Improving Science Education: The Role of Scientists

By Rodger W. Bybee and Cherilynn A. Morrow

For many scientists, improving science education seems a large, continuous, and sometimes insurmountable task. After a major curriculum reform initiated by the launch of Sputnik in October 1957, many scientists and educators thought the task was pretty well completed. But, that was not the case.

The 1980s had over 300 reports documenting the dismal state of education, including science education. In the 1990s, results from the Third International Mathematics and Science Study (TIMMS) (Peak, 1996, 1997) provided yet another indicator of the need to improve science education. We can probably identify two reasonable conclusions from this snapshot of educational history. First, one effort of any sort will not, once and for all time, settle our educational problems. And second, any one group, scientists or educators, will not provide the entire solution. Improving science education is a continuous effort, one that has to involve scientists and educators working in a coordinated manner. The magnitude of the problem can be summarized by pointing out that there are about 44,000,000 students in grades K-12 being taught by 3,000,000 teachers in 90,000 schools in 14,500 school districts.

In this short article, we address one issue about the scientists and educational improvement: How can scientists become involved in precollege science education so their involvement is coordinated, accommodates their interests and talents, and ultimately contributes to educational improvement?

The National Science Education Standards---One way we increase the coordination of efforts is by using a common document as the foundation for our work. We suggest that the National Science Education Standards (NRC, 1996) can provide that foundation. In late fall 1995, the National Research Council (NRC) released voluntary national standards for science education (NRC, 1996).

The process of developing these standards involved thousands of individuals representing various components of the science education community. Some of the best scientists and engineers from colleges, universities, business, and industry identified the fundamental concepts and abilities that all students should know and develop. Some of the best science teachers from elementary, middle, and high schools clarified the essential characteristics of effective teaching and professional development, and some of the best science educators from schools of education, state departments, and curriculum development organizations identified standards for assessment, science programs, and the educational system.

All of us must look beyond the process of developing standards and address the next phase using the Standards to improve school science programs and classroom practices. Using the national standards assumes some understanding of their purpose and place in reform efforts.

Understanding the Standards---Our first recommendation is to study the Standards; read the entire document, not just the content for your discipline or sub-discipline. The Standards are intended to be a coherent set of policies that are interdependent and interrelated. National standards are voluntary policies; they are not curriculum programs, assessment exercises, or classroom activities. As policies, standards provide guidance in the development of curriculum

and assessment. The Standards should inform decisions and should give direction. However, the use of standards must primarily occur in states and local school districts and ultimately in science classrooms. State educational departments, boards of education, and science teachers must decide what their students will learn and how they will learn.

National standards may be used to help make decisions about science curriculum, textbook adoption, professional development, and assessment practices. However, in all cases, local personnel have the freedom to make the final decisions. This point is important, as it should counter the misconceptions that national standards are Federal mandates, which they are not. Elsewhere, one author has described the uses of standards by scientists and engineers in greater detail (Bybee, 1998).

College and university scientists should consider what the standards mean for their own teaching. Some of the content may be different, but the teaching and assessment standards increase learning by all students. In addition, some of the students in their classes may become future teachers, who need to see the teaching and assessment standards modeled in the science courses that they take.

Roles for Scientists in Education---We turn to another important issue: the ways scientists can be involved in K-12 education. Our position is that scientists can be involved in a variety of ways that accommodate their talents, time, and interests and in ways that are ultimately helpful to the educational system. Traditionally, many scientists have made school visits, acted as role model, and taught single lessons. Although helpful, there are much broader and deeper ways that the expertise of scientists and engineers may contribute to educational reform. At the college level, faculty should consider developing collaborations with faculty in their school of education. Developing a real understanding of the issues faced in both disciplines can lead to better education for all students including future teachers. Further, faculty in four-year colleges and universities should develop teaching and research liaisons with faculty in near-by, two-year colleges. Two-year college faculty have found strategies to engage students having much greater diversity as measured along any dimension. Many future teachers take all of their science courses in two-year colleges before transferring to the four-year institutions.

One author (Morrow) has proposed a framework that describes the different levels of involvement in a variety of activities that contribute to improving science education. One can advocate, be a resource, or join as a partner in different components of the educational system. Advocating, for example, does not require the time and commitment as does becoming a full partner and joining in the work of teaching or developing instructional materials. Acting as a resource is a good intermediate level of involvement. Figure 1 describes a variety of options in which faculty can be involved from local efforts in one classroom, to district-wide activities, to national-level efforts. Time commitments can be fairy small or extensive. All of the components listed provide opportunities for meaningful and helpful involvement, especially if faculty will interact by learning the issues faced by the school personnel.

Conclusion---In this brief article, we have recommended that scientists use the National Science Education Standards as the foundation for their involvement in K-12 education. Further, their level of involvement can include advocacy, resource, or partnership within a variety of activities in the educational system.

*Figure 1. A Sampling of Roles for Scientists in Education

LEVEL OF INVOLVEMENT=>	ADVOCATE	RESOURCE	PARTNER
K-12 STUDENTS	• Participate in PTA. • Talk to school board about importance of science education.	• Judge a science fair. • Answer student e-mail. • Give tour of research facility.	• Mentor a student in your laboratory. • Partner with students in a research project.
IN-SERVICE K-12 TEACHERS	• Speak out in support of appropriate profesional development opportunitites for teachers.	• Answer teacher e-mail about science content questions. • Present in teacher workshop or some aspect of science.	• Work with a teacher to implement curriculum. • Hire a teacher intern.
SCHOOLS OF EDUCATION (Pre-Service Teachers, Graduate Students, Faculty Members)	• Speak out in your department or organization in favor of closer ties with Colleges of Education. • Speak favorably of teachers and the teaching profession in your undergraduate classes.	• Teach a science course or workshop segment for pre-service teachers. • Collaborate with education faculty to improve courses on teaching science.	• Hire a graduate in education to work as evaluator or co-developer of education project. • Develop a science course or curriculum for teachers-to-be.
SYSTEMIC CHANGE (District, State, National)	• Speak out at professional meetings about the importance and value of scientist involvement in systemic change.	• Review science standards for science accuracy. • Review the state framework for science education.	• Collaborate on writing or adapting science standards. • Participate on state boards for adoption of standards, instructional materials, or teacher certification.
EDUCATIONAL MATERIALS DEVELOPMENT (NSRC, EDC, Lawrence Hall)	• Speak out at a school board meeting for adopting exemplary educational materials.	• Agree to serve on an advisory board for a science education project. • Review science educational materials for science accuracy.	• Collaboarte to create exemplary science education materials.
INFORMAL EDUCATION (Science Centers, Scouts, Planetaria)	• Participate on the board of a science center, planetarium, environmental center, or museum.	• Review science content of scripts for science exhibits, planetarium shows, or environmental programs. • Give talk at a science center.	• Collaborate in creation of a museum science exhibit or planetarium show. • Serve as science coordinator for a scout troop.

CA Morrow Space Science Institute 2/97 *The idea for Figure 1 emerged from a 2-day meeting co-convened by Project ASTRO and Space Science Institute (SSI) in February 1997. Key scientist-educators from around the country considered what the proper content of a 1-day workshop in education for scientists should be. The group that produced the table's framework included Cherilynn Morrow (SSI), Dennis Schatz (Pacific Science Center), and Michael Bennett (Project ASTRO). After this meeting, Morrow filled in the boxes with a sampling of roles that reflect the different types and levels of involvement a scientist can have in K-12 education.

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Rodger W. Bybee is Executive Director for Biological Sciences Curriculum Study in Colorado Springs, CO. (rbybee@bscs.org). Cherilynn A. Morrow is Manager for Education and Public Outreach at the Space Science Institute in Boulder, CO. (camorrow@spot.colorado.edu).