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# Real-World Science From Internet Labs

**By LOUISE YARNALL**

### Correction Appended

THE sun was out and summer break was beckoning, but inside Girolann Accetta's classroom, her students were crowded around their computer screens, captivated by the image of a bug they had plucked from the Dodson Middle School garden a week earlier.

Magnified thousands of times, the thumbnail-size harlequin bug appeared huge, menacing and undeniably scientific. A student standing amid the tables of glowing computer screens murmured that this was the "kind of science" students usually only "heard about" in school.

With a few clicks of a mouse, Daniel Sandri, the 14-year-old in charge of controlling the microscopic image, zoomed to the tip of the insect's hairy leg, then its abdomen and face. These students were inspecting a bug they had found and mailed away to be examined as part of Bugscope, a new program offering classrooms free Web-based access to a $600,000 environmental scanning electron microscope at the Beckman Institute at the University of Illinois in Urbana-Champaign.

Bugscope (bugscope.beckman.uiuc.edu/bugscope99)is among several programs offering elementary-school and high-school students Internet and modem access to advanced scientific technology. Other students beyond the Dodson Middle School classroom have used similar programs to remotely operate a 24-inch optical telescope, a radio telescope, a magnetic resonance imager and NASA-designed robotic devices. Students using such resources have produced real data about stars and Jupiter's atmosphere, created digital libraries about chick embryology and insect anatomy, and provided hours of testing for the Mars rover. Some are making educational CD-ROM's.

"What has come along, much bigger than us, is the Internet, which has changed everything about participation," said Louis Friedman, co-founder of the Planetary Society, (planetary.org), which sponsors one of the granddaddies of remote learning activities, Red Rover. A Lego robot that can be controlled by Internet and computer, Red Rover reaches about 400 classrooms that have paid $700 each to take part. The latest project, Red Rover Goes to Mars, will allow 40 selected students to control the Mars rover in 2002, while other projects will buy $200 Lego simulation programs that mimic rover activities.

Most of these projects, except Red Rover, are offered free on a first-come, first-served basis, or at a modest cost to schools because the projects' producers obtain grants from NASA and private businesses. But there are hidden costs. There is no extra pay built in for teachers to run the programs, so they often end up working on their own time, and they often need training. And schools need Internet or modem connections and up-to-date computers to run some of the software.

For all its potential, such remote-controlled technology is something of a hothouse flower of educational technology. Each project requires extraordinary coordination between educators and scientists, and tremendous financial and intellectual generosity. Fitting it into the school curriculum is the hardest part.

"The use of such 'gee whiz' learning scenarios needs support for teachers in terms of their own

understanding of the science," said Roy Pea, director of the Center for Technology in Learning at SRI International in Menlo Park, Calif.

The educational impact of the programs is unknown, but some educators believe that giving students a taste of real-life science, complete with its scheduling headaches and detailed coordination chores, is important.

"I've always been interested in science, but it's having kids learn things that are real, not just memorizing things out of the books," said Jim Roller, a public high-school teacher who oversees the Goldstone Apple Valley radio telescope at the Lewis Center for Educational Research, about 65 miles east of Los Angeles (www.avstc.org).

Mr. Roller's radio telescope program, backed by a NASA grant and other government and private financing, offers free to schools a six-day training program at his site followed by six hours of telescope access that may be used over a few months. Universities pay $50 for the program. Today, 18 schools participate, but Mr. Roller hopes to expand to 500.

Remote-access projects have positive effects on student motivation and appeal to non-science students, educators say. "I think it's been a kind of demystifying process for them," said Cassie Dunham, an outreach coordinator at Washington University in St. Louis, Mo. She oversees the Field Integrated Design and Operation project -- FIDO -- a pilot project that selected a few dozen high-school students from Los Angeles; Phoenix; Ithaca, N.Y., and St. Louis to test the next Mars rover (wundow.wustl.edu/rover). "This project awaits further backing from the Jet Propulsion Laboratory and the Planetary Society," Ms. Dunham said, but its data will be available to students participating in the Red Rover Goes to Mars project."

The pilot program's chief costs are borne by the teachers, who donate dozens of hours of their time.

During vacations and after school, FIDO students remotely control a test rover at a secret location in the California desert. Steven Dworetzky, a robotics teacher at the Thomas Starr King Middle School in Hollywood, said his students have become experts in the computer language that commands the rover, sometimes troubleshooting for scientists at the Jet Propulsion Laboratory in Pasadena, Calif.

A physics teacher, Joe Wise, who runs the W. M. Keck Math/Science Institute at Crossroads School, a private secondary school in Santa Monica, Calif., has his students working on remote optical and radar telescopes (www.kmsi.org/astro /variable.html). The projects broaden students' view of learning, he said.

"Kids see high school as jumping through hoops," Mr. Wise said, "and so they want to know what they have to do in the quickest time, the shortest route. This thing tends to create an ambiguous route with more time."

To keep prices low to schools, the universities and research laboratories that produce such projects chase down grants and volunteers. The Telescopes in Education, or TIE, project (tie.jpl.nasa.gov/tie /index.html) at the Jet Propulsion Laboratory is one of the largest and oldest remote access programs. Offered free to elementary and secondary schools since 1993, it has reached 240 schools. TIE's director and co-founder, Gilbert Clark, has kept the program low-tech and free to schools through hours of donated development work on the prototype technology, NASA's annual $100,000 support and a 200-volunteer network. To expand the program, he plans to hit the grant trail again soon, raising enough to buy other telescopes around the world, each costing as much as $120,000.

Bugscope is expected to grow from a few classes to two to four classrooms a week, using high-school student volunteers and charging schools about $50 to prepare the bug for examination and provide two hours on the microscope.

Bugscope producers designed the program to run on volunteer time at minimal cost. An earlier effort at the Beckman Institute, Chickscope, which involved having individual schools submit fertilized eggs for periodic inspection under a magnetic resonance imager, was phased out because of cost and personnel demands, said

Clint Potter, the program director. But despite such obstacles, student enthusiasm keeps remote technology projects alive.

"It's kind of funny," said 18-year-old Aaron Parker, one of Mr. Wise's students. "One of the best parts is knowing that I have access to a telescope that discovered the center of the Milky Way, and I can spin it around if I want to."

Photos: DECIDEDLY COOL -- Girolann Accetta, above, shows microscopic images to her students, including Joshua Gile, left; Daniel Sandri; Alicia Holliman, front; Annah Inocente and Sean O'Dell. (Photographs by Chris Pizello for The New York Times)