<SPECIAL ISSUE>

Meaning of STS for Science Teachers

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The Meaning of Science

Science to most people means studying about living forms, stars and planets, chemicals, the earth, mechanics, energy, and other more specific topics found in textbooks about science and/or the major disciplines of science, namely, biology, chemistry, physics, and earth science. Such topics of science are fascinating to some persons-often over half of the students in the elementary school-but the number decreases to only a fourth of the students in high schools(NAEP, 1978; Weiss, 1987). Most adults look back upon their experiences with school science in negative ways-at least in terms of what most science teachers advance as their objectives and intentions for their courses and their instruction(Yager, 1985). Most people identify science as the material studied in science classes; that is the science which they report to be not too useful, nor particularly valuable, nor meaningful to their day-to-day pursuits. And yet these same adults feel that such experiences with school science are valuable for their own children to have. Over 85% of the adults today support rigorous experience with school science for their children-even when they can not identify value of their own experiences with it when they were students.

This situation is an intriguing one! Many science educators are convinced that a major problem is the lack of any utilitarian (useful) definition of science; most people never think beyond their own experience with studying science in school. And yet, what is typically studied represents only one dimension of science-perhaps even an unimportant dimension. Most persons-when pressed to offer a short, simple, concise definition of science-focus upon the informational dimension. For example, Campbell(1957) views science to be the generalizations concerning the natural world about which experts agree. Feynman defines science to be basic understandings of the universe and its contents(Feynman, 1985). Such definitions suggest a certain structure, a certain information base, and a certain degree of comprehension for students to master. Such definitions limit learning by concentrating on information that is presumed to be prerequisite to real understanding. Unfortunately, such unidimensional definitions allow teachers, curriculum developers, and the general public to view science as only the mastery of certain concepts, those identified by contemporary scientists.

George Gaylord simpson, biologist/paleontologist, has advanced a definition of science which is simple, easily associated with living, and yet more complete and comprehensive in describing what science is in practice (Pittendrigh & Tiffany, 1957). It is one which most scientists accept and one which is particularly attractive to science educators. Simpson's definition has three parts, suggesting three necessary ingredients for any human enterprise to be called "science." Simpson's definition is: Science is an exploration of the material universe in order to seek orderly explanations(generalizable knowledge) of the objects and events encountered: but these explanations must be testable(Simpson, 1963; Brandwein, 1983).

Simpson's definition restricts the domain of science to the material universe. It identifies the major action to be one of explaining(understanding);it is a personal act, a creative act, an act requiring skills which presumably can be improved and sharpened. But such explanations must be testable if they are to be called science. Simpson recognizes that there are many acceptable explanations for phenomena, ideas, and human perception; however, if a test of such explanations cannot be devised, one can not call the activity science. There are fine explanations of objects and events which are appropriate for fine arts, humanities, religion, and philosophy. Simpson's view of science enables us to see more dimensions of science, to see more of the total human enterprise, to consider more basic ingredients than normally found in the study of science in schools and colleges, it provides a richer context to consider science and its place among the various facets of the total curriculum for all learners.

The Meaning of Science Teaching: Goals and Problems

Many problems exist in schools with respect to meeting instructional goals. Many of these problems could be reduced if educators would use Simpson's definition of science; more of the essential ingredients of science would be practiced and incorporated into the fabric of the curriculum and the teaching strategies employed. At present most teachers argue that they are aiding students in "understanding" science by reviewing the information found in standard textbooks-textbooks which seem to focus on the structure of the various disciplines and the generalizations currently accepted by professionals. Often these generalizations are abstract and important and/or attractive only to practicing scientists. Infrequently is there any attempt to consider generalities that are useful and/or important in the lives of people.

Generally the real problems in school science can be summarized with the following statements:

1. The science textbook is the source of nearly all information successful students need to learn; it is the source of teacher questions, questions for quizzes and examinations, and ideas for activities.

2. Most information in science courses is justified as necessary before one enrolls in the next course; rarely, however, is this the actual case. Most teachers present, consider, and review everything that students in a given course ay a given grade level will need to perform in an exemplary manner.

3. The impact of science information on the lives of students and any applications of the concepts for students and/or society in general are omitted. It is assumed that impact and application will occur"naturally" or that other teachers in other curriculum areas will tend to this need.

4. Teachers view themselves as sources of information that is important for students to learn. They rarely admit to not knowing; they restrict student interest and attention to a rigid course outline.

5. Evaluation is based upon vocabulary acquisition and recall of information from textbooks and/or teacher lectures.

6. Science is restricted to what occurs in a science classroom. There is rarely any emphasis upon extensions of activities beyond the classroom or the school; it is rare to depend upon resources of any kind beyond the textbook, the teacher, and the science room.

The Meaning of STS

Central to the STS approach is the focus upon individual learners. Certainly everyone is a part of a society; the society(social structure) for younger students is more closely tied to the home, community, school, and classroom than is the society for older students, who can conceptualize a global society. The STS approach is one that necessitates problem identification by individual students and individual classes. Such problem identification includes-by its very nature-a multidisciplinary view. There are few problems that are related only to science-certainly mot to one science discipline. For most people, societal problems by their very nature exist in total context.

Science is habitually taught as if all students could and should become practicing scientists. Teachers often give special attention and praise to outstanding students in the traditional school setting. Teachers frequently brag about the most gifted students taking special note of their success in college and their choice of professional science, medicine, or engineering careers. And yet, the number from a given high school graduating class who achieve such success represent less than 1% of the total. Leyden has observed that the typical high school graduating class will contain more criminals than scientists(Leyden, 1984)

In addition to beginning with society-as defined by learners at given grade levels-the STS approach includes technology. Many science teachers find this to be a problem since most of their formal preparation was devoid of any work in technology(applied fields such as medicine, allied health, homemaking, industrial arts, engineering, agriculture, forestry). Science teachers are prepared in the pure sciences, taking college courses that are structured exactly like high school courses. If one were to examine the tables of beginning texts in biology, chemistry, physics, or earth science, it would be difficult to unearth variations between high school and college tomes.

Most science teachers find it difficult to start with society and to move to technology. After all, they are among the few who have succeeded with school science and who have continued with a bachelor's degree in science. They are the ones who find it most difficult to view science in any way other than how they have experienced it. This usually does not include any exploration for the sheer enjoyment of it. It does not usually allow students to formulate any explanations of their own; it certainly does not include any experience with devising and carrying our tests on the explanations advanced. the typical high school and college experience would not include any of the ingredients of basic science as envisioned and defined by Simpson.

Focusing first on questions and/or issues is appropriate for most people. Such a focus is basic to reports in newspapers, magazines, and television. Issues comprise the major treatment fir popular science publications such as *Discover*, *Omni*, and *WorldWatch*. Most people are fascinated with the unknown, genuine problems, and complex issues. Few recognize such actions as decision-making, probing, debate, and conflict as having any relationship to science. And yet, in excess of 90% of all societal issues today are grounded in science/ technology and require such actions!

Using societal issues as organizers for school science provides several advantages over the organization most recognize and the one which most teachers prefer. First of all, the use of issues provides a ready vehicle for utilizing the more complete definition of science as advanced by Simpson. The issue-the question-the uncertainty-become the point of departure and the reason for exploring. Issues by their very definition are motivating, thought provoking, call-to-action. There is a need for information and a reason for offering explanations. There is opportunity for much human interaction, including discussions of the relative validity of various explanations, the search for information/knowledge, and the formulation of tests for various explanations. Instead of students being told they need to have information(as in the typical classroom), students are the ones who recognize the need for informations; they seek it out, apply it, and use it. Suddenly the problems most science teachers encounter in terms of motivation are solved!

The use of issues as organizers for school science also resolves the major problems of science education as elaborated previously. Suddenly the textbook is not"the course"; it is no longer necessary to preach about the value of science understanding. Use of science information is suddenly the beginning point rather than a difficult "add on"; the teacher's role is that of facilitator and helper, instead of dispenser of information; student success can be observed in performance terms, including application and synthesis, as opposed to recall. science is seen as something that occurs everywhere-not just in books and science classes.

The STS approach provides other advantages-perhaps even more important than providing a better experience with real(and more complete) science and resolving the basic problems observed in science education circles. Such an approach may provide a major vehicle for tying the whole school program together. Using actual community, regional, and global problems provides obvious ties to all aspects of the school program. It can provide a means for the school to become a microcosm of society as a whole-allowing students to practice directly the skills needed for living in the adult world. Instead of assuming that all parts of the school program will be meaningful and that the parts over time will be useful and appropriate, student needs and experiences demonstrate the value and power of science explanation skills.

Using current issues as organizers for instruction is not foreign to other curriculum areas. Nonetheless, it is not a common pattern. Social studies teachers and their traditional courses of study are too often tied to discipline areas such as world history, American history, American government, sociology, economics, geography, and psychology. Any ties to world problems and any ties to science(as commonly approached in schools) are rarely observed. Many social studies teachers fear dealing with current issues-often exactly because of the ties to science and technology. Traditionally, social studies teachers feel threatened by these fields, inadequate to deal with such issues because of inadequate educational backgrounds.

Language arts teachers experience some of the same problems. They can deal with the mechanics of reading, writing, and speaking; they can teach journalism, drama, speech, debate, and literature. It is easy to focus upon the concrete and the mechanics. All too often, however, that which is concrete is not relevant. All too often the mechanics seem to have no value in the real-world. Mathematics is often a problem because it is taught as specialized skills for which applications in daily life are not apparent. An STS approach can focus upon use of mathematics skills in a real-world context.

The Value of a Relevant Curriculum

Dewey(1938) often talked and wrote about the value of a relevant curriculum-the necessity for real learning to come from actual involvement. The arbitrary division of the curriculum and the school day into subjects/courses may be detrimental to real learning. We may be missing every opportunity to involve students directly in real learning, and missing the chance of offering a program that is preparatory for students who will live and operate in a future not totally unlike the present. Instead of isolating students in places called schools and forcing them to learn information from books and teachers-interactions which often seem unrelated to the world today-perhaps a focus upon the world today, i.e., current issues and problems, will problems, will provide the missing ingredient that is necessary for real learning to occur.

Cognitive psychologists(Champagne & Klopfer,1984) are united·in their observations that most high school graduates(college students and adults as well) have many naive theories(misconceptions) about the real-world. They seem to retain these views even when they complete and succeed in advanced courses dealing with scientific concepts and theories. Apparently, the science learned in school is not internalized, i.e., not really learned. The best students perform well on tests and advance to the next level; however, they internalize and believe interpretations of the real-world based upon real experiences they have had. There is often a discrepancy between school science and real-world experience. The real-world experience wins out every time over the science of textbooks, classrooms/laboratories, and schools. There is every reason to believe that similar discrepancies exist between school experiences and personal experiences for students with regard to all other facets of typical school programs.

There is little worry about a world without issues. some fear that more issues- and more complicated ones-arise than can be dealt with. There are problems of energy depletion, population explosion, food supplies, toxic wastes, nuclear proliferation, nutrition, disease, warfare, communication, transportation, agricultural production, synthetics, computerization, and space exploration, It is difficult to conceive of any newsworthy current event which is not a science/technology-related issue. Appropriate issues will provide needs fir mathematics and a point of departure for social studies.

As for language arts, why should not current problems and issues be used to practice good communication, and to develop better writing, reading, and speaking skills? It would seem that an STS focus in a school would have advantages for all students-if they view school as preparation for living. Further, most curriculum areas could meet their objectives more easily since students would be motivated to learn because they would see a need. Teachers would not have to insist that their students "need to know" and yet find it difficult to justify the need.

Some schools, such as those in Chariton, Iowa, involve students and teachers in selecting an annual STS issue. For two years space technology has been chosen. Every department gets involved with the issue. Many aspects of space exploration are rooted in basic physical science. Industrial technology is directly involved with communication systems, principles of flight, and design and construction. There are economic, psychological, government, and sociological aspects-i.e., the social science focus. The need for communication, i.e., letter writing, public forums, debate, and journalism is great. The art department is intimately involved; there are also direct ties to foreign language. Mathematics is needed in a variety ways-always because of the need-not because there is another is another important skill to teach.

Many STS projects start with a common-and at times a comical situation. Some have included clogged toilets, a dripping faucet, a disaster caused by severe weather, an accident, or a news event arising from the Persian Gulf war. It is often amazing to see the connections students can make to basic science, and to the basic content of a variety of school disciplines, when they are encouraged to do so. When content is introduced by the teacher, textbook, or course of study, it is rare for the students(or teacher) to see or to identify any connectors to daily lives.

The Meaning of STS for Science Teachers

In every instance effective STS programs can be observed to affect teachers and learners more than did science alone. The focus upon community and world problems becomes something around which all can identify. The community becomes the laboratory-not just a place called a science laboratory. The amount of communication among the faculty as a whole increases by 50%. Administrators-central office as well as building-become pivotally involved. In some instances, administrators are directly involved in the school program. In all instances community leaders become directly involved in the school program. New alliances are created; new partnerships are formed; in several school community members form new organizations to support school efforts. Teacher inservice becomes much more important; teachers are quick to realize that they must continue to grow: the best teachers are involved learners. In all cases teachers become much more involved with each other, with students, with school officials, with community leaders, and with persons across the nation and world.

While real societal issues may provide a significant organizing force for the school program, expertise with developing needed communication skills is a vital link in developing an exemplary school program. Skills with interviewing, writing, speaking, reading, and debating are needed if teachers and students are to become involved on resolving school, community, state, national, and international problems. To be sure, most science teachers have too few skills in dealing with societal issues (traditionally handled in applied areas such as agriculture, industrial arts, and homemaking), and in dealing with communication(the primary responsibility of educators in language arts). A focus on local issues can help schoolwork to be seen as more relevant, as teachers and students work together on one or more problems. Such cooperative efforts can not help but to serve as a better model for future citizens who must work together to resolve problems and to advance our common culture.

STS has been introduced as an organizer for curricula in some states. Statewide inservice has provided a focus in such states as Arizona, New York, Iowa, New Jersey, and Wisconsin. Mmost science and social studies textbooks are introducing STS themes. However, the richness is not found in such new topics in textbooks, or in new units prepared by teachers. The richness of STS comes from students, and the central role they play in planning and carrying out their problem solving activities. STS often results in re-structuring the total school program.

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