

IMPROVEMENT OF THE DISCIPLINARY TRAINING OF HIGH SCHOOL SCIENCE.

EDWIN M. BRUCE, INDIANA STATE NORMAL SCHOOL.

It is certainly gratifying to those teachers who have been pioneers in the establishment of the sciences in the high schools to see their early dreams being realized in the magnificently equipped science departments in our best modern high schools. They can appreciate these attainments for they know what a long hard struggle science had in obtaining its present respectable standing. It was a fight for nearly every inch of gain, sometimes for the necessary funds for equipment, often for suitable laboratory quarters, and at other times for a fair consideration in the curriculum.

We are rapidly gaining the confidence of the public, as attested by the large sums of money being spent for the science work. But science can most assuredly expect to account for this stewardship. We shall be asked to show adequate returns for these large expenditures; and in that day of accounting it will not suffice to point to the scientific progress of the age, or to the wonderful achievements of science in general. We shall have to point to this or that specific contribution which the high school science is making.

But on the other hand we would do science an injustice, in pleading its cause, if we should attempt to evaluate it only in terms of knowledge imparted, or assistance rendered pupils in preparing for industrial positions. That it has these values no one would deny. But to measure the value of science to high school boys and girls primarily by these standards would not infrequently embarrass us at examination time by the meager showing along the information line, and greater still by the pupil's inability to make use of the information acquired.

By far the greatest contribution science can make to education is its disciplinary or cultural training. This is not a new thought at all. Nearly 50 years ago, in an address on "Science and Culture," Huxley advocated the teaching of science in schools because of its cultural value. And this doctrine has been reiterated to the present time, but science as taught today in many schools has but very little cultural value. We speak in extended terms of the material benefits of science but seldom boast of its disciplinary results.

This paper is a discussion of one of the possible reasons for the meager results along the line of disciplinary training, and an attempt to suggest a possible remedy for it.

The successful studying of science requires a peculiar analytical attitude of mind. The ideal student must possess, first of all, an inquiring, investigating disposition, a love for delving into the meaning of the facts of nature, accompanied with such an interest that the pleasure itself is sufficient incentive. He must be able to investigate with an un-

biased and impartial attitude of mind, reasonably free from all superstition and traditional influences. The scientific mind should not have a slavish reverence for the validity of anything and everything just because it happens to find its way into print. A further requisite for the study of any branch of science is the ability to make correct conclusions from the results of the investigations, and along with this, to possess a bit of skill in mechanical manipulation. Now these are a few of the fundamental qualifications which we wish students to have in some degree at least when they enter the formal science work; or to acquire very early in the course. The term disciplinary training as used in this paper means the further development of these and similar qualities.

From my own experience I would say that the greatest handicap to beginning students in high school or college science is the lack of the scientific or inquiring attitude of mind. Of course we do not expect beginners to have these capacities in any considerable degree of maturity. Their observing may be faulty, hypotheses crude, and conclusions poor, but if they manifest an interest in things, a desire to investigate, along with a little initiative, they are a mighty desirable bit of raw material for the science departments. But it is unnecessary to remind a body of science teachers that such students are a small minority.

The failure of the major portion of the student body to acquire the real disciplinary training of science has been attributed sometimes to faulty training in their preliminary education, again to a lack of mental capacity for strenuous science work, sometimes to a frivolous attitude of mind engendered by the demoralizing tendencies of this play and pleasure mad age. These and other such influences no doubt stand in the way of the most successful results. But there is a more fundamental cause for the inability of high school students to get the cultural training which may be acquired through the study of sciences.

Young children are naturally scientific. They are born with an investigating spirit or disposition. They have an impelling force to examine things, to ask questions, to experiment, even to do an elementary type of research work. Sense perception is functioning. It is nature's time and method for making children acquainted with their natural environment. They have a vital instinctive interest in nature because it is the source of their food, clothing, shelter and a large part of their pleasures. In these early years this investigating spirit functions even without the guardian influence of a school teacher, and sometimes even in the face of the teacher's attempt to suppress it.

Science thus starts with this simplest of all mental processes, sense perception. It is the means whereby most of the facts of any physical science are obtained. It goes without saying too that the proper time to stimulate a mental faculty is when it is active or dominant. But it is equally self evident that an unused faculty will atrophy like an unused muscle. In the common schools of former years and in many at the present time, there has been this peculiar situation—sense perception dominant in the earliest school years, but left without training until the students take up formal science in the senior high school, with an intervening gap of six or eight years.

Teachers know how difficult it is to get high school students interested in the study of natural phenomena after this first interest has been permitted to die out through lack of proper exercise. The predominance of book work in these early grades tends to discourage independent activities of all kinds making it almost impossible to again awaken interest in any type of experimental or observation work. On the other hand, those students whose home environment has encouraged the investigation of natural phenomena, come to the high school much better equipped for science studies than those who have not had such preliminary training. To repeat, it is of the greatest importance to high school science that we tide over the child from the period when he is a most intense inquirer into the meaning of the physical world all about him, to the time when he shall take up one or more of the formal sciences still possessing his early interests in nature.

Probably the best if not the only way to do this is to have some kind of systematic, well organized elementary science work all up through the grades and junior high school. Call it by whatever name you choose, nature study or elementary science.

But I am aware of the unpopularity of these terms among a group of orthodox scientists. When nature study was first introduced we declared that the study of science requires a maturity of mind capable of thinking inductively and therefore entirely beyond the capacity of grade children. We thought that grade teachers could not teach science facts in a scientific way. We were of the opinion that such power resides only in those who have been baptized into the elect body through a B. S. or an M. S. We thought that the quality of work which could be done would only lead to improper habits of investigation and false notions of science. So, for these reasons many science teachers have held themselves aloof from the nature study movement, sometimes even taking an antagonistic attitude to it.

But a sufficient number of superintendents and teachers have recognized its worth in the pre-high school years to save it from the educational scrap heap. Nature study has constantly but quietly gained ground and is today, in Indiana, a part of the preparation of all elementary teachers.

So what is being said in this paper is in no sense a plea for the introduction of elementary science. We already have it, and it is quite evident that it has come to stay. Some kind of elementary science is going to be taught throughout the grades and junior high school. The public has a right to expect the maximum results, which we can scarcely expect to attain under the present conditions. The work needs some directing hand and I believe the supervision of elementary science is our problem, and that we are missing a great opportunity to improve the science work not only of the grades but also of the high schools and colleges if we do not assume this responsibility.

The average results now being attained, though far from satisfactory, are probably all that can be expected under present conditions. This is no reflection upon the teachers who in the past have been obliged to teach a subject without any special preparation. In the first place there has generally been no means for unifying the nature work of the

several grades. Every teacher of every grade has worked independently, without consideration of the work of preceding or following grades which has resulted of course in endless duplications. There is and always has been a noticeable lack of unity of purpose. To some teachers elementary science is mere busy work to keep pupils occupied while they themselves attend to other duties. Others make a reading lesson of it from some book which uses nature at most as a background for children's stories. In these books facts, poetry, fiction and mythology are so intermingled that the child gets only the most perverted notions of nature. Many teachers think nature study is elementary agriculture and nothing more. Then there are those teachers, fresh from college science who under their glowing inspiration want to hand down to the little children the great fundamental generalizations of the sciences. But most pathetic probably of all is that class of nature study teachers who are making an aimless outdoor frolic of the work. The students of all these teachers later enter the high school science courses with this conglomerated background. Is it any wonder that we are failing to get the cultural or disciplinary results which we have a just right to expect?

Who is better fitted to correct these misconceptions than the high school science teachers, for it is their special field? To them the selection of material for this elementary science should be a very simple matter while it is a gigantic matter to the grade teachers. They would know as the grade teachers might not know what nature facts are suitable to study, the essential points to teach, and how to plan and conduct such lessons. In a supervising capacity they could unify the work by outlining a suitable course for the several grades. They would be the proper ones to give some kind of instruction to the grade teachers in the scientific method of conducting a lesson. The science teachers could be of great service in supplying simple materials from their stock, and more than all in being the main source of inspiration to the nature study teachers. Their assistance in these lines would not be considered an intrusion but would be most welcome.

This effort would by no means be without reward to the high school science teachers, for elementary science when properly taught gives children a start in the scientific method of studying natural phenomena. Of course the results will be very elementary, but the habits formed will be in the right direction and will not need to be undone in the physics, chemistry or botany class. Science will be benefited by the child developing some skill in interpreting results, in formulating them into reports, and in acquiring some alertness in discovering new problems for investigation.

Science has good precedence for a course of preliminary training in the grades. The success in high school literature is due in large part to the fact that the child starts the study of literary selections almost as soon as he enters school, and continues their study throughout the grades. Algebra and geometry start in the kindergarten with simple number relations. High school history lays the foundation for its work in the grades. Sentence construction throughout the elementary school is a stepping stone to rhetoric and composition. What would high school music accomplish if it were introduced for the first time to the fresh-

man class? This carefully planned and directed preliminary training is one reason evidently why these subjects are getting better and more definite results than we are in the sciences.

The views expressed throughout this paper have been based largely upon the results of a plan instituted in the Indiana State Normal Training School about 15 years ago. The nature study work was under the direction of one of the regular science teachers. At the start a number of conferences were held with the grade teachers, in which the disciplinary value of the work was stressed, and its purpose or aim, and method were explained. Special emphasis was placed upon the experimental phase of the work. A series of nature study lessons was prepared for the eight grades. They were outlined in considerable detail, taking into account the personal tastes of the teacher in the selection of the materials. Assistance was rendered in furnishing library references for the teacher's benefit, on the facts to be taught, and in securing materials and apparatus.

It was most gratifying to see how teachers and pupils became interested in the work under some kind of definite plan. The results were beyond our expectations. We noted a marked improvement in the training high school science as these grade children moved up into the high school. There was also a noticeable increase in the number electing science courses. After a few years a special nature study teacher took charge of the work, which of course is the better plan.

In conclusion, my experience with elementary science confirms me in the belief that there should be an uninterrupted study of the field of science from the kindergarten to the senior year in high school. There should be just as much concern for the work in the earlier years as for that of the high school, for whatever mistakes and weaknesses are in these earlier years are sure to appear later as handicaps to the best results. The disciplinary training of the high school science will be improved by giving special attention to the elementary science of the grades, and that the one best qualified to direct or oversee this uninterrupted science course is the high school science teacher.

