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ABSTRACT

The reform of elementary and secondary school science education in the United States has received renewed attention with the publication of several science reform documents and the 1989 Education Summit sponsored by the nation's governors and President Bush. This digest reviews documents which focus on the reform of science education and projects which have begun to answer this challenge including Project 2061 (American Association for the Advancement of Science) and the Scope, Sequence and Coordination (National Science Teachers Association) project. Areas covered include: (1) Strengthening Science Programs; (2) Strengthening Teacher Knowledge; (3) Working with Underrepresented Populations; and (4) Meeting the National Goal for Science Education. A list of 12 references is provided. (CW)

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Meeting National Goals for 2000 and Beyond in Science Education

President Bush has established a new national goal for improving science and mathematics education by the year 2000. The nation's Governors first proposed such a goal noting the poor showing by U.S. students on international comparisons (Lapointe, Mead & Phillips, 1989). The President and the Governors have proposed three objectives for meeting the broad goal:

- strengthening the science and mathematics throughout the system with special emphasis on the early grades,
- increasing the number of teachers with substantive backgrounds in mathematics and science, and
- increasing the number of college/university graduates in science, mathematics, and engineering, especially women and minorities.

The goal and objectives provide needed support and direction for educational reform in science education.

Strengthening Science Programs

The National Science Foundation (NSF) has been involved in supporting science curriculum development, funding a variety of projects through its Division of Materials Development, Research, and Informal Science Education Section. Current projects involve scientists and science educators, schools, and publishers. Seven projects have been developed for elementary school and others, for middle school science. These programs reflect advances in technology and involve the use of interactive videodiscs, computers and national computer networks, among other, more usual materials and equipment. These projects also reflect an increased understanding of how students learn by building or constructing their own knowledge based on observations and experiences.

Two of the largest reform efforts for K-12 programs include Project 2061 (AAAS, 1988) and the National Science Teachers Association (NSTA) Scope, Sequence, and Coordination Project (SS&C) which currently involves grades 6-12 only (Aldridge, 1989). These two projects are long-range efforts designed to transform the entire system of school science and have been called the major reform efforts in science education for the 90's. The central goal of Project 2061 reflects the philosophy that science is for all Americans, not just for those who may choose science or science-related careers. NSTA's Scope, Sequence, and Coordination Project also has as its goal making science accessible to all students. The SS&C Project proposes to abandon the conventional sequence of offering separate courses, a different science each year, in favor of spreading these subjects over four or six years of a student's secondary education, with each of the sciences being taught each year in some appropriate fashion for the student's level of cognitive development. While 2061 advocates the use of broad themes that integrate the sciences and mathematics, SS&C allows for science to be taught as separate disciplines or in an integrated fashion.

Strengthening Teachers' Knowledge

The reform of teacher education, while necessary, is a complex task. Teacher education programs are influenced by guidelines of state departments of education, accrediting agencies and professional associations and societies, as well as by an institution's view of what constitutes general education for its students. The activities of the Holmes Group call for teacher education leading to certification to occur at the graduate level. Holmes Group publications also call for a reform in general education courses and instruction within colleges and universities, as well as for the creation of professional development schools in which field experiences would take place (1986, 1990). Project 30 (1989) involves alternative activities for teacher education reform. The National Board for Professional Teaching Standards (1989) has been created and is working toward national certification for teachers.

Preservice teacher education reflects reform activities. Inservice teacher education has not been forgotten. The National Science Foundation supports a wide variety of teacher enhancement projects. In many instances these projects are headed by science faculty members of universities much like NSF-funded projects of the 60's.

The United States Department of Education sponsors the Eisenhower State Mathematics and Science Education Program. The Eisenhower Program is now five years old and in this time has become a major national strategy to improve science teaching. There are three components of the state program (state leadership activities, flow-through funds to districts, and higher education grants) which provide services that largely complement and reinforce one another. The program is promoting a kind of "vertical integration" of various elements of the educational system, so that they are aiming at common goals. Each component of the program is supporting primarily professional development activities for teachers (more than 75 percent of all state funds). It seems clear that at least one-third of all mathematics and science teachers (including elementary teachers) benefit each year from services supported by the program.

Working with Underrepresented Populations

A critical problem in science education is the drop-out rate for students from science all the way through the K-16 program (Shakhashiri, 1990). Another critical, and related, problem is the downward trend in enrollment of females and minorities in mathematics and physical science, accompanied by decreases in achievement and interest, as science courses become optional in secondary schools.

While there is much we do not understand about the low participation rates of women, minorities, and disabled

persons in science-related careers, what we do know suggests that there are alterable features of schools that appear to constrain participation. Three factors appear to govern attainment in scientific fields: (1) opportunity to learn science (and mathematics), (2) achievement in science (and mathematics), and (3) students' decisions to pursue science (or mathematics) related careers. Unfortunately, there is little theoretical research on how these factors work together or the relative contribution of each factor to participation (Oakes, 1990a: 26).

Researchers have found that, while women and minorities drop out of the science pipeline at various stages, women tend to leave primarily during senior high school and college, while blacks and Hispanics leave much earlier. Women leave because they choose not to pursue scientific careers, while blacks and Hispanics leave primarily due to low achievement in mathematics during precollege years. If this situation is to be changed, educators must intervene at those points in the pipeline where students drop out and interventions must be appropriate to each group. Available research suggests that altering the way science (and mathematics) is taught can promote females' achievement and the likelihood of females choosing to study these subjects. Minority achievement can also be increased by providing additional, positive science (and mathematics) experiences both in and out of school, as well as providing altered instruction, career information, and contact with role models (Oakes, 1990a).

Meeting the National Goal for Science Education

The President's national goal for science and mathematics speaks of the nation's preeminence by the year 2000, less than a decade from now. Many practices need to change. Research data provide evidence that low-income, minority, and inner-city students have fewer opportunities to learn science and mathematics. They have considerably less access to science and mathematics knowledge at school, fewer material resources, less-engaging learning activities in classrooms, and less qualified teachers. Such findings likely reflect general patterns of educational inequality. Such inequalities are not likely to be self-correcting or easily changed. Reform measures probably need to involve a multiple-strategies approach. This involves (1) calling attention to the problem, (2) generating additional resources, (3) distributing resources and opportunity more equitably, and (4) holding states, districts, and schools accountable for equalizing opportunity (Oakes, 1990b).

Findings of the National Center for Improving Science Education (Loucks-Horsley et. al., 1990) support a thirteen point pathway for meeting the national goals for science education: (1) making science basic; (2) build curricula that nurture conceptual understanding; (3) connect science to technology; (4) include scientific attitudes and skills as important goals; (5) view science learning from a constructivist perspective; (6) use a constructivist-oriented instructional model to guide learning; (7) assess what is valued; (8) connect curriculum, instruction, and assessment; (9) use a variety of assessment strategies, (10) assess programs as well as students; (11) view teacher development as a continuous process; (12) choose effective approaches to staff development; and (13) provide teachers with adequate support to implement good science programs.

Recognizing our dilemma, President Bush has provided this nation with direction by establishing a national goal related to science preparedness. His priority is to "make American students first in the world in math and science achievement by the year 2000." There is much to suggest that we are underway. However, we have no time to waste as we learn from the many projects designed to strengthen programs, improve teachers, and increase the numbers in the pipeline, especially those in underrepresented groups. NSTA has recently established priorities for science education as we contemplate the next nine years. NSTA has proclaimed these priorities:

- Developing standards for quality science education,
- Ensuring that all students, especially those in underrepresented groups, receive the same quantity and quality of science education,
- Implementing curriculum, instruction, and assessment based on the standards for science education and research, and
- Promoting the education, career development, and professionalism of science teachers, especially those in underrepresented groups.

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