Strategies for Science

The Executive Director of the National Science Teachers Association suggests ways to make large-scale improvements to science education.

Gerald F. Wheeler

A nation's ability to remain an economic and technological leader in a global marketplace relies on how well that nation educates its students in science, technology, engineering, and math. In the United States, the National Science Education Standards (National Research Council, 1996) and Benchmarks for Science Literacy (American Association for the Advancement of Science, 1993) describe the knowledge and skills students need in a society dependent on science and technology. States and districts have modeled their own standards on these national documents, and stakeholders at every level are struggling to evaluate, modify, and develop assessments, curriculums, and instructional materials to reflect this vision of science literacy. Moving that vision into the classroom, however, depends on the competence of science teachers.

Several studies reveal a positive correlation between student achievement and teachers' content knowledge (Chaney, 1995; Darling-Hammond, 2000; Druva & Anderson, 1983). Unfortunately, teacher preparation programs do not appear to be adequately providing content knowledge to science teachers (Allen, 2003). Significant numbers of science teachers lack degrees or even college coursework in the science they are assigned to teach, especially at the elementary level (National Center for Education Statistics, 2002; Weiss, Banilower, McMahon, & Smith, 2001). If the United States is to make significant advancements in science education reform, it will need new strategies to address the needs of its nearly two million science teachers. Three crucial challenges include raising the science content knowledge of all science teachers, effectively addressing science
Education Reform

standards, and, perhaps most important, developing solutions on a large enough scale to bring about significant change.

Raising Teacher Content Knowledge
Teachers need to know the science they teach. Whether because they are insufficiently prepared or simply assigned to teach in an unfamiliar subject area, far too many science teachers need a deeper understanding of their school's science curriculum. Although an understanding of teaching and learning is crucial, teachers can't teach what they don't know.

Inservice professional development programs for science teachers have largely failed to give teachers the specific content knowledge they need. Many programs offer activities for the classroom but provide little understanding of the underlying science. College courses for teachers that focus on science content—including an increasing number of online courses—are offered infrequently and are short-lived. Even successful face-to-face programs usually present only general introductory material. A middle school science teacher with a background in the life sciences who has been assigned to teach physical science will need more specific information than an introductory course in physics or chemistry is likely to provide.

Two programs that have focused on providing content for science teachers are the National Teacher Enhancement Network (NTEN) at Montana State University (www.scienceteacher.org) and the JASON Foundation (www.jason.org). Both of these programs offer content online, enabling large numbers of teachers to study small chunks of content.

Addressing Science Standards
With the emerging focus on science assessments, schools are going to be reexamining what they want their students to know and be able to do in science. Many educators agree that the national science standards contain far too many elements. One group of researchers has estimated that it would take as many as 22 years of schooling to adequately cover all of the content in the standards for the core subject areas (Marzano & Kendall, 1998). And most state standards developed in the wake of the national standards added even more content. This has left science teachers, professional development providers, and assessment writers with far too many concepts to address.

A nation's ability to remain a leader relies on how well that nation educates its students in science and technology.

At the same time, the quality of science education standards across state boundaries is uneven. When students move from state to state, they are subjected to gaps and disconnects in their education. General wisdom suggests that states will continue to do their own thing when it comes to education. Yet 71 percent of respondents in a 2006 survey conducted by the National Science Teachers Association (NSTA) agree that a uniform set of national science content standards that every state would be required to use is a good idea.

One strategy that would preserve the U.S. tradition of state and local control
Identifying these common elements would give all stakeholders—assessment writers, curriculum producers, and professional development providers—a common target to build toward. National-level groups would be able to develop materials and assessment items for a national market, rather than struggling to meet the diverse needs of an enormous number of local markets.

**Developing Large-Scale Solutions**

Over the past 50 years, strategies for improving science teaching have focused on holding events for small groups of science teachers. NSTA, for example, has offered summer programs that bring together one or two dozen science teachers. Although these programs have helped those who could participate, any face-to-face program, no matter how successful, can reach only a limited number of teachers. We shouldn’t abandon these smaller efforts, but we must realize that they will not lead to significant change on a national level and that they rarely reach those teachers who need the help most.

To sustain a world-class science and engineering workforce, the United States needs more programs that have an effect nationwide. Very few initiatives that bring about pockets of excellence ever reach a scale that will produce a substantial widespread increase in student achievement.

Enhancing the science content knowledge of teachers is one example of a large-scale challenge that cannot be solved at the local level alone. At any single school site, a small number of teachers must teach a wide range of content. At a regional level, enough teachers may need knowledge of, for example, genetics, to make it worthwhile to provide regionwide professional development on the topic. Yet many regions lack the critical mass of teachers needed to justify such training. To provide for the specific needs of all teachers, programs must be national in scope.
As one example of a national-scale strategy, NSTA has created online learning experiences for K–12 science teachers called "Science Objects," available free to all educators at the NSTA Web site (http://learningcenter.nsta.org). Science Objects are one- to two-hour stand-alone units of instruction that cover small portions of science content, enabling teachers to focus only on the content they want to learn. The objects will help teachers become literate in topics covered in the national standards, making them relevant to the classroom and useful to teachers across all grades and scientific disciplines. The 29 objects launched in December 2006 cover nine themes: Energy; Force and Motion; Gravity and Orbits; the Universe; the Solar System; the Earth, Sun, and Moon; Plate Tectonics; Rocks; and the Corals as an Ecosystem. Each theme is divided into multiple objects. The Energy theme, for example, includes four objects: (1) Different Kinds of Energy; (2) Energy Transformations; (3) Thermal Energy, Heat, and Temperature; and (4) Useful and Not So Useful Energy.

Meeting the crucial need to improve science education in a large-scale way requires innovative ideas and commitment from all stakeholders. Educators can use Science Objects within other ongoing professional development programs, enabling those programs to incorporate rigorous science content. These online resources can be especially beneficial to teachers who are forced to teach outside their field, elementary teachers who lack degrees in science, or teachers who need to increase their knowledge of a

At Argosy University, the best teachers never stop learning.

New EdD in Community College Executive Leadership.

Expand your horizons in education at Argosy University. We're here to help you continue along the path to higher knowledge. We offer master's, specialist, and doctoral degree programs in a range of educational concentrations.

Day, evening, weekend, and online instruction is available for your convenience. Contact us today and see how we can help you raise your level of professional education.

1.888.488.7537 argosyu.edu/el
particular science content area. Science Objects—and a host of other resources—are available on the online NSTA Learning Center. Through the Learning Center, teachers can search for professional development opportunities and resources aligned to specific standards and grade bands. Educators can also manage and document their professional development growth.

Meeting the crucial need to improve science education in a large-scale way requires innovative ideas and commitment from all stakeholders. Science Anchors, Science Objects, and the Learning Center are a few examples of how we can increase teachers' science content knowledge, establish a common set of standards, and develop large-scale solutions. The science education community must begin thinking strategically about more ways to create new projects and programs at the local, state, and national levels that work in a coherent way toward the common goal of excellent science education for all.

References

Several studies reveal a positive correlation between student achievement and teachers' content knowledge.


Gerald F. Wheeler is Executive Director of the National Science Teachers Association, Arlington, Virginia; gwheeler@nsta.org.