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Profile for

Appraising Secondary Science Teaching

WHAT is happening in secondary school science today? The casual observer is probably not aware of the extent or direction of the changes that have occurred. Nevertheless various forces have been operating to change both the internal nature of specific courses and the patterns of offerings by our schools.

The most recent study of offerings and enrollments in science by the U. S. Office of Education, based on data gathered in 1958, reports an increase, over previous years, in the percentage of schools offering various science courses.[1] The study, which has been made biennially since 1954, reveals a continuing upward trend as follows:

	Percent of Responding Schools Offering the Course in:		
Course	*1954*	*1956*	*1958*
General Science	*	85.3	87.7
Biology	89.0	90.3	92.0
Chemistry	57.0	63.8	72.3
Physics	52.0	56.8	63.9

*Data not collected.

[1] Kenneth E. Brown and Ellsworth S. Obourn. *Offerings and Enrollments in Science and Mathematics in Public High Schools, 1958.* U. S. Office of Education. Washington: U. S. Government Printing Office, 1961. 87 pages.

In addition, advanced general science, and a second year of biology, chemistry and physics were reported by 11.9, 4.0, 2.2, and 1.6 percent respectively of the schools in 1958. It is also significant to note that 1.4 percent stated that they offered science research seminars.

Between 1956 and 1958 there has also been a slight increase in the percent of pupils enrolled in biology, chemistry and physics. In contrast, a slight decrease in the percent of pupils in general science was revealed. This situation is due to factors which are largely undetermined and open to speculation. Experimentation in the course offering at the ninth grade level is undoubtedly one of the principal contributing factors. Earth science, biology and physical science have replaced the traditional general science course in a considerable number of schools.

The over-all picture of the number of schools offering the four typical courses, the number of pupils enrolled in them, and the new advanced courses shows substantial evidence of change. This evidence points up a renewed interest in science and a trend toward greater depth

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in the secondary school science programs. The 1958 study was the first to disclose a perceptible number of schools offering a second year of biology, chemistry and physics.

Although these data may be encouraging, there are some disturbing conditions which must be noted. In the post-World War II years, and more particularly in the post-Sputnik years, there has been a great clamor to up-date our science courses. It is not at all difficult to find numerous course revision projects which have amounted to nothing more than a "rearrangement of the rubble" that existed prior to the revision. To add a further complication, the original courses had grown more or less like Topsy without pattern or purpose.

Problems in Science Programs

Two pervasive problems must be faced squarely if our science programs are to make a really worthwhile contribution to society. These are:

1. The need for a continuous flow of excellently trained young people to constitute our scientific manpower pool, and

2. The need to raise the level of scientific literacy of our entire citizenry so that they will be able to live fully in a society which is influenced by science and technology.

One immediately recognizes the fact that the secondary school science program contributes perhaps indirectly to the first of these problems. Our future scientists, engineers and mathematicians require long, intense, specialized study even through the graduate level. However, the need for identifying and encouraging these young people cannot be postponed to the college years. Glenn Seaborg, for example, has credited his high school chemistry course for sparking his interest in science as a career.

Raising the general level of scientific literacy may be even more crucial than the manpower situation. Over the past decade science and technology have played an increasingly important role in our way of life, and there is every reason to believe that this trend will continue. Our comfort, many of our activities, our very existence may depend on decisions we make regarding the way we will use these fields. To assign responsibility for these decisions to individuals who are unaware of the implications of their action is inviting disaster. On a more mundane level, we encounter a need for an understanding of science in our daily lives, for example, reading the daily newspaper, consumer purchasing, communications, transportation and avocational activities.

In developing scientific literacy, two aspects of science merit attention. Knowledge outcomes, which might be regarded as the *product* side, have always appeared in the objectives of science teaching. Less obvious but even more important is the *process* side—the methods and attitudes of the scientist. These processes of inquiry are essential to the development of a feeling or a sensitivity for science. While facts themselves change and their applications are continually altered, the processes remain more or less constant. Unless they are taught intertwined with the product, the true nature of science will ever remain elusive, and whatever gap may exist between the scientist and society will be perpetuated.

These two broad problems, scientific manpower and scientific literacy, provide the frame of reference for a modern science program. The experiences which we propose for our pupils must be evaluated with respect to their contribution to both goals.

A Suggested Evaluative Instrument

There can be little doubt that there is a wide range in the quality of science programs in schools across the country. Many courses are excellent in every way, taught by teachers who have kept up-to-date in regard to science and professional education. In other cases one can find elements that leave much to be desired. Textbooks may be out of date, equipment obsolete, or teachers inadequately trained. There are undoubtedly elements of strength, however, in even the poorest science program. It seems only logical, therefore, that the first step in the reorganization of a program should be a survey to identify the strengths and weaknesses of the current program. Then it becomes possible to build on the strengths and to remedy the weaknesses.

To carry out such a procedure, some type of yardstick must be constructed or located. A further decision must be made in regard to *who* will appraise the program and *how* the evaluative instrument will be used. The value of the survey will depend on these decisions.

In recent months the science staff of the U. S. Office of Education has developed a checklist for use in appraising science teaching. The instrument has been adapted by permission from *School Management* Magazine.[2] Eleven broad aspects are suggested for consideration, together with specific items of information in each.

1. *General and Coordinate Activities.* The National Defense Education Act, the National Science Foundation, private foundations and industry have made a vast pool of resources available for improving science teaching. These resources must be identified and organized into an ongoing program if they are to be used effectively.

2. *Administration.* Many administrative policies relate directly to the effectiveness of the teaching program. Periodic review of teaching assignments in terms of qualifications, encouragement of up-dating science and professional backgrounds, and the use of new curricular materials are examples of ways in which the administration must be brought into the picture.

3. *Finances.* The budget must provide realistically for facilities, equipment and supplies. Beginning salaries and the salary range need review in terms of those offered by agencies with which the school must compete for manpower.

4. *Staff.* Both scientific and educational organizations have centered attention on the preservice education of teachers. To supplement this background, and in certain cases to remedy weaknesses, in-service workshops and institutes must be provided. Professional and scientific journals are sources of helpful suggestions. Guidance responsibilities of the classroom teachers cannot be neglected, and the lack of a "science-sensitive" guidance counselor should be cause for concern.

5. *Public Policy.* The needs for identifying and encouraging the talented in science and for raising the level of scientific literacy have been mentioned previously.

6. *Aims and Objectives.* Long range purposes and a point of view must be established. Development of understandings and skills in the processes of science, as well as a knowledge of facts and principles, requires attention.

7. *Curriculum.* The availability of science instruction to all pupils, K-12, class

[2] "Your School's Science Program." Copyright. *School Management*, Vol. 3, No. 5; May 1959. p. 42-46.

size, and types of classroom activities merit attention. Are "open-ended" experiments used in the laboratory? Is provision made for double laboratory periods? How much and what types of science are required for high school graduation?

8. *Youth Activities.* The youth activities program should supplement and reinforce classroom teaching. Individual projects and club activities should arise from class work and should provide opportunities for broadening and deepening classroom experiences. The combination should provide an enriched, meaningful experience for all children.

9. *Facilities.* The suggestions of science teachers and supervisors constitute an important early step in planning classrooms. Physical conditions, suitability of facilities and equipment, teaching aids and adequate storage and preparation rooms are important considerations.

10. *Teaching—Learning.* Does the program *teach science* or teach about science? Evidence of the former includes such things as providing for firsthand observational work, using genuinely thought-provoking questions in contrast to "cook-book" activities, teaching for specific elements of scientific methodology, and providing a classroom environment which promotes a spirit of inquiry.

11. *Evaluation.* A good evaluation program makes use of a variety of procedures. Teachers should have a variety of evaluative materials on hand for reference purposes. Using standardized tests periodically furnishes extremely useful information. Special attention should be given to the evaluation of growth in the process goals of science teaching.

The ideas suggested above are by no means all-inclusive. Other aspects of the science program may occur to the reader, and within those listed there may be other important elements. The most important point is that a thorough evaluation which provides an accurate profile constitutes a sound basis for action in setting up a science program.