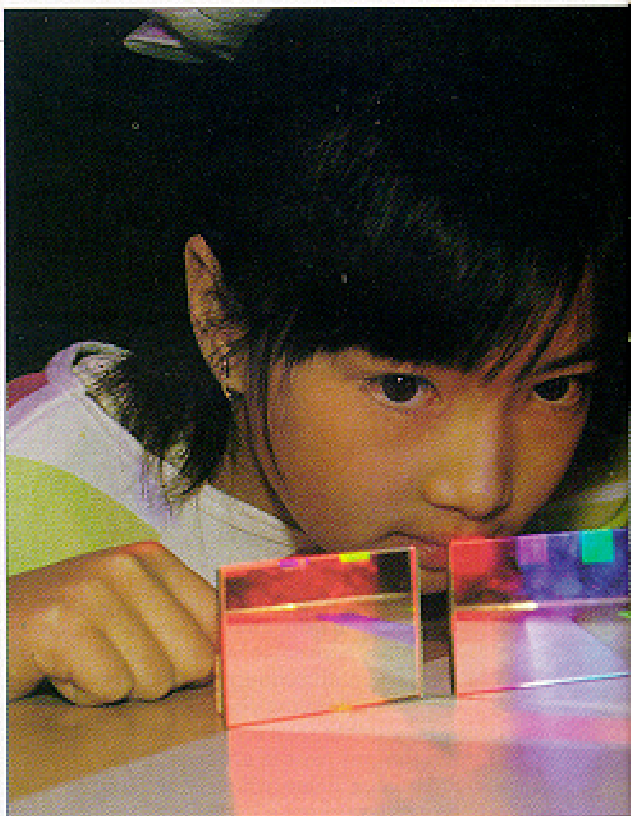
EDUCATION

Helping Kids Like the Lab

Hands-on science comes to the classroom



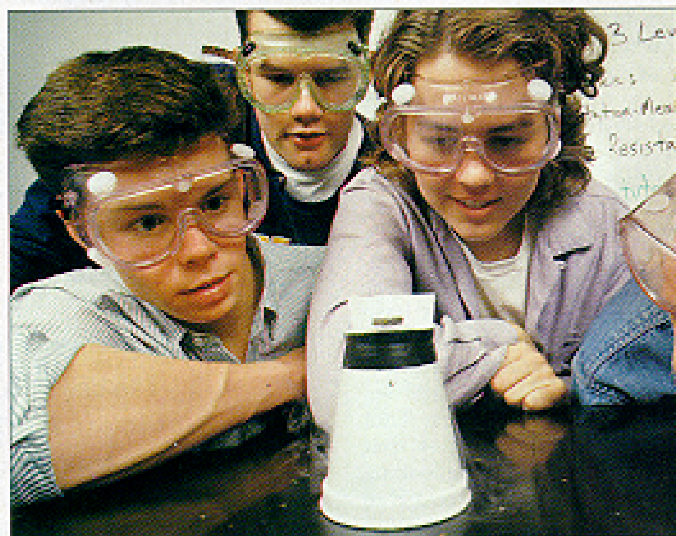
Tripping the light fantastic: *Pupil Aileen Manalo ponders*

One day last week the fourth graders at Piney Branch Elementary School in Maryland eagerly filed into Craig Logue's class for a lesson on chemical reactions. They were smiling because they knew they didn't face a lecture on electron exchange, catalysts and other sleep inducers. Rather, Logue, 37, was making alchemists of them. Working in pairs, the students added 20 drops of vinegar from a squeeze bottle to each of five little cups of "mystery powders." They stirred the sludge with a Popsicle stick and recorded the look and texture of the mixtures that fizzed, got hot, developed lumps and otherwise put on a good show. The bell rang but no one wanted to leave. "When you get plain old lectures, you don't learn anything," said Alex Patchen, nine. His friend Scott Collins agreed. "We learn more because we get to see it for ourselves. And it's funner."

"It" is hands-on science, and it's part of the biggest push to improve science education in the United States since the Soviets orbited Sputnik 1 in 1957. Then the goal was to groom elementary and high schoolers for college science and swell the nation's ranks of researchers and engineers. No one would mind if that happened this time around. But today the emphasis is more on reaching the ordinary student, not the one who will cure AIDS but the one who will vote on whether AIDS carriers should be quarantined. The rationale is simple. Crucial political decisions increasingly depend on science and technology—everything from deploying the Strategic Defense Initiative to releasing genetically engineered bacteria. The scientifically illiterate "are foreigners in their own culture," says Paul DeHart Hurd, professor emeritus of science education at Stanford University. Ignorant of science, they can't understand the debate, much less shape it.

The symptoms of the ills in science education are legion. One-third of Americans don't know what a molecule is, reports Jon Miller of Northern Illinois University, who surveyed adults in 1985. Five out of six don't understand the basics of genetic engineering; more than two-thirds have no clear understanding of radiation. The causes of this ignorance are clear, too. Science tends not to be taught, or to be taught poorly, in most public schools. The average third grader spends 18 minutes a day on science; the average sixth grader, 29 minutes. About one-third of science and mathematics courses are staffed by teachers who are not qualified to teach the subject. High schools have only minimal science requirements for graduation, particularly compared with schools in the Soviet Union (table). Science education is, in part, an unintended victim of the back-to-basics movement. Educators, pressured to teach Johnny to read and add, neglected to teach him biology, chemistry or physics. And since schools are often rated on reading and math scores, many don't seem to care as much as they might whether their pupils know what DNA is.

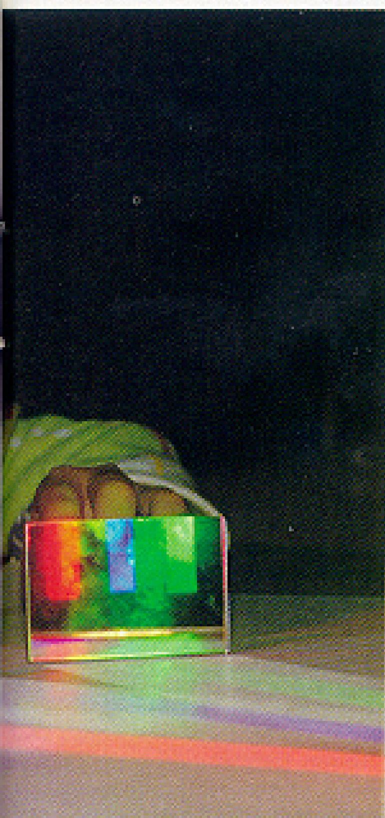
Gradually, however, science education is changing. Tedious lectures on batteries or magnetism or photosynthesis are disappearing. In their place is the kind of hands-on science offered at the East Los Angeles Science Center, one of eight in the school district where teachers take their charges for mesmerizing demonstrations that go beyond show and tell. Last week fifth and sixth graders watched in awe as light beams bounced off mirrors, bent through prisms and burst into rainbows. It was a painless way to get acquainted with optics and the discoveries of Isaac Newton.



MICHAEL KIENITZ—PICTURE GROUP

Headline experiments: *Madison West class with superconductor*

Perhaps the biggest hit among students lately are lessons based on cutting-edge research. The science story of 1987, for example, was superconductivity, in which special materials conduct electricity with no loss of power. Already, thousands of high schools are using a $25 superconductivity kit developed by chemist Arthur Ellis of the University of Wisconsin. For many students at Madison West High School in Wisconsin, David Braunschweig's senior seminar was



JOHN T. BARR—GAMMA-LIAISON

optics in a reflection demonstration at Los Angeles teaching center

Don't Know Much About Science Books . . .

■ 30% of the 23,000 public and private high schools in the U.S. offer no physics courses, 18% have no chemistry and 8% no biology.

Soviet students take six years of biology, one year of astronomy and three years of mechanical drawing.

■ 56.7% of U.S. high-school students are enrolled in science courses. Of these, 17% take physics—for one year—and 35% study chemistry for a year.

In the Soviet Union, all secondary-school students study physics for five years and chemistry for four.

SOURCES: I. WIRSZUP, UNIVERSITY OF CHICAGO; NATIONAL SCIENCE TEACHERS ASSOC. DATA FOR SCHOOL YEAR 1985-86.

one of the few times science wasn't drudgery. During one recent experiment, 17-year-old Deborah Chagnon watched with delight as she levitated a magnet above a superconducting pellet amid wisps of liquid nitrogen. It looked like magic, but the students were demonstrating a key property of superconductors: their ability to repel magnetic fields. "I had to go through three years of science classes before I had fun," Chagnon says.

Flying trains: The levitation experiment sent the students' imaginations soaring, too. They envisioned a world of uses for superconductors, foreseeing a tomorrow in which hockey players float above superconducting ice rinks and trains fly along superconducting rails. "I like the idea of taking ideas that are usually science fiction and making them practical," says Chagnon.

The need to hook students before they get turned off by science has made elementary schools the focus of many of the reforms. Traditional lessons "do a good job of killing our kids' natural curiosity," says Bassam Shakhashiri of the National Science Foundation. To keep it alive, classes are getting away from rote learning, especially of vocabulary. As part of its drive to replace the tedious, old ways, the NSF gave $2.2 million to the Technical Education Research Centers in Cambridge, Mass., to develop curricula for grades four through six. Next week 200 schools will begin testing the program. It shouldn't bore anyone. In the unit on acid rain, for instance, the students collect pond, tap and rainwater, measure its acidity, enter the results into a computer and compare them with what kids across the country have found. The idea is not only to teach students about acidity but to expose them

KEN HEINEN

Stimulating curiosity: *NSF's Shakhashiri*

to the collaboration and conflicting results of real science. "This is a far more appropriate educational strategy than the usual fact-and-formula approach," says TERC's Robert Tinker.

The trend of linking science to contemporary issues such as acid rain addresses one of the most serious failings of education: that it teaches the facts of science, not its process. Educators may endlessly debate whether physics or biology is more important, but most everyone agrees that the real need is to produce citizens who can think critically and reason logically. "We want students to know why the results of experiments are sometimes different, how conclusions are reached," says Anthony Galitsis, science director of the New York City schools. "We don't want them to take everything they hear and read as gospel." The curriculum at Nathan Bishop Middle School in Providence, R.I., has brought such lofty sentiments to life. Last year students learned about garbage incinerators, an emerging environmental issue. They visited a landfill, made up a questionnaire on the pros and cons of incineration, heard from experts and built a model incinerator. Finally, they staged a mock talk show, debating the policy implications of incineration. They saw how scientists working with the same facts can honestly reach different conclusions, a process that baffles most laymen.

New recruits: Despite the advances, science education still faces considerable hurdles. The most innovative curriculum won't do any good if the teacher is too science-phobic to tackle it, for instance. Some states are addressing the problem by hiring scientists and engineers to teach now and pick up education credits later. Beginning next August, Mills College in California will be training midcareer scientists and mathematicians to be teachers. And for researchers who want to lend a hand in the classroom but not abandon the lab entirely, there are programs such as a volunteer effort in Washington, D.C., where 170 university scientists bring specialized knowledge and news of their discoveries directly into the classroom.

Perhaps the greatest obstacle to improving science classes around the country is that "it takes a lot of money to do these comprehensive programs," says William Holliday, director of the science teaching center at the University of Maryland. For all the rhetoric about the importance of science education to the nation's economy and security, Congress appropriated all of $98,939 to NSF's science and engineering education department for 1987. This year the agency was euphoric because Congress upped its budget—to $139,200.

SHARON BEGLEY *with* BOB COHN *in Washington,* ELISA WILLIAMS *in Madison and bureau reports*