# Scientists Educate the Science Educators

*Some California researchers are taking matters into their own hands—devising ways to get more science into the schools*

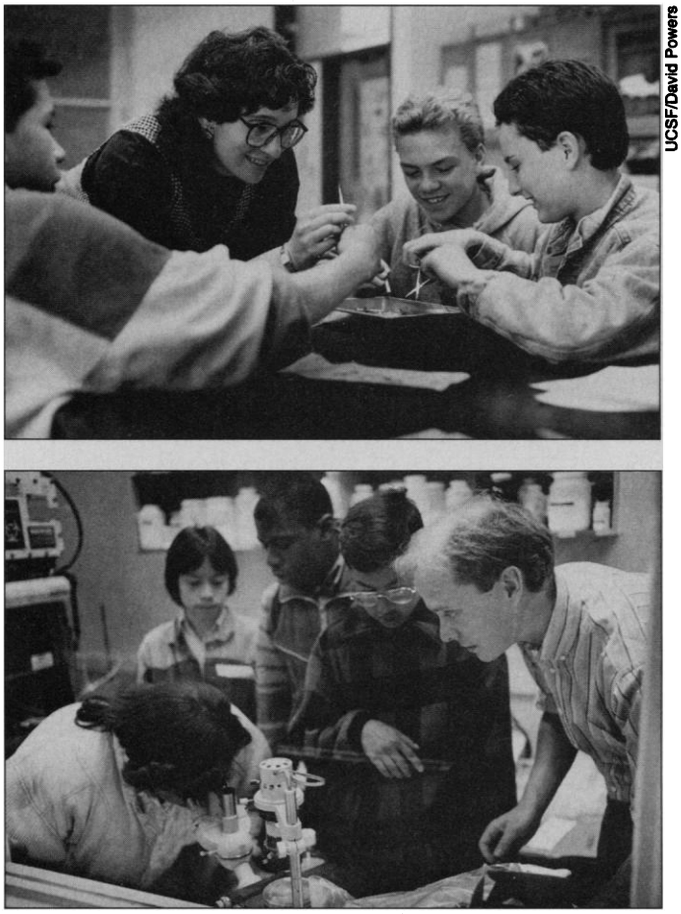
PAUL SALTMAN WAS PUZZLED. APPALLED AT the lack of science curriculum in the local elementary schools, Saltman, a full professor of biology at the research-oriented University of California, San Diego (UCSD), had taken it upon himself to organize an ambitious science course for elementary school teachers. But from all of San Diego County, only 102 teachers had applied for Saltman's compelling program in biology, earth sciences, astronomy, oceanography, meteorology, chemistry, and physics—taught by some of UCSD's best research scientists.

On the first day of class in the summer of 1988, Saltman found out why so few teachers had taken him up on his offer. "I could smell the fear," he recalls. "I asked how many had had one year of college science before they began teaching. Out of 102, eight hands went up." Because of their intense "fear and loathing" of science, Saltman says, these teachers were avoiding the subject, teaching an average of only 20 minutes of science per week.

Saltman persevered in the education of his 102 brave pupils. Three years later, they are teaching an average of 40 minutes of science each day, and in the next stage of the program they will be sharing what they learned with other teachers. He attributes the remarkable leap to an increased "comfort zone of knowledge" they gained from his program, and to the fact that each teacher has a bond with working UCSD scientists who are eager to help when problems arise.

That close bond between teachers and working scientists is turning out to be a key in scientists' efforts to improve science education. And there are many such efforts. Saltman is one of a growing group of researchers who have gotten tired of waiting for improvements in elementary and secondary science education and decided to plunge in personally, on their own time, to make a difference in their local schools.

These scientists are learning the hard way about the enormous cultural gap that separates scientists and schoolteachers, a gap that must be bridged before their programs can achieve success. And there are other difficulties as well, ranging from skeptical school administrators to colleagues in the scientists' own departments who view their efforts as irrelevant to the mission of research—and to the advancement of a scientist's career. But in spite of all these obstacles, the most committed scientists are charging forward with an air of almost religious fanaticism and the conviction that they can make a difference.



UCSF/David Powers

**The two cultures.** *UCSF postdoc Jeanne Magram dissects a frog with San Francisco high school students (top); UCSF pathologist Tristam Parslow and students examine cell cultures.*

In California alone there is a remarkable variety of scientist-initiated programs, ranging from highly structured summer courses to free-form partnerships between individual scientists and teachers; these efforts mirror what's happening around the country.

"Science has been an orphan in the elementary school curriculum," says Douglas Lapp, director of the National Science Resources Center (NSRC), an organization devoted to improving public science education that was founded by the Smithsonian Institution and the National Academy of Sciences. "Scientists have a real potential for changing that situation," Lapp says, "because they understand the true nature of scientific inquiry." But, he adds, "it requires a period of learning for the scientist, of what is appropriate for elementary school children."

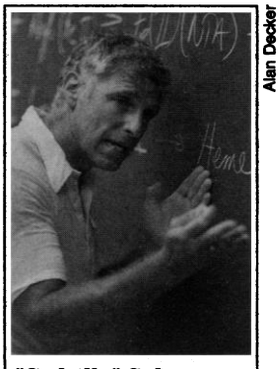
And appropriate for their teachers. Communicating with elementary and even secondary school teachers doesn't come naturally to most scientists, says George Miller, a chemist at UC Irvine. Eight years ago, Miller and his chemistry colleague Mare Taagepera began a summer science institute for Orange County teachers. They started with "a pretty classic university delivery style," Miller admits. And their pupils were quickly turned off. "It was like going back to college," recalls elementary school teacher Maureen Allen, who took the course the first year. "Even though they were slowing down lots...there were some [teachers who] had no clue what was going on at all."

It didn't take long for Taagepera and Miller to realize what was needed—an active, hands-on program and skilled teachers to add some pizzazz to the scientists' teaching. They invited talented teachers like Allen to come back the following year to develop exercises that would not only help illustrate the concepts but would also give the teachers something to use in their classrooms.

Allen now works regularly with the institute as a "master teacher" whose job it is to bridge the gap between the scientists and the schoolteachers. She meets with the scientists who teach in the institute and asks what concepts they want to convey, then devises classroom activities to accompany the lesson. In one case, she choreographed a "biodrama" in which the teachers who are pupils in the class play the roles of nucleotides and act out the base-pairing involved in DNA replication.

Lively presentation is fine, but first these researchers-turned-educators have to decide what to teach—very specific knowledge, oriented to particular elementary school lessons, or a general grounding in science? Saltman is among those who believe in giving teachers a broad background in science. "Paul and I feel that if you meet someone who is hungry, you should teach him to fish, rather than give him a fish," says molecular biologist Harold Slavkin, who directs a teacher education program at the University of Southern California. "Giving them a fish" is Slavkin's characterization of the view held by others that the teaching should focus on ready-made lessons the teachers can take back and teach in their classrooms.

Some think the fish metaphor misses the point. "We're not going to turn [the teachers] into junior colleagues," argues Eugenie Scott of the National Center for Science Education in Berkeley. "So let's make it as easy as possible for [them] to teach good science."



Alan Decker

*"Godzilla" Saltman*

Jerome Pine, a Caltech physicist who has been working with the public schools for nearly 30 years, agrees with Scott. With Caltech biologist James Bower, he has devised a program for teachers in the Pasadena elementary schools, completely designed around kits that use hands-on exercises to teach concepts ranging from electricity to insect behavior. In one kit for fifth graders, for example, students are given a battery, wire, and a light bulb, and are encouraged to learn about electrical circuits by finding different ways to light the bulb. The idea, says Pine, is to give the teachers the science background they need to teach the lessons with confidence and encourage the students to ask questions and devise experiments with the kits to answer them.

As in Miller and Taagepera's Irvine program, the Caltech approach relies on master-teachers as "translators" between the culture of science and the culture of elementary education. At Caltech, scientists are paired with master-teachers who actually do the teacher-training. The scientists answer questions and try to add scientific depth to the lessons. NSRC's Lapp is a big fan of that approach. "The scientist comes in as a coach," he says. "It's a wonderful role. . .because the scientist doesn't preempt the teacher's expertise. It keeps the leadership with teachers who are credible with other teachers. If scientists tell teachers how to do things, they often go blank, and say, 'of course the scientist can do it, but how am I supposed to know all he knows?' "

Master-teachers represent one way to bridge the gulf between scientists and educators. A different approach is a personal, one-on-one bond. A 4-year-old program conceived by UC San Fransisco molecular biologist Bruce Alberts takes that informal route, matching faculty, students or postdocs directly with interested San Francisco science teachers. Each partnership is then free to evolve as the scientist and teacher see fit.

UCSF postdoc Stephen Doxsey has had a productive 3-year partnership with science teacher Gerry Pelletier, from San Francisco's Marina Middle School. "What I enjoy most is working with the kids," says Doxsey. He has coached Pelletier's students, for example, in the design of special science-fair projects. Pelletier says he prefers his one-on-one relationship with Doxsey to a formal summer institute. "When universities do formal things for teachers, they often don't work very well because they don't really understand what it is all about. They ask what you [the teachers] want, but you know they'll do what they want." Having Doxsey as a personal resource works much better, he says, and he is continually learning from their interactions.

Coming up with a program that's appealing to teachers, however, doesn't assure scientists immediate acceptance by school administrators. "We ran into a brick wall in the school-district middle management," says UCSF professor Stanton Glantz of his early efforts to start a program (similar to Pine's at Caltech) that would provide elementary school teachers with science kits and instruction on their use. The administrators, he adds, "have their own bureaucratic power base, and they don't like outsiders coming in." Glantz's solution: avoid official dealings with the school-district and go straight to individual schools, where teachers are clamoring for scientists to teach them science and help them plan curricula.

Yet there may be legitimate reasons why school districts get worried when they spot a band of well-meaning scientists heading their way. "Most scientists don't know anything about science education; they have to be taught," says UCSF's Alberts, adding that "a scientist who has been trained is much more valuable than one with just good will." Tom Sachse, director of California's math, science, and environmental education unit, says the answer may be a "teacher institute" for scientists, to help them understand the kind of learning that works best for school children and their teachers. Such institutes, on a national level, may soon be available through the NSRC, says director Lapp. With the help of Caltech's Pine, Lapp is designing a program for scientists to utilize all of that raw good will productively.

Even when school administrators can be convinced that these outsiders have something good to offer, the problems for the scientists aren't necessarily over. There's another hurdle that sits squarely within the profession of science itself, and that is that improving education simply is not high on the list of what gets you ahead professionally. "I would venture the suspicion that those who do all of this are looked down upon by colleagues for wasting their time," laments Scott, of the National Center for Science Education. "You get more credit for sitting on university committees."

UC Irvine's Miller agrees. "It's tricky to see this as a major part of the mission of a [research] university.... It's very much the perception in the major research universities that your fame and fortune come from doing research, and you better not do anything to detract from that." But he adds that crusaders like himself may have been making some headway. "Our department seems to not only tolerate Mare [Taagepera] and myself, but to even encourage us," he says. That encouragement lately has taken an extremely tangible form: promotion. Miller says that his most recent promotion, to senior lecturer—a tenured position in which he maintains a modest research lab—was based largely on his teacher-education work.

Whether researchers get credit for such efforts within the profession or not, all would agree that those efforts are well intentioned. But are they making a difference? It may be too early to tell for sure—what evidence there is of success is largely anecdotal. Saltman proudly points to the tenfold increase in the time his elementary teachers are now devoting to science in the classroom. And Maureen Allen adds: "I'm seeing more conceptual thinking going on. Teachers are more comfortable with the process of science."

Buoyed by their conviction, as well as the encouraging anecdotes, the scientists are moving forward. It's like a giant experiment, says USC's Slavkin. "We're all guessing," he says, about what methods will work best to improve science teaching in the schools. "None of us knows what the outcome will be." No matter which specific program works best, however, all these intrepid investigators deserve credit for venturing out into unfamiliar territory for a worthy purpose. By virtue of their sheer energy (says Saltman: "I'm Godzilla in education-land") their efforts seem bound to yield results. ■ MARCIA BARINAGA