Our Common Task

By ***Donald G. Decker***

THE history of education has been a series of stormy, volcanic eruptions which have periodically changed the character of American Education. Educators have been hampered because they have been without one consistent aim. Education has been a public enterprise and therefore at the mercy of certain pressure groups, individual opinions, and community whims. Educators have also been hampered because the great philosophers of education have interpreted the values of education individually and personally. Each has been an educational missionary who gathers a group of followers, deviates from other groups, and eventually becomes powerful enough to break through a small fissure in the side of the volcano of education and start another little volcano.

During the last two decades educators have been urged to get away from subject matter and to get back to subject matter; they have been urged to get away from religious education in schools and back to religious education in schools; they have been urged to expand the curriculum and to contract the curriculum; they have been urged to have more extracurricular activities and to have less extracurricular activities; they have been urged to make education specialized and they have been urged to make it general. A calm head and steady nerves are needed by a teacher who desires to steer a consistent course in education these days.

The Work of Scientists and the Science Educator

THESE opposing ideas are mentioned because of the direct bearing they have upon our common problem. They make a striking contrast with the field of science in which there is a common aim, a common value, and a common method. The scientist in any part of the world holds to one value, truth through evidence. He makes this value the criterion of his work and has accepted the scientific method as the way to make this value a reality. The scientific method is his expression of the attitudes that govern his work. The foundations of his work are neatly packaged once he has accepted the values, the beliefs, and the method of the scientist. If a person wishes to be a scientist, he must accept these ideas and work in this way. He then becomes of value as a scientist.

The science educator has no such neatly packaged set of values, methods, or beliefs. He probably never will have as long as education is a public enterprise. In a democracy a person is free to accept or reject the findings of science. Science confines itself largely to the investigable in the universe. Formal education confines itself to the investigated. Herein lies the difference in the professional lives of the scientist and the science educator. People are more willing to believe something about a volcano for example, than they are about themselves. A fact about humans is destined to be judged by prejudice. A fact about a volcano is destined to be accepted as truth. Therefore, judgment by prejudice and acceptance as truth, make the difference between the work of the scientist and the science educator. How shall people be educated best is open to the variables of prejudice.

There is no one best way to educate so long as we educate free thinking human beings. The late, great Einstein said, in effect, there is no basic law that can be established by which the behavior of humans can be predicted. There are too many factors involved. This is the reason we can have no one best method of science education. Too many individuals are involved and too many factors operating in the learning process to make *a* method *the* method of science education. In addition teachers deal not with single individuals but with groups of individuals. Their methods must be group methods. They can make some attempt to provide for individual differences, but they educate groups. The attempts in the past to make education individual and make the individual responsible for his education failed miserably. Students were not capable of assuming their responsibility nor were schools staffed to handle such time-consuming projects. One by one these schemes have been abandoned as a solution to the problem of better public education.

The Objectives of Science Teaching

WHAT, then, can guide the science educator in making a program for groups of students? His first guide is the fact that the science program has something to offer that cannot be learned in any other subject.

The facts and principles of science are peculiar to the field of science. Students in science classes learn

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the information discovered by the scientist. This information has the quality of truth at the time in all places, in all countries of the world, and in all environments. Its quality is the result of discovery by the scientific method. This is not true of art, of social studies, or any other school subject. All subjects but science are cultural and vary as the culture varies. Science does not vary with the culture; it varies only with new evidence discovered and new avenues of truth opened. The facts and principles of science are then the first guide for the science educator.

The values, beliefs, and methods of the scientist are peculiar to the field of science. The second difference then between science in the public school and other school subjects is the fact that in science classes students learn how the information was discovered by the scientists. They learn how a scientist solves problems. This is basically the work of the laboratory, the nucleus of the experiment, and the application of the scientific attitude.

Science education has two objectives: 1. To teach students the facts and principles with which a scientist thinks. 2. To teach students how a scientist discovers these facts and principles. The training of a science teacher involves training for the understanding of the facts and principles and the method of the scientist. A science teacher cannot teach well without this background. The training of a science student by a science teacher involves training for the understanding of scientific facts, principles, and the method of the scientist. The science student cannot hope to progress in the field of science without these understandings.

The acceptance of these ideas can determine the program in science in the public schools. The science educator has the task of selecting facts, principles, and experiences for each grade level which is a part of the science program. The organization of a science program based on the facts and principles of science presents the problems of selection and grade placement. Since selection must be in terms of the maturity level of students consideration must first be given to the scope of the science program and then the sequence of it.

The Science Program

AT no age in the public school is the student too young to have some experiences with science. To refrain from teaching science in any grade is to withhold an important part of education from students. To refrain from teaching science in any grade school is to widen areas of ignorance about a certain part of the environment. Science surrounds an individual the day he is conceived. He is born in a culture that rests upon a foundation of science. He has questions and interests in science long before he comes to school. The stories he reads, the conversation he hears, and the television programs he sees promote and increase his interest in science. The experiences he has in living in this age are largely experiences with science. His basic needs of food, water, and shelter, and recreation are largely controlled by the applications of science. His communication and transportation are basically scientific. The great fields of industry, agriculture, and services are basically applications of science. In the public schools teachers cannot hope to interest students in science, or in becoming scientists and science teachers, unless they teach science to students.

The science program in the public school should be a cumulative program from the kindergarten through the twelve grades. The science program should be organized around the principles of science. In each grade students should have the opportunity to learn and to have experiences with science. Each grade should have, as a part of its program, definite concepts to be developed by students to help them understand a principle of science. As students develop more concepts and have more experiences, the principles become meaningful and useful to them in explaining and predicting their environment.

In the first nine grades, the cumulative program should be in operation and it should be divided into five main topics of science: Plants and Animals, the Human Body, the Earth, the Universe, and Matter-Energy. Students should know some facts and have some experiences with each of these areas.

In the last three grades there should be a double-track program for the science student. He should be required to take biology, physics, and chemistry, and also have the opportunity to elect such science subjects as astronomy, geology, meteorology, human physiology, and other science subjects. The elections should be for the student with particular potentialities and interests in the field of science. For those students who are not going to enter the field of science as a vocation, there should be three major courses for the modern citizen, namely, a course in the physical sciences, a course in the life sciences, and a course in current science. Each of these courses should be coupled with the social aspects of science so that a person graduating from the modern secondary school knows the extent of the application of science in his daily life. Public schools do not offer too much science. They offer too little.

The Present 12-Year Science Program

THE contrast of this plan with the present offerings in science in the public school reveals one reason why the number of scientists and science teachers is low. The public school may or may not offer a program in science in the elementary school. If it does, the program may be a reading program supplementing other programs. The program may be one in which a teacher with a special interest in science does a great deal and others do nothing. The program may be taught by teachers who through no fault of their own are without training in the field of science.

The 7th, 8th, and 9th grade science courses may be well organized or not organized at all. Science may be offered in the 7th and not in the 8th, in 8th and not in 7th or in 9th as a required subject.

In high school, if two years of science are required, most students take their second year in biology and

have no physical science before they graduate. Schools may alternate physics and chemistry. Laboratories are often poorly planned and poorly equipped. The teacher may have the minimum requirements of eight semester hours in physics or chemistry or he may have one year of either subject; a bare introduction to the field. He may or may not have had student teaching in the subject in which he is teaching and he may or may not have had a methods course in the teaching of his subject. More than likely the elementary and secondary teacher had one methods course of a general nature to prepare him to teach several sciences.

The present program of science education in the public schools needs to be improved. It needs consistency and organization. It needs better trained teachers.

With such a program as the present one, the reason for a dearth of students interested in continuing in the fields of science or science teaching is not obscure. Up through the elementary grades there is usually an increasing interest in science. Questionnaires reveal this interest on the part of boys and girls. In the junior high school this interest continues, but too often schools make it impossible to function because of the program offered or the teachers who are asked to teach it. Interest begins to wane and at the end of the program there is not a great demand for more science. Students satisfy the minimum requirements with a minimum of interest. For this reason, too, science is not an expanding program in high school but one that is being slowly and gradually reduced.

The result of the present 12-year program is the popularity of the general education program in science in the first two years of college. Much of what is taught is what should have been learned in the secondary school. Many students delay the beginning of their training as scientists or science teachers until the last two years of college. During these two years they try to cram enough education to fit them for the teaching of the subject or research in the field of their specialty.

Training Science Teachers

THE training program in the colleges must go hand in hand with the program in the secondary school. Teachers must be trained for the job they are to do. In most schools the only science requirement for an elementary teacher is one methods course in science teaching. The science subject matter is left to elective courses and personal choice. How can a person feel comfortable in the field of science with such programs of training? Teachers flock to summer schools and take content courses with the hope of getting help for the job they are really eager to do. This too presents a problem. With an undergraduate degree, the teacher wishes to do graduate work, but does not have the prerequisites for courses in science and must elect the costly program of getting them without graduate credit or the school must give graduate credit for courses of undregraduate caliber. These considerations should give educators cause to wonder.

The secondary teacher is often required to have one year of chemistry, one of physics, one of biology, or a combination of zoology and botany. The junior high school teacher must teach astronomy, geology, and meteorology. These are elective courses in college. The teacher may not have had these courses. The biology teacher is required to teach, in addition to botany and zoology, health, physiology, conservation, heredity, and genetics. These, too, are elective courses. He may or may not have had them. The junior high school teacher usually has not had any course in the methods of teaching junior high school. The secondary teacher has had, perhaps, one general course in the teaching of science. He must step into a specialized field and order materials, make a program, evaluate his students, make tests, use audiovisual aids, and contribute to state and local meetings. One wonders why science teachers do as well as they do. No other profession is asked to work with this minimum of training.

Improving the Situation

WHY does such a situation exist? It exists partially due to the fact that the scientists and the science educators have grown apart in many institutions. The schools of education have not seen fit to face the problem of the training of the science teacher with any degree of reality. The scientist with his specialty has often not faced the reality of the number of sciences a teacher teaches, or the present organization of schools in which a teacher is required to teach many subjects. A science teacher with a major in chemistry cannot teach physics, biology, and general science well. Scientists and science educators should get their common tasks.

Scientists are needed in universities who will make special courses for our elementary and secondary school teachers, and who will select for these courses the subject matter that will help the teachers teach the units they will be required to teach. Scientists are needed who have an understanding of the task of the science teacher. They need to participate in preparing him well. They must understand that special courses are needed to prepare a person for a special job. Teachers will be appreciative of this effort. Professional educators need to realize that time must be released from educational requirements to allow the student time to get the background in the subject matter that he needs. Also they must realize that one methods course in the general aspects of teaching science is not sufficient to prepare a teacher for the task that is ahead of him. Scientists must also encourage more individuals to consider teaching as a career.

The caliber of the science teacher will partially determine the kind of science student that enters college. There is no other source for science majors but the secondary schools of the nation and there is no source for them but the elementary schools of the nation. If this nation is to remain secure and great, schools must have good science programs, good science teachers, and good scientists. This is our common task and the important task of the next decade.