rhetoric have during part of this period, gained ground, probably more because their friends have been at peace among themselves than because of actual merit of the subjects. Doubtless this unrest and agitation among us is an evidence of life and growth, and we may profit by it in the end, but I believe that we might at least try to see to it that the criticisms we utter are just.

I now come to the new thing that I have to report, and it is that this last conflict which was aroused by general science and the project method, is suddenly over. Essentially the same treaty of peace was drafted independently, and unanimously adopted, both at a joint meeting of the science sections of the Illinois High School Conference, and at a meeting of the Central Association of Science and Mathematics Teachers, last November.

The first number on the program of the joint science session of the High School Conference meeting, was a very excellent paper by Dr. J. A. Stevenson of the University of Illinois, on "The Project in Science Teaching." Dr. Stevenson made perfectly clear to us what a real project is, and he summed it up in the following definition: "A project is a problematic act carried over to completion in its natural setting." For example, one may teach by ordinary class-room and laboratory methods, the life history, the breeding habits, the disease spreading propensities, and the common methods of destruction of the house fly. This is not a project, but a project may be made out of these same materials, by attempting a fly eradication

campaign in the community of the school. Such a campaign involves many problems which a class of pupils may work out under suitable direction, and if the flies are actually eradicated, the act is carried to completion in its natural setting. Now, if this is a project, there is nothing in it to be afraid of. Furthermore, it is not altogether new. I had carried out a fly eradication campaign in my community some years before I recognized the act as a project, and yet I believe that it is a perfectly typical example. So, the project, being not entirely new, being now clearly worked out as a definite and workable device, and being in this form an altogether desirable addition to our collection of recognized teaching devices, is no longer a cause for strife or difference of opinion.

Following this paper, we had a sort of symposium on the topic: "The High School Science Curriculum, with Special Reference to the Common Pabulum of Science." This consisted of five papers, one by a representative of each of the five science sections of the Conference.

All of these papers except one which was only a little discordant, and nearly all of the general discussion which followed seemed to be in substantial agreement with the resolutions which were finally adopted by unanimous vote of the meeting. The following is the resolution: "Be it resolved that we pledge our united support to the following program for science instruction in the high school:

First: Two full year-courses in what shall be essentially fundamental science; this work to be given in the first two years of the high school, or where junior high schools exist, the same work may be done in the eighth and ninth grades, or spread over the seventh, eighth and ninth grades; this work to be required of all students, insofar as it is administratively possible.

Second: As many full-year courses in the applied sciences, and pure sciences, should be given the later years of the high school course as there is demand for, and as the size of the faculty and equipment of the school will permit. These later courses, unless it be in the case of agriculture and home economics for certain groups of students, should be purely elective, and should be so organized and taught that each year course may answer as the equivalent of a first semester course in the subject in college."

Following the adoption of this resolution, a motion was made and carried, providing for the appointment of a committee of ten, whose duty it is to attempt to draft an outline for a suitable content for these two year courses, in fundamental science, which should be required of all high school students.

One week after this High School Conference meeting, the North Central Association held its meeting in Chicago and among other things, appointed a committee of seven with Dr. E. R. Downing as its chairman, and called the Committee on Reorganization. Later, the following resolutions were adopted for the guidance of this committee on reorganization:

1. Instruction in science for the first two high school years should be such as to put the child in an understanding and appreciation of his environment, that he may become a better social being and better citizen.
2. That this instruction should be such as will contribute to the further development of any science he may choose to pursue.
3. These aims and principles should be incorporated within the material content of the course in general or fundamental science.

Now, you may be asking, why I can say that the adoption of these two sets of resolutions and the appointment of these two committees means the end of the war over general science. First of all, this is because both of these meetings were pervaded by a splendid spirit of compromise and a seeking for common ground, and second because so much common ground was revealed in the discussions of the two meetings.

It is clear now, for example, that general science is not a new science; it is not a different subject matter, necessarily; it is merely a different method. It is a method which seeks to place the emphasis on application, to appeal to a child's native interests, and to present the work in problem form as much as possible. These are things which have been too much neglected in some science teaching. The main common ground, however, which these meetings brought out, is found in the fact that all of us seem to be convinced and united in the belief that the

first two years of science study in the high school should be devoted to a mastery of such fundamental principles and facts of science as are likely to have the largest possible practical social outcomes in the lives and citizenship of those we teach. It is not a matter of such great moment, whether we teach this science by the general science method, the project method, the special science method, or some admixture of these various methods; the matter of common concern, is that we select, organize and teach by some method, the kind of science that would be of most social value, should it become generally known, among high school graduates.

Now, I know that it would be a perfectly fine thing if every high school student could spend a year or even two years in the study of botany or chemistry, or geography, but it would be a deplorable thing if he had to remain forever ignorant of all other science in order to do this. At present, there are six fundamental sciences competing with each other for space in the high school curriculum, namely: botany, zoology, physiology, physical geography, physics, and chemistry. It is absolutely impossible that every high school student should be expected to study each of these sciences, even if they should be offered in half-year courses. I take it as self-evident, too, that each of these six sciences contains something which ought to be a part of the common pabulum of science knowledge possessed by high school graduates. Consequently, I believe that the best thing to be done is to select from these six, and possibly from other sources, the facts and principles which are most worthy, because of their direct social outcomes, to be made common knowledge among the future citizens who are now passing thru the high schools, and then teach this science to all these people, by the best methods that we can devise. You may be asking: Am I overvaluing the knowledge side and forgetting training in the scientific method and the scientific attitude of mind? That is a matter of method, and not so much a matter of subject matter. The science that is socially most valuable, is just as good for training as any other kind of science.

By deliberately selecting a common pabulum of science and seeking to teach it to every one who stays in high school long enough to learn it, we shall greatly increase the

potency for good what science is taught. This general knowledge will become a common medium for the exchange of ideas; it will naturally lead to community of action and it will function in community life, just because it is common knowledge, in a manner that the heterogeneous training in science that we are giving today cannot.

It may be said that we can not determine accurately at once what science is most valuable. This is true, but we can make a pretty good guess at it, and we must make the best guess we can, until future scientific studies of the problem gives us better guidance.