Science Education: The Search for a New Vision

Paul DeHart Hurd

The goal is not merely to increase scientific requirements, but to increase students' ability to *use* science in their lives.

The National Commission on Excellence in Education concluded that the "mediocrity" of school programs places our "nation at risk" in maintaining world leadership in scientific and technological advancements and achieving a stable economy.[1] This is indeed a harsh indictment, and certainly not unfounded. But it represents only the symptoms of much deeper issues.

The Pressure for Action: A Note of Caution

The list of recommendations for reforming science education is long. The pressure for immediate action on correctives, while making for good political rhetoric, is largely counterproductive. For instance, doubling science requirements for graduation from high school will not alleviate the science teacher shortage. Requiring students to take more of the kind of science they already dislike is not apt to improve their scientific literacy. Lengthening the school day and the school year does not ensure more or better learning. Inservice programs for updating the science background of teachers are not of great value unless the question "to what end?" is answered first.

The outcry for higher levels of scientific and technological literacy is a plea for fundamental reform in science education. The tenor of the discussions is to bring science education into harmony with modern conditions of science, technology, and society as they are interrelated in the welfare of the individual and of the nation. The basic issue is not the current insufficiencies of science education, but the more fundamental question of the place of science and technology in the wider texture of life.

Mandatory lengthening of the time students are in school, making science courses and science tests more difficult, increasing science graduation requirements, modifying teacher certification requirements, refurbishing science laboratories, and rewording traditional statements of educational goals do not constitute a conceptual reform of science education. We must first achieve a new vision and a new educational agenda in the sciences that will focus on human concerns in the 1980s and beyond. The source of this vision is found in recent changes in the ethos of science and technology, cultural shifts in American life, and a selection of subject matter from fields of science and technology that can make "scientific literacy" a meaningful educational purpose. What is sought is a science program that has both scientific and cultural validity.

A Higher Order Curriculum

The science curricula that are most widely used in schools are now viewed as too narrow and too discipline–bound to serve individual and national needs in a high–technology society. For example, the essential technology and engineering concepts and the modes of thinking characteristic of these fields typically are not represented in the curriculum or textbook. Science courses are taught as separate intellectual disciplines, such as biology, chemistry, or physics. However, for decades science and technology as enterprises have been on a path of development that now blurs distinctions between them. They should be viewed as a sum or as an integrated system rather than as distinct fields. Unfortunately, we do not have a word in our language that represents this unity of science and technology. But it is this "marriage" of the two that has

Paul DeHart Hurd is Professor Emeritus of Education, School of Education, Stanford University, Stanford, California.

Wayne Welshans

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resulted in our "high-tech" society and become a major force propelling our economy and setting public policy. At the same time it is the impact of science and technology on human affairs that gives our culture much of its uniqueness and determines the circumstances of life in our nation. Yet young people are taught an historical view of science rather than a modern science-technology perspective. A result is that the specialized knowledge characteristic of science disciplines has little meaning for the student in the world outside of school.

Many of the problems of everyday life that beset individuals and our country require an understanding of science or technology for their resolution—for example, air, water, and soil pollution; environmental management; energy resources; health and nutrition; nuclear power; overpopulation; genetic engineering; human organ transplants; life-sustaining support systems; and safety. Because these problems are likely to persist, young people will be called on to make decisions for action—decisions that influence human well-being, the national welfare, and the quality of life. The worthiness of those decisions will depend on the decision makers having a valid understanding of science and technology as enterprises, as bodies of knowledge, and as ways of thinking and investigating. The discipline-based science courses as they are now organized promote scientific illiteracy; students are unable to identify and reasonably interpret a science/technology-based personal or social problem.

The intellectual skills required for dealing with science/technology-social issues are those associated with rational decision making. Decision making is a process of organizing and using a body of relevant and valid information to isolate or define a problem and determine a course of action. The style of thinking associated with science and technology in a personal or social context tends to be more holistic, systematic, and qualitative than the inquiry processes taught in traditional science courses. Inquiry processes are internal to a discipline, usually quantitative, and are focused on a search for new information. What has been missing from science courses, and is essential for scientific and technological literacy, is how to make use of information already discovered.

Scientific and technological information used in the context of personal and social problems invariably raises questions about values and ethics. These are questions that often arise from conflicts in deciding whether or how best to use knowledge that might somehow alter the course of human existence. The current debates on the use of nuclear energy and the application of biotechnology in human genetics exemplify the diversity of judgments people make and conflicts that arise even when people work from a common knowledge base. The making of ethical judgments based on the interpretaton of reliable information is an essential part of social decision making.

Typically, questions involving value considerations have not been a part of science teaching. Students are taught that science is value-free; however, this is not a well-supported position. Technology is seldom value-free and, when introduced into the science curriculum, it changes the requirements for teaching and learning. Nearly 1,000 colleges and universities now offer courses or programs in ethics and values in science and technology.[2] Scientific and technologically literate citizens recognize the need for and are capable of making ethical judgments regarding science/technological problems and issues. They are also capable of distinguishing questions of science from those of technology and, in turn, of recognizing the limitations of each field for dealing with a problem.

The emerging vision for an education in the sciences is that science and technology must be brought into the real life of the student. In this context, science teaching would be focused on personal well-being, the quality of American life, the economic progress of the nation, and the development of intellectual skills essential to the application of knowledge. The major goals are to lessen the cultural deprivation of students in the modern world of science and technology and to reduce the gap between those who are literate in science and technology and those who are illiterate. □

[1]The National Commission on Excellence in Education. *A Nation at Risk: The Imperative for Educational Reform.* (Washington, D.C.: Government Printing Office, 1983).

[2]American Association for the Advancement of Science, Office of Education. *EVIST Resource Directory: Ethics and Values in Science and Technology.* (Washington, D.C.: AAAS, 1978).