Teaming Up *with* Scientists

A two-year teacher-scientist partnership benefits all involved—especially students.

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Wouldn't it be great to have community-minded research scientists working alongside teachers in elementary science classrooms? Imagine classes led by teachers armed with cutting-edge scientific knowledge. Imagine scientists teaching precollege education students. Imagine how students' developing interests would be piqued by direct interaction with scientists, and how students would benefit from the combined expertise, knowledge, and experience of educators and scientists working side-by-side. Just imagine!

A new partnership among the Houston Independent School District (HISD), other Houston-area schools, and Baylor College of Medicine (BCM), known as the Science Education Leadership Fellows (SELF) program, is creating such an environment for these experiences. This innovative program, funded in part by the Howard Hughes Medical Institute, was established in 1999. By facilitating interaction between two groups of educational professionals that generally would not have much contact, the program addresses key challenges facing elementary science educators today.

HISD serves approximately 122,000 elementary students (grades K–6), 88 percent of whom are Hispanic or African-American. Science achievement in Houston at the elementary grades is uneven. Some schools are achieving gains through curriculum reform and teacher professional development, but other schools are still struggling with leadership and meeting new Texas state standards (Texas Essential Knowledge and Skills). The SELF program seeks to foster local science education leadership and provide a model that can be replicated at other locations.

SELF-Help

Headquartered at Baylor College of Medicine, the SELF program teams Houston-area scientists (graduate students and postdoctoral fellows from BCM) with elementary educators for an intensive two-year mutual learning experience. The project goals are to create joint-learning communities of elementary teachers/administrators and scientists and promote interaction of elementary school students with "real" scientists.

The *National Science Education Standards* (National Research Council 1996) calls for scientists to "take the time to become informed about what is expected in science education in schools and...take an active role in formulating science education policy." The *Standards* also emphasizes the need to improve teachers' science content knowledge and understanding of the nature of science. The SELF program addresses both of these issues by involving scientists in the educational process and by providing teachers with firsthand experiences with scientific research and advanced science content. Furthermore, the designation of participating teachers and scientists as "fellows" reflects the program's emphasis on personal growth and advanced learning.

Fellow Learners

In 1999–2000, 16 teacher and 8 scientist fellows were selected to work together over the ensuing 24 months. Teacher fellows represented 372 elementary school students. To be eligible for the program, teachers must have participated in at least one intensive summer science institute offered by a Houston-area college or university and must provide evidence of teaching inquiry science in their classrooms.

During the school year, each teacher fellow completed approximately 60 hours of professional development, conducted monthly on Fridays and/or Saturdays. Some of these events teamed scientists and educators to conduct inquiry-based science laboratories. For example, teacher/scientist teams explored the periodic table by using the Mendeleev Periodic Table Simulator, a card game in which known elements are first grouped by similar properties and then ranked by increasing atomic weight. Teams also investigated chemicals and reactions through inquiry by comparing the properties of white "mystery" powders, such as salt, sugar, and cornstarch. One teacher fellow explained, "I was challenged in the practice labs. . . Exposure to so many new concepts allowed me to understand the importance of teaching science to students with a hands-on methodology because so many things did not become clear to me until I actually had the opportunity to physically be involved in experimenting."

Program-related professional development focused on science content knowledge (especially in chemistry and biology), new teaching resources, leadership skills, and teamwork. Teachers studied genetics and conducted a survey activity on inherited traits. They also learned about the structure of DNA and how to build models of organic molecules. Many of these experiences were designed to lay a foundation for an intensive summer laboratory experience.

In turn, scientists learned about the current best practices in education, such as having students work in cooperative groups and using the learning cycle to organize lessons, for facilitating inquiry in the classroom.

Beefing Up Content Knowledge

Teacher/scientist teams engaged in group discussions, and question-and-answer sessions were fully integrated into the professional development activities. Teams also received new teaching materials and cooperative grouping instruction from the BrainLink unit "Brain Chemistry" and the My Health My World unit "Water and My World." (These two programs were developed by scientists and educators from BCM; materials are published by WOW! Publications.)

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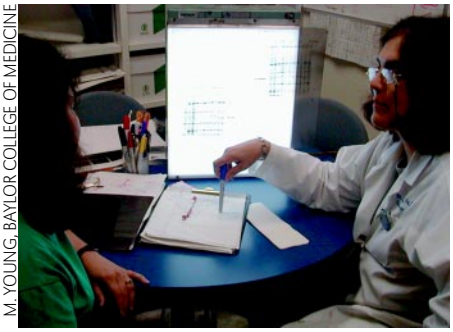
A scientist and elementary teacher team up in the SELF program—here they are working to clone a specific gene from mouse DNA.


M. YOUNG, BAYLOR COLLEGE OF MEDICINE

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Science content instruction addressed topics most relevant to the teachers' upcoming summer research experiences. SELF program scientists introduced teachers to cell and molecular biology and fundamentals of cell division. Teachers also learned about microbiology, immunology, and bacterial genetics. SELF scientists especially emphasized the uses of bacterial genetics as a tool in the laboratory.

In addition to classroom-based instruction, scientists and teachers worked collaboratively to complete activities in elementary science inquiry kits. In the Food and Nutrition kit, they tested and compared various foods for fat content; for the Human Body kit, teacher/scientist teams built leg and foot models, including simulated tendons and muscles, with rubber bands, Popsicle sticks, rubber tubes, and paper clips. Their models emulated the action of the human leg and foot while jumping.

Teachers in Summer School

During summer 2000, the first group of teacher fellows took part in 160 additional hours of professional development, which included a two-week molecular biology laboratory course taught by a BCM cell biologist and a BCM graduate student in molecular biology, as well as a short research project under the guidance of teachers' scientist partners. All projects involved cell or molecular biology research occurring at BCM. Examples of teacher projects included cloning a gene responsible for signaling to T cells in the immune system of the placenta; finding the mechanisms of glucose stimulation of insulin release; cloning fruit fly DNA; and exploring micronutrient regulation in *Medicago truncatula,* a legume related to alfalfa.

Upon concluding her first year in the program, one sixth-grade teacher fellow commented: "I find it difficult to teach concepts of which I have limited understanding. Because I teach elements of genetics and DNA, I have now done research to help me understand the subject matter. This program helped me understand more than any book ever could. The firsthand experience in the laboratory was valuable, not only because I actually saw what some 'real' scientists do in a lab, but also because I can now describe the work of scientists better to my students."

Sharing their Experiences

During the following 2000–2001 school year, the teacher fellows conducted one or more science events, such as a science festival and/or special professional development activity for teaching peers, at their schools in collaboration with their scientist fellows. One teacher, for example, organized and supervised an all-school, all-day science festival in conjunction with her school's annual science fair. She enlisted the assistance of fellow teachers, parent volunteers, and SELF program scientists. The festival offered a wide variety of innovative and interesting science education activities:

- short sessions for student/parent teams in such subjects as Search for Life on Mars (led by a NASA scientist guest presenter);
- science fair project displays from all grade levels;
- hands-on activity booths (e.g., tornado tubes and owl pellet dissection);
- tours of the turtle habitat on campus, which also housed a petting zoo; and
- tours of the school's vegetable garden.

Scientists Teaching Students

The SELF program also promotes the interaction of scientists with elementary school students. During 1999–2000, each SELF scientist fellow participated in classroom activities of two different SELF teachers. They began by observing at least two teachers' classrooms and kept a journal about their observations, discussing them with teachers and later collaborating with teachers to develop inquiry lessons that were relevant to students' current class work and consistent with the *National Science Education Standards*. In March, scientists taught lessons in their partner teachers' classrooms. Lessons included Living vs. Nonliving Things (first grade), Inherited and Learned Traits (fourth and fifth grade), and Bacteria are Everywhere! (fifth grade). Teachers assisted with the activities and used a standard evaluation instrument to assess scientists' use of instructional time, skill at motivating students, ability to promote productive student behavior, and proficiency in content areas.

In the Bacteria are Everywhere! sessions, students created and observed bacterial cultures and used mathemat-

ics to calculate growth rates. Each student team received an agar plate, divided into four quadrants. The scientists instructed students to plan and collect samples to inoculate three quadrants and to choose a fourth quadrant as their control area. Students used cotton swabs to swipe each quadrant with the designated sample, and they then developed hypotheses on which test quadrants would produce bacteria. They observed their agar plates and recorded observations for six days, noting the presence, speed, and location of bacterial growth.

During these classroom sessions, scientists learned about classroom management, tailoring instructional approaches to a particular audience, and the general public's perceptions of science. Teachers enjoy this aspect of the program because they have an opportunity to serve as mentors in science pedagogy for their scientist partners. (During the research-based program activities, it is the scientists who usually mentor the teachers.)

A BCM postdoctoral fellow at Houston's Children's Nutrition Research Center noted that the experience helped to shape her view of teaching: "I think the program had the most impact on my view of how undergraduate science classes could be taught to improve the basic science background for nonscience students . . . I think this will have a very positive influence on how I develop any classes I teach in the future. I also have learned the value of having scientists participate in the development and implementation of science education in schools."

We are currently creating more opportunities for scientists to teach—either as part of teacher workshops sponsored by the SELF program or in classrooms. The program has also led to a successful application to the National Science Foundation's Graduate Teaching Fellows in K–12 Education Program, which will allow five Baylor biosciences graduate students to partner with Houston biology teachers each year for three years.

Collaborating Colleagues

Our efforts have yielded valuable information about how to promote meaningful, collegial collaboration between elementary educators and junior scientists. However, this collaboration did not develop without some challenges. Early in the project, we realized that teachers and scientists sometimes have very different collaborative/interactive styles that reflect the environments in which they work.

The elementary teachers, for example, tended to allow their scientist team members to dominate collaborative group work and sometimes were intimidated by scientists' direct ways of asking questions and challenging one another's answers. The SELF program countered this obstacle by making firm cooperative grouping job assignments (e.g., principal investigator and materials manager) that promoted equitable participation by all team members. We also created more opportunities for teachers to demonstrate their own expertise in areas unfamiliar to scientists, such as classroom management, authentic assessment, and data representation strategies for elementary students. We observed that scientists soon became more adept at explaining concepts clearly as they worked with teachers over the course of the first year.

Benefits All Around

The partnership benefits scientists, teachers, and students. Scientists enhance their communication, teaching, and community outreach skills. Teachers achieve a deeper understanding of how science works than can be gleaned from textbooks and consequently leave the program more confident and effective in the classroom. By participating in ongoing research, teachers (and, by extension, students) also develop awareness of pathways and requirements for science careers.

Teachers report that their students have responded positively to having a "real scientist" in their classroom and that they show increased enthusiasm for science, not only as a subject area, but also as a possible career. Teachers have also noted that their students are excited to have a teacher who has participated in scientific research and who can communicate from personal experience the challenges and rewards of science learning.

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