A university-school network is pioneering a comprehensive reform of K-8 science education.

Betty Young

Science testing, as mandated by the No Child Left Behind (NCLB) Act, has refocused attention on the quality of the K-8 science curriculum and instruction in many districts around the country. It has become clear that to improve quality, and meet NCLB requirements, elementary and middle schools must develop different teaching approaches and reconsider some existing notions about the nature of science. Fortunately, as a result of the training and research programs funded by the National Science Foundation (NSF), as well as the work of science educators, reform ideas initiated in the 1990s have been translated into a new generation of science curriculum materials that are yielding positive achievement results in many schools. Future implementation efforts can benefit from the lessons learned in the NSF-funded training projects of the past.

However, helping students construct science understanding through a more rigorous curriculum and the use of discovery and inquiry experiences requires teachers to understand far more about science content and processes than at present. The issues are somewhat different for elementary and middle-level teachers. Elementary teachers generally need more support in dealing with science content and in building enthusiasm for teaching science. Middle-level teachers may understand more science content but often have fewer skills in guiding learning through inquiry and discovery. Too many still rely on lectures, text readings, and “canned” laboratories—instructional methods that they personally experienced in their high school and college science classes.

Meeting the Challenges

The ideas presented here are derived from many research and implementation projects as well as more than 11 years of work in the Guiding Education in Math & Science
Network (GEMSNET), a partnership of 10 school districts and the University of Rhode Island. Together, we have implemented a comprehensive K-8 kit-based science curriculum and provided ongoing professional development support led by teams of classroom teachers and university scientists and engineers, who volunteer as science mentors.

Additionally, we are in the second year of a five-year study of the process of how elementary science teachers can become highly qualified. CAREERS (Change Associated with Readiness, Education, and Efficacy in Reform Science) is an NSF research project that tracks the attitudes, beliefs, content knowledge, and teaching practices of elementary teachers, from their entry into college preparation programs through their science methods instruction, student teaching, and first three years of classroom teaching. Our multidisciplinary team (including researchers from science education, science, psychology, and adult education) examines all factors that contribute to elementary teachers’ sense of efficacy in science knowledge and teaching, and their attitudes and beliefs about how children learn.

The CAREERS project is also examining the preparation, coaching, and material support that promote the highest quality science teaching among elementary teachers. We are documenting the changes that take place as skeptical, often science-phobic, aspiring teachers experience hands-on inquiry science
and develop the pedagogical skills to engage elementary children in exciting science explorations.

Many of these future teachers enter preparation programs with the notion that science is not as important as literacy and math, which are more frequently tested. This belief is reinforced by preparation programs that require more instructional experiences in language literacy than in science, or even math. Most elementary teachers do not enter teaching because of a burning desire to teach science, and science often is their least desirable subject.

Implementing and sustaining a new science curriculum (see box) is not without great challenges. As with any meaningful change, it will need dedicated leaders. Districts need to make considerable investments in materials and ongoing professional development, along with an infrastructure to facilitate the scheduling of materials for classrooms and professional development. Districts also need to keep track of which teachers need more science training, and to recruit and prepare teacher leaders to model professional development activities, using the discovery and inquiry methods.

How Technology Can Help
Here are some of the ways our CAREERS project has benefited from technology in terms of classroom activities and managing program logistics:

New Learning Tools. Data collection probes allow students to collect data on variables such as temperature and salinity. Video microscopes project microviews on big screens, enabling students to share the results of their investigations and for teachers to demonstrate lab techniques.

Search and Research Engines. A growing number of Web sites help students locate accurate background reading materials on topics they are investigating. These sites can fill in for the expensive textbooks that the hands-on kits and modules replace.

Video taping. In a new activity we are promoting, groups of teachers will use our digital cameras and viewing software to share their science teaching methods with others in their building, and to discuss ways to more effectively present science lessons.

Project Information Centers. Keeping training and materials schedules accurate and accessible online helps everyone stay on the same page and facilitates planning.

E-mail Communication. E-mail links with scientists and engineers who agree to serve as science mentors to teachers and students can facilitate questions and clarifications. For example, a third grader asked one of our university plant scientists if plant lights were exactly the same as sunlight and, if not, could the plants tell the difference. After explaining the light spectrum of each source, the scientist asked the young student how he might test his question to determine if plants could tell the difference. They worked online to develop a test that the student conducted and reported back to the scientist.

How Principals Can Facilitate Change
There are a number of ways that principals can effect positive changes in science instruction:

- Common core curriculum for all grades, with fewer topics and multiple investigation opportunities within each unit.
- High-quality materials, created and classroom-tested for developmental appropriateness, content accuracy, and high cognitive demand.
- Ongoing professional development to prepare all teachers for kit and module content and materials, provide teaching strategies using inquiry and discovery methods, and allow them to experience inquiry and discovery as learners.
- Advanced training in inquiry methods and activities for teacher leaders in order to have them present professional development from the perspective of classroom teachers experiencing the inquiry process.
- Teachers-in-residence who work two-year terms to assist with organization, lead training sessions, help prepare classroom-based trainers, provide in-class coaching, facilitate connections with science mentors, and deliver presentations at district, administrative, and parent meetings.
- Partnerships with colleges and universities to engage science educators, scientists, and engineers who can assist with grant writing and curriculum content, and can connect kit and module topics to real-world applications.
- A central facility to refurbish and maintain science materials.
- Yearly retreats to build connections among teachers, scientists, and administrators, and to learn new approaches to science instruction.

What Makes a Great K-8 Science Program?
“We’re Relentless”

The shift to these new approaches to science teaching requires time, energy, and persistence. Our informal motto in the GEMSNET program is “We’re relentless” and the payoff has been very rewarding. The kit-based curriculum is now accepted by all of the districts in the network, as are the training sessions for teachers. Our teacher leaders recruit new trainers as they visit classrooms to offer instructional support.

Our teachers report having students who can’t wait until it is time for science class, and who look forward to science topics and investigations in the next grade. Teachers have received high praise for the science curriculum from state assessment teams who examine instruction, student outcomes, and school improvement plans.

Although we continue to face challenges in funding and program delivery, our success, as measured by the accomplishments of students and their teachers, has given us a great sense of satisfaction.

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WEB RESOURCES

The Institute for Inquiry at the Exploratorium in San Francisco has an extensive online set of professional development activities.
www.exploratorium.edu/ifi

The Connecticut Center for Science Inquiry and the Texas Center for Inquiry are among the growing number of sites that can help develop teacher leaders.
www.fwmuseum.org/educate/prof_dev_tci.html

The National Science Resources Center, established by the Smithsonian Institution and the National Academies of Sciences, provides workshops for districts that are preparing to revise their science curricula.
www.nsrconline.org

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