Taking Science Education on the Road

Traveling laboratories deliver engaging science lessons to classrooms everywhere. **BY LAURA BONETTA**

The crown jewels were stolen from the City Museum. *"Once on the scene, I noted that the only window in the room was broken. Officer Ligase approached me and said that there were no prints or any apparent evidence left at the crime scene. However, upon further inspection of the window, my partner, Dee Enae, noticed some blood on the sill…"*

"Dee Enae," a pun on DNA, is the quick-thinking sidekick in this popular science education module for high school students, created by Boston University School of Medicine's CityLab program. Dee and other characters visit schools around Greater Boston, providing hands-on science lessons that engage students' imaginations.

"If you want to teach someone to play baseball, you don't give them a video of someone playing the game," says Carl Franzblau, associate dean for graduate and biomedical science at Boston University School of Medicine. "You give them a ball and bat."

To solve the case of the crown jewels, students are given gloves and pipettes to perform DNA restriction analysis, or DNA fingerprinting. They then look for a match between the DNA fingerprint of the blood sample collected at the crime scene and that of one of four suspects. Other modules have the students purifying proteins or diagnosing a disease. (See sidebar, "Mobile Lab Modules.")

Franzblau launched the CityLab program in 1992 with funding from an NCRR Science Education Partnership Award (SEPA). Initially, the program offered science lessons on the Boston University Medical Campus. But in 1998, CityLab unveiled a 40-foot bus outfitted with state-of-the-art biotechnology equipment that could deliver the lessons directly to students at their schools.

■ High school students onboard Boston University School of Medicine's MobileLab are hard at work identifying the culprit of a crime. They are using DNA fingerprinting and other molecular biology techniques.

PHOTO BY VIVIAN RONAY PHOTOGRAPHY

■ Mobile labs are located across the United States. There are 12 mobile labs in nine states. Several of these programs—Boston University School of Medicine's MobileLab (an extension of the CityLab program), the University of North Carolina at Chapel Hill's DESTINY Program, and The University of Texas-Pan American's Regional Biotech Program—are supported, at least in part, by NCRR.

The ensuing demand for the traveling lab inspired the creation of similar programs across the country, many of which use the same lesson plans and materials. Each program quickly became oversubscribed. "The reason mobile labs have been so successful is that people running the programs share all their resources," says Tony Beck, SEPA program officer at NCRR. "Their first priority is the kids."

HOW IT ALL STARTED

The original CityLab program, using four biotechnology laboratories housed at Boston University School of Medicine, provided a great way for kids to learn about molecular biology and biotechnology methods. But field trips are unwieldy: Teachers must justify taking a group of students out of school for an entire day, and many students can't pay the required transportation costs. So Franzblau and colleagues decided to build a laboratory that could go to the students. (See sidebar, "A Q&A with Carl Franzblau.")

Dubbed "MobileLab," the traveling laboratory was unique. At the time, there were programs that brought science educators to classrooms or lent science equipment to teachers, but nothing like what the Boston group created.

"In many ways, MobileLab really levels the playing field," says CityLab director Don DeRosa. "Whether a school is well equipped or not, the students are exposed to the same program and with the same staff and equipment. It does not matter if the school does not have running water or computers or microscopes. No one gets shortchanged."

MobileLab typically visits one school within 75 miles of the university each week, hosting five to six science classes every day. "We can do four different lessons for each class in one week, all during regularly scheduled science classes," says DeRosa. "The students don't have to miss math or English."

The six years DeRosa had already spent learning from visiting teachers and students at the on-campus lab made startup easier, but not without challenges. "I had to get a bus driver's license and learn the protocol for going into a truck stop and filling up the gas tank," says DeRosa. "The first time I had to back down a little alleyway, I was sweating."

FROM ONE TO MANY

One of the programs that followed in CityLab's footsteps is headed by George Eyambe at the University of Texas-Pan American (UTPA). An associate professor in clinical laboratory

■ Sixth graders from Cuellar Middle School in Weslaco, Texas, verify the micropipette setting as they begin to work on a protocol for analyzing protein samples. They are participating in a project offered by The University of Texas-Pan American Regional Biotech Program.

science, Eyambe had heard Franzblau speak about his education programs, including MobileLab, during a SEPA-sponsored meeting at NIH.

"I thought a mobile lab could be useful in the Rio Grande Valley," says Eyambe. A four-county region situated along the south Texas border with Mexico, the Rio Grande Valley is one of the poorest metropolitan areas in the United States. It comprises 30 independent school districts with a predominantly Hispanic population. Many of the students are from migrant families who speak little or no English.

With SEPA funding, Eyambe established UTPA's Regional Biotech Program. Initially, the program provided a university-based clinical lab for students and teachers and an equipment lending program. Program staff used several CityLab modules, translating some of them into Spanish. They also created new lesson plans. "The teachers wanted us to do something about evolution and, because we have high rates of diabetes in Rio Grande, we are now developing a module on glucose determination in diabetes testing," recalls Eyambe.

Although the on-campus program was, and continues to be, popular with many teachers, it was clear to Eyambe that it was not serving all students. "We realized that a lot of students and school districts could not come to us because they could not afford the transportation," says Eyambe. "And many of the teachers did not have the skills to use the loan program."

In 2004, with support from the Howard Hughes Medical Institute, the group built a mobile lab to take its SEPA curriculum to rural schools within 120 miles of UTPA—from Brownsville to Rio Grande City. "The mobile lab filled an important niche," says Eyambe. "It quickly became very popular, and it is booked one year in advance."

IS IT WORKING?

There is no shortage of personal accounts that programs like CityLab and the Regional Biotech Program are increasing students' interest in science careers. "A mother called to tell us that her son attended our weeklong summer lab at Boston University and is now going to get a degree in molecular biology," says DeRosa. Another student, who is now an investment banker, wrote to CityLab staff to say that her experience at the lab "provided my first taste of modern biotechnology and medical science and sparked my interest in this field and its commercial applications."

In addition, according to a 2002 survey, 76 out of 91 teachers polled indicated that their experience at CityLab affected their teaching in a positive way. Fifty-three percent of respondents indicated that aspects of the CityLab curriculum were directly incorporated into their lesson plans.

Following SEPA guidelines that require all its projects to move beyond anecdotal evidence, Eyambe hired a professional evaluator to gather and analyze data about the program. Preliminary findings from a group of students who spent a month at UTPA, including two weeks in the on-campus teaching lab, show that "at-risk" students—those who were not performing well in science—start to perform as well as non-at-risk students after this experience. Other mobile lab programs are similarly being evaluated to gauge their effectiveness.

Most educators agree that many students see science as something beyond their grasp and that this notion can only be changed through exposure to positive hands-on experiences and role models. "When students see themselves accomplishing tasks and begin to see this is something they can do, they become interested in it," says Eyambe.

Martha Medina, a teacher at Veterans Memorial High School in Mission, Tex., agrees. "My students spent three hours in the

PHOTO COURTESY OF UNIVERSITY OF TEXAS-PAN AMERICAN

lab at UTPA, and then we went for lunch in the university cafeteria," she recalls. "All the other kids looked like them; they dressed the same. They said 'You mean I could fit in here?' They were very excited."

THE MOBILE LABORATORY COALITION

In addition to MobileLab and the UTPA bus, there are at least eight other mobile lab programs in the country. The interest in these programs has been growing so rapidly that mobile labs have formed their own organization. "We were constantly getting calls asking for advice," recalls DeRosa. "We realized we were all sharing ideas but not in a very organized fashion. We decided we needed to come up with a mechanism to do this better."

In 2006, DeRosa and others established the Mobile Laboratory Coalition (www.bu.edu/mobilelab), a partnership of traveling laboratory programs, institutions of higher education, and K–12 schools and school systems. The organization has grown to include almost 80 members.

The members meet annually to share information and resources. They also meet in smaller groups throughout the year to evaluate each other's programs. The meetings help

■ Regardless of whether a vehicle began its life as an army truck, trailer, mobile home, or school bus, it can be outfitted to include lab benches; video players; and storage space for centrifuges, gels, pipettes, and reagents and to have its own electrical power, plumbing, and Internet connectivity.

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MOBILE LAB MODULES

In **The Case of the Crown Jewels,** students become forensic scientists who analyze drops of blood found at a crime scene as they determine which suspects are guilty or innocent. It is one of many science modules funded through NCRR's Science Education Partnership Awards (SEPA) that can be taught "on wheels." Other SEPA modules, with equally engaging names, include:

In Search of the Body's Antibodies. Students perform enzyme-linked immunosorbent assays to screen fictional patients' blood samples for HIV (using simulated viral extract). (Created by Boston University's CityLab.)

Amp Up Your DNA. Students use polymerase chain reaction and gel electrophoresis to amplify and visualize a portion of their own DNA. In particular, students are taught to amplify the Alu insert on chromosome 16. This is a DNA sequence that is repeated hundreds of times in the genome; the number of repeats varies from person to person. (Created by Boston University's CityLab.)

Nothing Fishy About Evolution. Students isolate muscle proteins from various fictional fish species and analyze them with denaturing polyacrylamide gel electrophoresis. They then look for a correlation between the properties of the proteins and the evolutionary relatedness of the fish species. (Created by the University of Texas-Pan American's Regional Biotech Program.)

Weigh to Go! Students explore connections between obesity, diabetes, high blood pressure, and high cholesterol. Using chromatography, students purify a protein called leptin, a hormone that regulates appetite. Other activities help students become more aware of the obesity epidemic at global and individual levels. (Created by the University of North Carolina at Chapel Hill's DESTINY Program.)

The State We're In. Students perform a bioassay experiment using the water flea *Daphnia*, an indicator of ecosystem health, to detect and assess what would be considered a harmful level of a toxic chemical. While discovering the effects of environmental toxins, they gain insight into the interplay between scientific data and human judgment that underlies legislation. (Created by the University of North Carolina at Chapel Hill's DESTINY Program.)

The Beat Goes On. Students focus on the cardiovascular system and identify the genetic and environmental factors that influence an individual's likelihood of developing heart disease. They use EKG sensors to make graphical recordings of their hearts' electrical events, identify the waveforms produced, and determine the patterns typically associated with them. (Created by the University of North Carolina at Chapel Hill's DESTINY Program.)

■ At the June 2007 annual meeting of the Mobile Laboratory Coalition in Rockville, Md., participants shared information and resources. The meeting was hosted by the J. Craig Venter Institute and MdBio.

educators gain insight and advice on how to get a mobile lab program up and running—and not just within this country. One of the attendees at the coalition meeting held in June 2007, an entrepreneur from Malaysia, contacted DeRosa for help in establishing a mobile lab there.

In less than a decade, the mobile lab has gone from a daring experiment by one group to a coalition of programs with common goals and a shared vision for science education. Students from all walks of life, regardless of the resources available at their schools, are experiencing science in exciting new ways.

In years to come, colorful mobile labs could become common sights on school parking lots across the nation and Dee Enae and Ligase well-known characters in every science class. ■

TO GAIN ACCESS: NCRR's SEPA program funds grants for innovative educational programs. Such projects create partnerships among biomedical and clinical researchers and K–12 teachers and schools, museums and science centers, media experts, and other educational organizations. For a list of currently funded programs, please visit www.ncrrsepa.org/projects/Active.asp.

A Q&A WITH CARL FRANZBLAU

How did you come up with the idea of a traveling laboratory?
I was attending a meeting at the Convention Hall at the University of Miami and I saw a bloodmobile parked outside. I thought, 'Why can't we build a lab the way they are building a bloodmobile?'

Why did you think there was a need for such a program?
At the time, we had an on-campus lab dedicated to teaching high school students. But teachers were yelling at us because they did not want their students out all day. In the old days, if you could not go to the doctor's office, the doctor would make a house call. So I thought we could do the same.

What is your vision for science education?
I would like to create 30 to 40 mobile lab units throughout the country. We could enlist young graduate students and teachers to volunteer to staff them. I call it a 'Science Core.' Its mission would be to bring science education to all students. From the foothills of South Dakota to the inner city of Chicago, students would be exposed to the excitement of science.

■ Carl Franzblau (left) and Don DeRosa of Boston University School of Medicine stand in front of their MobileLab. The traveling science laboratory made its debut in 1998.

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