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# Los Alamos National Laboratory Science Education Program Annual Progress Report October 1, 1998 through September 30, 1999

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# Los Alamos National Laboratory

## Science Education Program
## Annual Report
## October 1, 1998–September 30, 1999

**The science and mathematics education programs described in this report were funded primarily by the Office of Defense Programs of the Department of Energy (DOE) with additional funding from other DOE offices, the National Science Foundation, the New Mexico Department of Education, NASA (National Aeronautics and Space Administration), and other sources.**

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# Executive Summary

The 1998-99 Annual Progress Report summarizes science education programs coordinated by staff from Los Alamos National Laboratory. The Laboratory has a unique contribution to make to science, mathematics, engineering, and technology education. Illustrations of these unique contributions to education in northern New Mexico and throughout the United States can be found in the project descriptions in this report.

The mission of the Science Education Program is to apply the unique scientific and technical resources of the Laboratory to the critical needs in education. Our goals are to:

- improve the quality of science, mathematics, engineering, and technology education;
- enhance the technical literacy of the public;
- contribute to systemic change in mathematics and science education; and
- ensure a highly trained, diverse workforce.

With this mission and these goals in mind, the Laboratory conducts a wide variety of science education projects, funded primarily by the Office of Defense Programs of the Department of Energy, with additional funding from other Department of Energy offices, the National Science Foundation, the New Mexico Department of Education, NASA, and other sources. Some of the projects are national in scope, others are regional and still others are local.

FY99 was an active year for the Science Education Program at Los Alamos National Laboratory. We conducted 24 separate projects totaling 1,735 direct participants. The indirect impact of these projects was significantly greater, because many of the direct participants were teachers and faculty, each of whom impacts 100 or more students. Also, some of our projects involve working with the schools to help them apply new technologies to the educational process. These latter projects directly involve some participants, but indirectly impact entire schools and districts. Our technology projects make a direct and immediate impact on the educational system and how teaching (and more importantly, learning) is accomplished. We estimate the indirect impact of our programs in FY99 to be approximately 110,000 students.

In all of the science education projects we partner with other organizations and entities. We partnered with the schools, teachers, faculty, and administrators; other national laboratories; the New Mexico Department of Education; the U.S. Department of Education; the National Science Foundation; NASA; curriculum specialists; universities; industry; and others.

We make a special effort to link every science education project with the unique resources of the Laboratory and to the technical programs and core competencies of the Laboratory and the Department of Energy. Those projects funded by the Office of Defense Programs are especially linked to technical areas of interest to Defense Programs and its mission. All of the projects make extensive use of Laboratory technical personnel for talks, demonstrations, and tours. These direct

contacts with the scientists and active science projects result in excited and enthusiastic students and teachers. This enthusiasm is the very best way to improve the teaching and learning of science and math.

Many of the post-secondary projects bring in students and faculty as research interns to work alongside Laboratory scientists and engineers. Each of these interns is assigned a Laboratory staff member as a mentor. Based on technical background and interest, care is taken in matching mentors with students. Training and information are provided for the mentors who serve as role models for the student and teacher participants.

The Science Education Projects have a very good record of diversity, of which we are proud. Diversity is an important goal for each of the projects. Of all of the direct participants in our projects in FY99, 45% were minority and 43% were female. This distribution is for direct participants, and the indirect participants were even more diverse. For example, some of our Caucasian teacher participants facilitate classrooms that are 80-100% minority. Additional data about participant gender and ethnicity are located in the final section of this report.

We carefully evaluate every project internally every year, measuring it against its own goals and objectives as well as against the broader criteria of the Science Education Program and the Department of Energy. We use these evaluations to make modifications in the projects.

An Internet Web Site (http://www.education.lanl.gov) is maintained that describes all of the science education projects and gives contact addresses for those who would like to apply or need more information. In addition, many of the projects use their part of the site to post schedules, products, summary reports, lesson plans, suggested activities, and other materials from their project. The projects are making more and more use of the Internet each year, many of them in an interactive fashion. The Web site was accessed an average of 3,500 times per day in FY99, by hosts from more than 68 countries.

The Science Education Program at Los Alamos is very valuable to the Laboratory and to the Department of Energy. We are very proud of our accomplishments recorded here, and look forward to 1999-2000 with enthusiasm.

# Teacher and Faculty Enhancement

## Teacher Opportunities to Promote Science (TOPS)

Teacher Opportunities to Promote Science (TOPS) is a three-year teacher enhancement program conducted by Los Alamos National Laboratory for northern New Mexico teachers of K-12 science, math, and technology. The primary goal of TOPS is to increase teachers' physical science knowledge and teaching skills, while promoting curriculum alignment and communication through computer networking. Over the course of the three-year program, TOPS teachers participate in a total of ten meetings: one two-day orientation at the Laboratory; three two-week summer institutes at the Laboratory; and three academic-year two-day regional workshops held between each pair of summers (six workshops, in all). TOPS teachers receive on-going instruction, tuition assistance, classroom materials and equipment, stipends, grants, and interaction with Laboratory education specialists, scientists, and sites.

Participants form district or regional teams that represent all three levels of instruction—elementary (K-5), middle (6-8), and high school (9-12)—to develop "spiral" curricula (increasing depth centered on key concepts and learnings). Based on inquiry and the contructivist educational model, the curricula integrate math, science, and technology. Laboratory scientists and educators act as mentors on curriculum projects tied directly to on-going Laboratory areas of scientific research. TOPS teachers learn the skills to develop and post their projects on web sites, making them available to anyone with Internet access.

For several reasons, the Laboratory's continuing success at least partly depends on high-quality science instruction in northern New Mexico K-12 classrooms. The schools closest to the Laboratory are educating the public most impacted by the Laboratory's presence, who therefore need to understand and appreciate the mission of the Laboratory. This requires that they learn science. Furthermore, the Laboratory cannot attract or retain the specialized workforce it needs if the schools are not up to the standards that that workforce demands. Additionally, much of the Laboratory's future workforce could be children enrolled today in K-12 northern New Mexico classrooms, who will have grown up near the Laboratory and may want to live and work in this area as adults. The skills they will need to be employed at a national laboratory are related to science and technology.

While the Laboratory's continued success depends on science being taught well, nationally, too few K-12 teachers of science are good science teachers. Elementary teachers are often science generalists who completed only those science classes required for their

elementary education degrees and K-8 teaching licenses. With identical pre-service preparations, some become teachers at the lower grades who must teach science as one part of the elementary curriculum, and others teach science full time at junior high schools and middle schools. They may have inadequate knowledge or confidence to teach science well, and lack the skills to integrate it effectively with math and current technology.

Although secondary science teachers are specialists whose college education earned them a science endorsement on their 7-12 teaching licenses, they often are not teaching in their specific field of concentration. These teachers often need a more comprehensive understanding of science in general, their course in particular, and effective teaching methods that incorporate more math and newer technology into their instruction.

These are compelling arguments for the Laboratory and its partners to be dedicated to improving science education in northern New Mexico schools by addressing the crucial need here for quality K-12 science teachers. For this purpose, the Laboratory created TOPS in 1991. With funding from the U. S. Department of Energy, TOPS is the longest running science education program at any of the three Department of Energy, Office of Defense Programs national laboratories. The program has directly served almost 300 teachers in over 30 school districts, benefiting thousands of northern New Mexico school children.

External validation of the value of TOPS has come in the form of a new collaboration with the College of Santa Fe to offer a 24-hour science endorsement licensure program for practicing New Mexico teachers in the TOPS program. In March 1999, this proposal received final New Mexico Department of Education approval, resulting in the addition of eight new separate courses in the College of Santa Fe's departments of math/science and education. These graduate-level courses can only be taken through participation in TOPS. Beginning in July 1999, TOPS teachers had the option to earn college credits leading towards a teaching endorsement in science.

## Goals

The TOPS program seeks to enhance the overall quality of science, mathematics, and technology education in northern New Mexico's school districts by

- Increasing teachers' knowledge of physical science, math, and technology
- Enhancing teachers' skills in teaching science, math, and technology
- Providing hands-on activities, materials, and training to take back to participants' schools
- Exposing teachers to the application of science, math, and technology to research at a national laboratory
- Enabling teachers to provide their students with the education and encouragement to pursue careers in science, math, engineering, and technology
- Developing a web-based communications network that will provide a strong educational support network among program participants and in their own communities

## Implementation

TOPS teachers participate in a series of academic-year workshops and summer institutes. Rounding out the program are site visits by Laboratory education staff to teachers' schools and classrooms, and ongoing contact through the Internet, World Wide Web, and other forms of communication. Details of the program are given below.

### *Participants*

Two groups of TOPS teachers participated during FY99: Forty-one teachers in the 1997-1999 cohort completed their third and last year in the program by attending regional workshops and their final summer institute. Fifty-six teachers in the 1999-2001 cohort began their first year in TOPS by attending the spring orientation and their summer institute. The table below is a summary of the demographics of these participants:

### *Site Visits*

The TOPS program coordinators visited the 1997-1999 cohort of TOPS participants at their schools during fall 1998. The main purpose was to observe and talk to the teachers, administrators, and students about how TOPS has affected their education programs to-date. Teachers were able to share the changes they had made to their curricula and teaching methods, and they allowed the coordinators to see first-hand how they modeled the use of technology in their classrooms and incorporated computers into their students' hands-on learning.

The Los Alamos program coordinators frequently observed the impact of TOPS on the school and district beyond the participants' own classroom. The site visits also afforded the opportunity to note the results of the implementation of materials and resources the teachers had obtained as a result of their individual TOPS grants. Site visits took place at 13 different school districts in 15 different communities with almost 50 TOPS teachers.

### *Regional Workshops*

**Fall Regional Workshops for 1997-1999 Cohort**—The first of the three 1998-99 academic workshops took place during the fall of 1998 at the Kirtland Technology Center near Farmington, NM, and at the Laboratory. Approximately 20 teachers attended each, where the time was divided into three main parts: a

**Demographics of TOPS Participants**

| Cohort | 1997-1999 | 1999-2001 | Total |
|---|---|---|---|
| Total Participants | 41 | 56 | 97 |
| Ethnicity: | | | |
| African American | 0 | 1 | 1 |
| Caucasian | 30 | 31 | 61 |
| Hispanic | 9 | 16 | 25 |
| Native American | 2 | 8 | 10 |
| Gender: | | | |
| female | 28 | 45 | 73 |
| male | 13 | 11 | 24 |

math/science workshop on the metric system and energy/motion; special instruction on the finer points of web site construction; and open lab time for the teams to plan and work on their curriculum projects.

**Winter Regional Workshops for 1997-1999 Cohort**—During winter 1999, the regional groups met at workshops in Kirtland and Los Alamos for two days of sharing, teaching, and learning from one another. The teachers gave presentations, demonstrations, and instructions on lessons they had developed and used in their own classrooms that they chose as representative of the innovations TOPS had made to their teaching. Most teachers indicated that they felt this exercise validated their efforts in TOPS to-date and they particularly appreciated the resulting informal discussions and peer evaluations.

**Spring Regional Workshops for 1997-1999 Cohort**—Several short, self-contained workshops made up the two-day spring 1999 workshops in Los Alamos and Kirtland. A half day was spent discussing gender equity in the classroom, based on the Myra and David Sadker book, *Failing at Fairness*, a copy of which was given to each teacher to read and share with colleagues, family, and friends. That was followed by a hands-on workshop on simple machines—the teachers shared or created their own activities on this topic with suggestions of how to make modifications for various age levels. Most of one day was spent in a probability and statistics workshop that featured numerous activities to generate data to graph and analyze using dice, cards, sunflower seeds, shaved pencils, coins, and numerous other easy-to-obtain materials.

The Los Alamos group also met briefly with other members of the Laboratory's Science Education Team to learn about programs that might be appropriate for their students, such as Educational Pipeline for Student Initiatives Linked on the Network and Critical Issues Forum. They also met with a Laboratory scientist who works with insects. He brought collections—both live and pinned—of specimens from all over the world and discussed his research at the Laboratory. Many of the teachers were pleased to received their own Madagascan giant hissing roaches to take back to their schools with information on hands-on activities they could do with their students and the bugs.

**Program Orientation for 1999-2001 Cohort**—The 56 teachers selected to make up the 1999-2001 TOPS cohort came to the Laboratory for two days in spring 1999 to complete registration, attend General Employee Training and testing, obtain their Laboratory badges, and begin to get acquainted with one another and the Science Education Team.

**Summer Institute III for 1997-1999 Cohort**—Twenty-three teachers attended the last TOPS summer institute for this group in June 1999. Two days were cancelled, however, due to the Security Immersion Program that ceased all normal operations at the three Defense Programs national laboratories, and the teachers were sent home.

The summer curriculum had four main components:

- **Physics instruction.** This course focused on topics of modern physics that included kinetic molecular theory, the Periodic Table, atomic models and elementary particles, ions and molecules, nuclear energy, fission, fusion, and radioactivity. The primary goal was to develop a scientific understanding of basic modern physics, both in content and

teaching methodology. Teachers discussed ways to adapt many of the hands-on activities they were taught for their own classrooms.

- **Laboratory Site Visits and Workshops.** Teachers visited Bradbury Science Museum and the Los Alamos Neutron Science Center, where special tours, presentations, and demonstrations were conducted for the purposes of both educating the teachers and making them aware of possible field trip options for their students.

  The StarLab portable planetarium was demonstrated so the teachers would know how to set it up and use it, if they borrow it for their school district.

  Laboratory researchers conducted a workshop that let the teachers try out experiments geared for K-12 students on fluid dynamics. The Activities Integrating Math and Science program will soon publish a book based on this work, and the teachers received advanced copies to take back to their classrooms.
- **Math classes.** The elementary teachers attended a course conducted by a math education specialist who provided activities and instruction for an alternative method of teaching called "music teaches math." The secondary teachers' math course focused on the topics of statistics that included lessons with Texas Instruments graphing calculators and Computer Based Laboratory units.
- **Technology.** Time and assistance was provided in the computer classroom for the teachers to continue or begin new web-posted science curricula.

About one-third of the teachers chose to earn an optional 3-hour course credit through the University of New Mexico–Los Alamos based on the physics instruction and site visits/workshops components described above.

**Summer Institute I for 1999-2001 Cohort—**The 56 teachers who comprise the newest participants in the TOPS Program came to the Laboratory for their first summer institute in July 1999.

The curriculum had four main components:

- **Physics instruction.** This component was the same as described for the 1997-1999 cohort above.
- **Laboratory Site Visits and Workshops.** This component was the same as described above
- **Pedagogy.** This course covered topics that included Socratic dialogue, multiple intelligences, constuctivism, hands-on/minds-on, and spiral curriculum. The instructor was a New Mexico Mathematics, Engineering, Science Achievement (MESA) teacher with over 20 years of middle school math teaching experience. The instructor modeled these methods for the TOPS teachers and provided numerous activities that they will be able to use with their own students.
- **Technology.** An educational technology specialist introduced the teachers to the

computers (both PC and Macintosh platforms), skills, and types of software they will use throughout the TOPS program. The instruction focused on individual activities that required their use, rather than doing out-of-context exercises. At the conclusion of the class, each teacher had produced a computer slideshow that illustrated a lesson from one of the other summer institute courses. The software used in this course included ClarisWorks, Netscape Navigator, and Inspiration to instruct the teachers on word processing, draw, paint, databases, graphic organizers, spreadsheets, slide show, concept mapping, graphing, and using the Internet effectively.

Fifty of the 56 teachers are pursuing the new option to earn a science endorsement through TOPS participation and each received a total of 6 hours of credit from the College of Santa Fe at the end of Summer Institute I.

**Integration of Science Instruction with Computer Technology.** As a total of 79 TOPS teachers learned the science content and teaching methods (the primary goal of the TOPS Program) described above, the physics course instructor modeled the capabilities of on-line instruction. A visiting university professor, he used the Chemistry Folder he created and added to the Science Education Teams' Web of Learning site (http://set.lanl.gov/programs/learning) as he taught during both of the two TOPS Summer Institutes. In addition to observing its use in class, the teachers went to the Internet on their own to review lessons, get homework assignments, and explore links to enrichment resources. The final products expected from the TOPS teachers at the conclusion of their three-year participation in the program are on-line lessons that they designed, posted, and use in their classrooms, exactly as they saw the science instructor demonstrate at the summer institutes.

## Evaluation

The Laboratory conducts numerous formative and summative evaluations throughout the course of the TOPS program. Through 1997-1999 the same group of TOPS participants have given their feedback on each of three summer institutes and six regional workshops. Along with these different evaluation surveys, the Laboratory has gathered information on the TOPS program through teacher journals, written assignments produced for college credit, and reports on various grants.

A final evaluation summarized the overall impact of TOPS on the teachers who completed the three-year program in June 1999. The teachers were asked to reflect on the program and evaluate the influence TOPS has had on their professional and personal development:

- 90% of the teachers say that as a result of TOPS they have a better awareness of the variety of research and of the mission of the Laboratory.
- 90% of the teachers say that as a result of TOPS they have improved their knowledge and teaching skills in math, technology, and science.
- 95% of the teachers say that as a result of TOPS they have greatly increased their use of computers and software to produce documents, materials, and presentations for their teaching.

- 90% of the teachers say they have greatly increased their use of the Internet in their classes.

All the teachers (100%) say that they

- Increasingly ask their students to solve problems.
- Increasingly give their students tasks that require critical thinking.
- Increasingly support and encourage student investigations in the classes.
- Increasingly incorporate real-world issues into their classes.
- Increasingly teach with hands-on activities in their classes.
- Increasingly feel inspired to improve their teaching.
- Feel updated on what is going on within science education and find more satisfaction in their job as teachers.
- Have expanded the network of teachers that they work with and/or share ideas with throughout New Mexico.
- Feel they have developed professionally.
- Feel they have developed personally.

Asked to give TOPS a letter grade, 60% of the teachers responded “A”, and 40%, “B.” All the teachers (100%) said that they would recommend TOPS to their colleagues.

# Curriculum Improvement

## Activities Integrating Math and Science (AIMS) Fluid Instabilities Curriculum Development

The goal of the Activities Integrating Math and Science (AIMS)–Fluid Instabilities Curriculum Development project is to educate students in grades 5 through college and the public about fluid instabilities and their consequences in the everyday world. The Laboratory is developing a book of hands-on activities intended for grades 5-12 and a series of journal articles for college and high school. Also, the Laboratory continues to do presentations for students and teachers regionally in the Four Corners area and nationally through the American Physical Society.

The behavior of interfaces between different fluids provides a delightful set of activities to arouse the interest of students in fluids, both gases and liquids. The Laboratory made substantial progress during FY99 on the book in progress. Titled *Spills and Ripples,* it is an introduction to fluids and fluid instabilities. The book is a compilation of activities developed by Dr. Robert Benjamin, Laboratory Fellow, in collaboration with the research staff at the AIMS Education Foundation of Fresno, California, during the last five years. During FY99 the Laboratory completed the first draft of the book and field tested it in both classroom and workshop venues.

The focus of the book is an integrated approach to fluids. Fluid-instability experiments provide the gateway to the study of fundamental properties of fluids, like pressure, density, surface tension, and interfaces. About half of the book's activities are about fluid instability and combined pressure/density effects. The rest are about the fundamental properties of fluids and apparatus for measuring these properties. For example, activities direct students how to build a low-cost manometer and hydrometer to measure pressure and density respectively.

The basis of the book is an effect known as the Rayleigh-Taylor Instability (RTI). A dynamic effect induced by buoyancy, RTI can be observed when water spills from an inverted glass. It is involved in ocean dynamics and atmospheric phenomena, as well as "kitchen physics." However, because buoyancy is usually perceived as a static event, fluid instability and its everyday effects are rarely taught.

Dr. Benjamin and others wrote a cover article for the September 1999 issue of *The Physics Teacher* magazine. Many readers have commented on its usefulness. The magazine is read by college, junior college, and high school faculty.

### Implementation

RTI activities have been developed for *Spills and Ripples* and additional ones are in progress. The activity published first,

"Look Out Below," shows how to confine water in an inverted glass by using different barriers. "Flow Fingers" enables the student to view flow patterns induced by RTI, which are triggered by another fluid effect, the "Widnall instability." *Spills and Ripples* will contain a biographical sketch of Professor Sheila Widnall, which can be used in schools for women's history studies.

"Soapy Spills" shows students the consequences of reducing surface tension at a water-air interface. "Trickle Triathlon" is a group of three events that provide students an opportunity to push the limits of confining water in inverted bottles. "Oopsy Do!" uses RTI to teach students about "failure-mode analysis" and the engineering of wet papers. "Brackish Waters" shows students how RTI can drive the mixing of saltwater and freshwater. Several activities about the "Cartesian Diver" show students that combined density and pressure effects can influence dynamics of objects submerged in water.

The Laboratory continues to present RTI lessons to high school teachers under the auspice of the American Physical Society. The Laboratory also presented a workshop to about 30 teachers at the High School Science Teachers Day at the annual Plasma Physics Meeting in November 1998 at New Orleans. Los Alamos has trained additional "Rayleigh-Taylor presenters," including the lead science presenter at the Bradbury Science Museum, who now gives RTI presentations regularly.

# Web of Learning

The Web of Learning program involves using the World Wide Web to distribute and continually upgrade educational materials among a community of students and educators. The program features two primary activities that are linked for a common purpose. First, the web site is a place where students, teachers, and others can find immediately useful information, activities and events that are currently in progress, or in development. The site is also a continuously updated virtual library, created on-the-fly by the activities and information that program participants contribute. For example, a contest helps Laboratory education program coordinators identify mathematically talented students. These students use the web site to help them prepare for the contest, while other students contribute information about mathematics to the site.

In other competitions, the Web of Learning challenges teams of students and teachers to write tutorials on specific subjects in mathematics and science. The best tutorials are posted on the web site. This pilot project is currently restricted to tutorials based on the innovative text, *Algebra through Problem Solving*, by Hillman and Alexanderson; however, plans include expanding the range of tutorials to include other branches of mathematics and scientific disciplines.

Discussion about the Web of Learning concept with others has generated interest and enthusiasm for partnering between the Laboratory and other institutions to "grow" the web site in breadth and depth. Other national

laboratories in the Department of Energy complex have expressed interest in the site and plan to link it. In addition, New Mexico State University is developing a web site that teaches mathematics through the understanding of cryptography; this site will become another resource on the Web of Learning site.

The Web of Learning is an ambitious project that has the potential to make a significant positive impact on math and science teaching in the U.S. Although the program is developmental, its progress to date and the interest it has generated in the concept are encouraging. An October 1999 press release about the Web of Learning and the Go Figure mathematics contest in the Four Corners area (the first sponsored activity) has generated interest at Los Alamos from scientists about contributing time for mentoring and tutoring students. This is the next step to making this virtual site a reality.

## Goals

The goal of this project is to provide an electronic resource that can be accessed by teachers, students, and others. The program addresses the following objectives:

- Give every student in the country access to an excellent education in mathematics and science
- Provide students a resource to study mathematics from a non-traditional and potentially more effective point of view
- Provide students a resource for exploring mathematical and scientific research
- Provide help on-demand for motivated students to move ahead at an accelerated pace
- Provide teachers a means to enrich math and science content for students who need it
- Help students who fall behind or are away from school for extended periods because of illness, injury, travel, etc.
- Provide teachers with a tool to evaluate learning
- Encourage wider acceptance and use of the mathematics and science education standards

## Implementation

In FY99, the Laboratory established the Web of Learning web site (http://set.lanl.gov/programs/learning/), including text from *Algebra through Problem Solving*, guidelines for the tutorial writing contest, and a sample tutorial. By conducting a math contest and using the problem set in the Web of Learning web site, program coordinators have identified a pool of students and teachers who can be invited to participate in future tutorial activities and other program features.

Seventy-five students participated in the Go Figure math contest, which was sponsored by Los Alamos and held at San Juan Community College in the Four Corners region of northwest New Mexico. Sandia National Laboratories also sponsored Go Figure contests in central New Mexico and California. The goal of Go Figure is to identify young people with talent in mathematics. These students are candidates for participating in the Web of Learning. Many of them may not demonstrate a latent ability in math in the usual ways and their talent goes unrecognized. Mathematics and algebra are the building blocks for all the scientific disciplines. Without this foundation, a student's opportunities are limited, so

spotting aptitude is important to their future.

These students accepted the challenge of a two-and-half hour test on problems that ranged from easy to very difficult. Many students said they enjoyed the contest and found it mentally stimulating and challenging. Some of the students were working on problems in the hall outside the classrooms even after they turned in the tests.

### *Partnerships*

An exciting addition to the Web of Learning site is the chemistry folder. Still a work-in-progress by its creator, visiting professor Dr. Jerry Easdon of the College of the Ozarks, this online learning tool was an important component of the science curriculum taught at two Teacher Opportunities to Promote Science (TOPS) summer institutes in 1999. As the TOPS teachers learned math and physical science content and teaching methods related to on-going Laboratory research, Dr. Easdon modeled the capabilities of on-line instruction by using the chemistry folder as he taught. Furthermore, teachers were able to access the folder independently to review lessons, get homework assignments, and explore related Internet resources.

The final products expected from the TOPS teachers at the end of the three-year program are on-line lessons of their own creation that they design, post on the web, and use in their classrooms in the same way they saw Dr. Easdon demonstrate in the summer course. Many of their lessons could later become part of the Web of Learning site as well, further expanding it. The chemistry folder in the Web of Learning is an outstanding resource for physical science instruction available to anyone with Internet access.

## Evaluation

The Web of Learning has now evolved beyond the proof-of-concept stage. The Laboratory is evaluating how well it has met its goals for the development of the site. The volume of visitors and activities generated on the Web of Learning, as the program goes into full production, will determine impact. Metrics will include problems submitted, tutorials developed, and the interest generated by the contests. The Laboratory will further assess impact and improve the program based on data collected from on-line surveys received from teachers and students.

# Student Support

## American Indian Community and Science Education Partnership

Nationwide there is a great concern that many American Indian students in particular are not achieving at their potential in math, science, and technology. Historically, they have scored very low on national standardized tests in these areas and therefore seldom choose careers in the fields of math, science, and technology—the heart of the work conducted at the Laboratory.

This is a particular concern to the Laboratory because Los Alamos is surrounded by many Indian pueblos that represent 12% of the population in northern New Mexico. Yet little more than 2% of the Laboratory workforce is American Indian. In addition, the Laboratory occupies historic Native American land and the tribes have long expressed concerns about the Laboratory's operations and environmental and cultural impact on their communities. If more Native Americans were employed here, their communities would have greater understanding of the work and mission of the Laboratory, and the Laboratory would gain a more diverse workforce within commuting distance.

The American Indian Community and Science Education Partnership (AICSEP) recognizes that American Indian high school students are the future leaders of their pueblos. Their science education and work experience today can greatly influence their relationship with the Laboratory tomorrow. They are important resources to the Laboratory, both for the future workforce, as well as for the development of literate, well-informed neighbors who contribute to, and understand, the day-to-day activities at the Laboratory.

AICSEP is a six-week, K–12 summer education program that provides a unique combination of applied science work and innovative science learning. By successfully partnering for two years with the Santa Fe Indian School's (SFIS) Community Based Education Model program (CBEM), Los Alamos offers AICSEP to enhance mathematics, science, and technology learning experiences for American Indian high school students and their communities.

The CBEM project has its foundation in pueblo involvement by engaging tribal communities in issues and problems related to the areas of science that are most relevant to their culture, environment, natural resources, and health. This educational model is unique in that the pueblos are directly involved in identifying the thematic issues for curriculum development and are called upon to be teachers and mentors when their children are conducting scientific studies in their communities. CBEM allows SFIS students to learn and use math, science, and technology experimentally toward a resolution of real-world community issues and problems. The

program further provides positive experiences in science and demonstrates its relevance to Native Americans' lives and cultures.

In AICSEP, each participating northern New Mexico pueblo, or Native American community, has a team of high school students and adult community supervisors who spend one day per week at the Laboratory, participating in tours, lectures, demonstrations, and hands-on activities for learning about physical science. Pueblo community leaders, elders, and others who want to learn and observe more about the Laboratory are also invited to accompany their teams on these visits.

The remainder of the week, the students serve as interns with their community supervisors, continuing baseline scientific studies begun during the previous school year through the CBEM program. An AICSEP program coordinator or teacher reinforces the science content of the Laboratory visits by going weekly to each pueblo for a discussion of the topics just covered at the Laboratory and to help the students relate those topics to the experiments they are conducting in their communities.

The combined efforts of the AICSEP partners permits SFIS and the Laboratory to achieve their goals together with greater benefit to the participants and their communities. AICSEP combines CBEM educational objectives with knowledge of physical science, particularly the history, work, and mission of Los Alamos. AICSEP provides the participating students summer employment at home, practical application and continuation of their school-year studies, and science education enrichment provided by the unique resources of the Laboratory. It also expands the concept of "community" beyond the borders of the pueblos and Santa Fe Indian School to include Los Alamos National Laboratory.

## Goals

The Laboratory's goals in creating and continuing AICSEP include

- Reaching more traditionally underserved students and teachers
- Increasing the number of minority professionals in math, science, and technology
- Encouraging and supporting systemic reform beyond the scientific community
- Fostering an understanding of the Laboratory's mission to maintain and safeguard the nuclear stockpile

SFIS implemented the CBEM program several years ago as an elective course of study to increase their students' academic interest and achievement in math, science, and technology.

## Implementation

After a pilot year in 1998, the second year of the AICSEP program took place for six weeks in summer 1999. The program supported three teams, one each from Santa Clara and Jemez Pueblos, and one from Cochiti Pueblo. Twenty students and educators participated: 12 were high school students (all Native Americans, 5 girls and 7 boys; all 16-19 years of age; 5 participating for the second time); 2 were CBEM educators (1 female Hispanic and 1 male Native American); and 6 were supervisors of pueblos (all Native Americans; 2 from each community; 2 female and 4 male). The teams visited the Laboratory one day each week and worked on scientific field studies in the pueblos the remainder of the week,

including a weekly visit from the AICSEP instructor.

Laboratory divisions make a substantial contribution to science education through AICSEP tours and presentations. In FY98, AICSEP made a notable debut due to the curriculum-planning partnership between the Laboratory's Science Education Team and the Nuclear Materials Technology (NMT) Division's diversity and outreach initiative. During the 1999 program, presentations at a one-day visit to NMT included a hands-on opportunity to experience working in a glove-box, making the FY99 AICSEP visit to the Nuclear Materials Site unique and rewarding.

AICSEP participants also attended workshops and tours at numerous Laboratory sites or groups including Bradbury Museum, Los Alamos Historical Museum, archaeology group, ecology group, Tritium site, and LANSCE. Laboratory specialists at these divisions, many of them Native American employees from the participating pueblos, volunteered their time and energy to provide content and process expertise to AICSEP.

In another component of the program, students on each team create an on-line presentation summarizing their AICSEP experiences. They presented them twice at the Laboratory, once for the Education Programs Office staff, guests from the Laboratory, and visitors from the New Mexico State Department of Education, and again as part of the Laboratory-wide Annual Native American Summer Students Presentations. The presentations were provisionally planned to be given throughout the 1998-1999 school year at numerous pueblo day schools to get younger children interested in the CBEM and AICSEP programs, and at pueblo community centers to inform the adults of the programs' activities.

## Evaluation

The Laboratory conducted a final evaluation through a four-page questionnaire completed by the participants during the last AICSEP Laboratory visit of the summer. Respondents rated each of the Laboratory presentations, tours and activities, as well as general program features, on a scale of 1 (little value) to 4 (most valuable). Highlights included the following:

- 91% indicated that they have an improved knowledge of physical science
- 75% said that they have an improved understanding of nuclear physics
- 85% reported an improved awareness of Los Alamos history.
- 100% said that they have a better knowledge of linear accelerators
- 85% indicated that they gained an improved knowledge of ecological contamination monitoring
- 100% said they have an improved awareness of job and program opportunities at the Laboratory
- 100% responded that they gained an improved understanding of the Laboratory's mission

A 1999 first-time AICSEP participant from Jemez Pueblo had much to say during his last visit to the Laboratory, including: "I felt like a detective coming here, exploring the Laboratory for myself and discovering it wasn't so mysterious after all—the Laboratory really cares about the same stuff we do… It was all pretty cool! LANSCE looks like a scene from Star Wars. I was so proud to have my own LANL badge to wear, because it

made me look and feel smart! I wish I could keep it."

Recent progress in Laboratory-pueblo relations shows many common interests and concerns, along with a desire for cooperative interactions to address and resolve issues. The Laboratory signed formal cooperative agreements with the Pueblos of Cochiti, Jemez, Santa Clara, and San Ildefonso to demonstrate a strong commitment to maintaining and strengthening relations. In addition, the U.S. Department of Energy has formal agreements with the same four pueblos.

AISECP addresses these commitments to improve tribal relations as it educates the current and future leaders of the surrounding pueblo communities of the work safely conducted at the Laboratory. AICSEP can get young people excited about a meaningful future in science while they still have educational options that can better prepare them for further study in science, or science-related fields. AICSEP participants also have opportunities to meet and learn from Native American Laboratory employees, and are thus more likely to believe that they themselves could be employed here some day, as well. AICSEP students become part of the Laboratory education database. It can assist them in finding part-time or summer employment at the Laboratory or participating in other Laboratory programs, which can aid them in obtaining some of the funds and motivation needed to pursue post-secondary education.

On August 6, 1998, President Clinton issued an executive order on "American Indian and Alaska Native Education" that recognizes the unique educational and culturally related academic needs of these groups. The order requires federal agencies to focus on six educational goals. Three of those six goals are common to those of the AICSEP Program: (1) improve mathematics; (2) improve science education; and (3) expand the use of educational technology. A task force was established by this executive order that includes representatives of the Department of Energy, which, through its Office of Defense Programs, funded AICSEP in FY98 and FY99. AICSEP is a successful science education program that allows the federal government to address many of the goals of the American Indian and Alaska Native Education executive order in a relevant and effective way.

# Critical Issues Forum

The Critical Issues Forum in FY99 focused on students' abilities to develop and examine concerns about issues surrounding the topic of nonproliferation of nuclear materials. This topic was chosen to actively engage students and teachers in an interdisciplinary area of study. Scientists at Los Alamos National Laboratory were able to interact with schools throughout the state via a Laboratory-maintained web site.

The Critical Issues Forum targeted high school teachers and students throughout New Mexico. Focusing on issues dealing with proliferation of nuclear weapons, students and teachers examined every facet of this complex subject using a number of resources, including Laboratory personnel. The teams researched the scientific, economic, social/cultural, and political domains of this critical issue and developed various

dissemination products, including games, focused on public understanding.

## Goals

The goals of the Critical Issues Forum are to

- Increase public understanding of the issues relating to the future of the nuclear world
- Develop the connections between scientific concepts and everyday life
- Increase understanding of the science process
- Provide opportunities to develop and apply critical thinking and problem solving skills to a complex problem of global significance
- Promote cooperative learning through successful teamwork

### *Links to Goals of Office of Defense Programs*

This program leverages the Laboratory's scientific capabilities and resources by integrating its core competency in nuclear materials management, stockpile support, and stockpile stewardship with the curriculum. The Critical Issues Forum supports the U.S. Department of Energy, Office of Defense Programs education mission by aligning with two of the Office's goals. The first Defense Programs education goal is to contribute to systemic improvement in science, mathematics, engineering and technology education. The Critical Issues Forum supports that goal by

- Developing partnerships between the Laboratory and the education community
- Providing educational access to Laboratory personnel
- Enlisting participation and support at the district, school, and classroom levels
- Increasing communication within and between schools
- Providing resources and technical support to schools and districts
- Providing electronic communications technology as one method of distributing educational materials to the public

### *Program Objectives*

The Critical Issues Forum supports the third Defense Programs education goal of enhancing scientific and technical literacy by

- Preparing teachers and students to use technology appropriate to the research topic
- Enhancing students' use and understanding of science research methods
- Providing enrichment opportunities for students and teachers through research, workshops, and curriculum development

Within this framework of goals, the objectives of the Critical Issues Forum are to

- Increase content understanding in the science

and history of nuclear materials and security safeguards
- Increase public understanding of safeguarding nuclear materials
- Increase teacher and student understanding and use of telecommunications with computers
- Model the use of technology for research purposes
- Demonstrate how to research a complex critical issue in depth
- Increase content understanding by using a problem-based approach to learning science
- Model the scientific process
- Promote successful teamwork through cooperative and collaborative learning

## Implementation

During FY99, students and teachers applied to the program as research teams. Each team participated in regional workshops throughout New Mexico. The representative schools supported the program by providing administrative resources and participation. They also provided the students with an academic credit for completion of the program. Program quality was assured through workshops, site visits, benchmarked curriculum, and student-developed products.

### *Workshops*

The Critical Issues Forum was designed to match Laboratory expertise with the needs of high schools in New Mexico to provide a unique educational opportunity tied to the DP Mission. Los Alamos National Laboratory program staff met with teachers and students in a series of workshops to develop and promote an effective curricular approach. The workshops demonstrated effective instruction for students and teachers in process and content, and the application of resources that required teams of students to sharpen their critical thinking and problem solving skills on a current real world problem of global concern.

Laboratory program coordinators visited each participating school twice during the academic year. This provided an opportunity for program staff to interact with students, teachers, and administrators in their school setting. This also helped to ensure that students had access to computers and other necessary resources, that they were provided with time to pursue the critical issue, and that any on-site problems relating to the program were addressed.

Teams were required to demonstrate their learning and understanding through completing various benchmarks that combined content information, critical thinking, problem-solving skills, and telecommunications.

Each team produced dissemination products based upon their work on the topic. The students examined a specific real-world problem supported by the Laboratory's Nonproliferation and International Security Division. They worked to formulate group consensus and prepare recommendations in a format of their choice, such as games, posters, PowerPoint presentations, and documentary videos that were demonstrated at the Student Conference on the Nuclear World held in Los Alamos last spring.

The program also featured workshops at Los Alamos for teachers. The first helped six teachers continue developing classroom activities that supported the curriculum for this year's topic of "Nonproliferation versus Proliferation in

the Nuclear World." A second workshop brought 19 New Mexico teachers representing 14 high schools. The teachers engaged in using the curriculum as well as establishing the network that would be utilized in the program, which included Los Alamos scientists acting as electronic mentors. They attended this workshop and offered a varied cross-section of opinions and experiences within the non-proliferation issue.

The Critical Issues Forum kicked off the spring semester with 3 regional workshops held around the state. The Southern Region was held at New Mexico State University in January 1999. Three schools attended (New Mexico State University, San Andres HS, Alamogordo HS) bringing 40 students and 7 teachers/administrators. The Northern Region was held at Albuquerque Technical Vocational Institute, with 7 schools participating (Menaul High School, Sandia High School, Rio Rancho High School, Rio Grande High School, Los Lunas High School, St. Bonaventure High School, Career Prep High School) with 56 students and 13 teachers/administrators. The Eastern Region was held at Eastern New Mexico University, with 4 schools attending (Clayton High School, Floyd High School, Ft. Sumner High School, Tatum High School) bringing 32 students and 4 teachers/administrators. The workshops had a total of 153 participants comprising 128 students and 25 teachers/administrators.

A Mentor workshop at Los Alamos introduced web-based constructions for answering student questions and for using the mentor resource areas in the Critical Issues Forum web site. This training session was held in conjunction with the Laboratory Public Affairs Office and Operations Security Office, which provided material and discussion items relevant to all Laboratory staff members who participated as mentors this year.

Students demonstrated their accumulated knowledge at Los Alamos by participating in the Student Conference on the Nuclear World, which served as the culminating activity for the 1999 Critical Issues Forum. Students throughout the state of New Mexico, and some from California and Washington, came to the Laboratory in May to deliver

| Demographics of Participants in Critical Issues Forum | | |
|---|---|---|
| Gender Breakdown: | | |
| Male Participants | 124 | 49.2% |
| Female Participants | 128 | 50.8% |
| Ethnicity Breakdown: | | |
| Caucasian | 132 | 52.4% |
| Minority | 120 | 47.6% |
| Hispanic | 91 | 36.1% |
| Native American | 22 | 8.7% |
| Asian American | 4 | 1.6% |
| African American | 3 | 1.2% |

multimedia presentations on the topic of nuclear proliferation.

The Critical Issues Forum in the summer hosted 14 high schools and New Mexico State University in New Mexico with participation by 202 students and 50 teachers, administrators, and technology coordinators. There were also 8 high schools participating in cooperation with Lawrence Livermore National Laboratory, which included 2 high schools in Washington state, 1 in Oregon, and 5 in northern California. Four high schools participated in Sarov, Russia. The approximate overall student enrollment was approximately 350, and the overall participant involvement was approximately 425, up from 269 in FY98.

The participants used the Laboratory-developed curriculum based on Nonproliferation versus Proliferation in the Nuclear World. Fourteen of the 15 participating schools in New Mexico scheduled a class devoted to Critical Issues Forum that met daily or regularly for at least 5 hours per week in an Internet-ready classroom or facility.

## Evaluation

The evaluation was composed of both formative and summative strategies, including monitoring use of the Internet and an analysis of student products. This analysis includes student developed position papers and presentation materials that determined the extent to which the students developed their critical thinking skills and their abilities to work cooperatively in teams. A variety of evaluation tools measured how well the program met its objectives. These tools included process feedback forms, student surveys, teacher surveys, student written papers and oral presentations, evaluation of student products, and observations by program coordinators.

Careful review of the teacher and student surveys showed the Forum succeeded in meeting its overall goals. The students enjoyed interacting with each other within their schools, as well as meeting students from other schools. Teachers generally agreed that the students learned a lot about the topic, as well as how to work in cooperative learning groups and how to prepare presentations.

In evaluating the program, students and teachers showed significant positive increases in the following areas:

- Understanding of nuclear materials
- Content understanding in the monitoring of nuclear materials
- Understanding of telecommunications
- Use of technology for research purposes
- How to research a critical issue
- Ability to use the computer to communicate and share information with others
- Ability to research a complex issue in-depth
- Use of concept mapping
- Understanding of content by using a problem-based approach to learning science
- Small group work

One teacher commented that the Critical Issues Forum had “profoundly influenced my teaching career in each of the areas of pedagogy, technology, and science.” Another said, “My involvement with Critical Issues Forum has reestablished the need to look at education holistically. Nothing exists in a vacuum. Issues in social studies are driven by science the same as science is driven by social studies.” A third said that the program allowed “me to challenge the student. We will never again do a ‘class’—it will be independent study from now on.”

Critical Issues Forum also had an effect on teaching and learning within the participating schools. For example, at Clayton High School in northeastern New Mexico, the teacher's role shifted to using many of the techniques from the Critical Thinking Curriculum Model (CTCM) that forms the basis of the Critical Issues Forum. The student concept maps generated at the regional workshop were displayed on the walls of the classroom. The maps demonstrated a definite transition from teaching methods used before the workshop to methods used as a result of the workshop. Prior to the workshop, student maps were linear and had an outline form. Students were separated in distinct groups to tackle the benchmark assignment. The maps generated by students after the workshop demonstrated a transition to more collaborative activity. These maps merged into one composite map with the entire class taking part in the development of a single response to the benchmark task, as is intended by the CTCM design.

Another example was at San Andres High School, an alternative high school in Las Cruces, New Mexico. The teachers and students were very comfortable using technology in the classroom and the students were expected to use the technology as part of the Critical Issues Forum class. The Critical Issues Forum instructors coordinated with the computer teacher so students were able to develop needed computer skills in the fall semester before engaging in the Critical Issues Forum curriculum in the spring.

# Explorations in Energetic Materials Science and Technology

The Explorations in Energetic Materials Science and Technology pilot project provides opportunities for students and teachers to participate in scientific research activities related to energetic materials and mechanisms to learn about career opportunities in science. The prime focus of this educational project is to establish long-term interactions between students and teachers in the region and researchers in the High Explosives Science and Technology Group at the Laboratory. The program targets Northern New Mexico middle school and high school students and their teachers. This approach has the dual benefit of building a diverse local workforce for the future and enhancing public appreciation of the Laboratory's national mission. As planned, most of this year's effort occurred during the last half of the fiscal year. The Laboratory accomplished its Phase 1 milestones: completing the teacher summer research at the Laboratory, developing technical modules for classrooms, and creating an extensive educational web site. The Laboratory plans to implement Phase 2 in science classrooms during FY00.

## Goals

The goals of the program are to

- Stimulate student interest in science/engineering,

particularly in energetic materials
- Provide role models in chemistry, physics, engineering, and computer science
- Mentor students interested in pursuing scientific and technical careers
- Educate students about academic programs, technical career opportunities, and Laboratory student employment programs
- Provide teachers with intensive, first-hand research experience
- Establish long-term relationships between teachers and Laboratory researchers
- Promote learning about the Laboratory throughout the educational community
- Convey a strong message that a technical career is an achievable goal for anyone with interest and motivation, and that scientists, engineers, and technicians comprise people of different genders, cultures, and ethnic backgrounds

The program supports the education mission of the U.S. Department of Energy, Office of Defense Programs by

- Developing a diverse workforce skilled in energetic materials science and technology to serve future nuclear weapons mission needs
- Encouraging students to pursue technical careers by improving the science curriculum in local and regional schools
- Strengthening relationships in Northern New Mexico by demonstrating Laboratory commitment to community service
- Promoting strong public support for the Laboratory and its mission by emphasizing its national security mission and role in “science serving society”

## Implementation

The Laboratory has developed intensive, ongoing relationships between two Northern New Mexico high school science teachers and High Explosives Science and Technology researchers at the Laboratory. These two outstanding science teachers were invited to participate in the Explorations in Energetic Materials project. Selection criteria for the core teachers included demonstrated teaching excellence; documented record of accomplishment; innovation and creativity in curriculum development, and a diverse student population.

*Dana Rodda, a Santa Fe secondary school science teacher, checks a sample mount in a high-pressure combustion chamber used to measure burn rate and flame propagation. Photo by John Bass*

The participating teacher from Santa Fe Indian School teaches chemistry, physics, and other physical sciences. She teaches Native American male and female students, primarily high school juniors and seniors. This teacher is both a Native American female role model and an outstanding science

teacher. Her goals are to encourage more of her students to attend college and to consider technical careers. In addition, she is adding more rigor to the science curriculum by replacing some of the nonmathematical science "overview" courses with college preparatory courses. She also leads the American Indian Science and Engineering Student (AISES) group of 30 students. Prior to working on this project, she had been a two-year participant in the Los Alamos Teacher Opportunities to Promote Science (TOPS) program.

The other participant teaches chemistry, physics, geology, and mathematics at Santa Fe Secondary School. She is a founder of the school and teaches multi-age coeducational classrooms. She is a creative and interactive teacher who incorporates risk assessment and societal issues in her teaching. Although virtually all of her students attend college, her goals are to encourage more to consider technical courses of study. Santa Fe Secondary provides a progressive educational experience for those seeking an alternative to public and parochial schools. These diverse and talented students benefit from this flexible, intense, and intimate school setting. The primary criterion for acceptance at the school is a demonstrated desire and commitment to attend Santa Fe Secondary.

Both teachers held summer research positions at the Laboratory in the High Explosives Science and Technology Group. The teachers were hired under Laboratory guest agreements.

### *Original Research in Energetic Materials*

The core teachers worked with Laboratory researchers (including technical staff members, technicians, postdocs, and Laboratory students) on projects supporting the Laboratory's energetic materials research mission. The teachers built technical expertise that will allow them to incorporate first-hand laboratory research experience into the science classroom.

The Santa Fe Indian School teacher conducted original research on the synthesis and formulation of high nitrogen energetic materials (explosives, propellants, and pyrotechnics) with the High Explosives Chemistry Team (which won a 1998 R&D 100 Award for low smoke pyrotechnics). The teacher

- Learned principles relevant to pyrotechnics and high explosives (i.e., oxygen balance, sensitivity, and spectral characteristics)
- Formulated and fired "smokeless" pyrotechnic devices (gerbs and star mines)
- Synthesized a variety of tetrazine molecules as intermediate compounds for a new high explosive (calculated to be safe and to have high performance)

The Santa Fe Secondary School teacher conducted original research with the High Explosives Physics Team on the combustion properties of two nuclear weapons high explosives, HMX and TATB. Her research focused on burn rate measurements and on critical pressure measurements of combustion propagation in cracks. Collection of these original data supports current efforts to model high explosives combustion and detonation.

The teacher

- Learned concepts in high explosives combustion (i.e., pressure effects, gap effects, and crack propagation)
- Prepared high explosives samples and obtained high-speed video images, pressure

data, and other diagnostic data to track the progress of high explosives sample combustion.
- Analyzed data to extract both burn rate and its pressure dependence.

### *Development of Energetic Materials Science Units*

Teachers and Laboratory researchers have developed innovative science curriculum units for the high school classroom. These units, along with science kits, will be used in the classroom during the 1999-2000 school year by the research team (the teacher, technical staff members, and technicians). The research team is working with the Laboratory Science Education Team to ensure the curriculum is consistent with modern teaching methods and with state and national standards.

### *Science Unit Components*

Each of the two science units consists of three technical modules designed to exemplify the scientific method as practiced by chemists, physicists and engineers:
- Preparatory activities (fundamental principles, literature search, hypotheses)
- Classroom presentation with Laboratory researchers (physical demonstrations, hands-on experiments, interactive computer presentations, video presentations)
- Follow up activities (data analysis, data manipulation, calculations, potential experiments, related research, real world applications, technical career options)

**Unit 1–Energetic Materials Combustion.** The combustion unit will include burn rates, pressure dependence, materials properties, experimental configuration, explosives behavior, optical diagnostics, and laser diagnostics.

**Unit 2–Energetic Materials Chemistry.** This chemistry unit will include flame chromaticity, visible electromagnetic spectra, fuels and oxidizers, oxygen balance, detonation velocity, materials sensitivity, and high nitrogen chemistry.

### *Full-spectrum Science Education Web Site*

The Laboratory has created a web site that contains information on science classroom activities, elegantly simple experiments, laboratory safety, teacher resources, and technical careers. It provides an educational model that builds on Michael Faraday's approach to scientific discovery. In his classic book *The Chemical History of a Candle*, he states, "There is no better, there is no more open door by which you can enter into the study of natural philosophy than by considering the physical phenomena of a candle." This is an elegant starting point to explore the science of combustion and the physics and chemistry of energetic materials. The "candle" section provides a web-based innovative education model that illustrates the scientific method. The model structure is content neutral so that it can be used for any science (or other) curriculum. Web site navigation and overall design are complete, as is the initial content. The Laboratory will continue to add content throughout Phase 2.

The High Explosives Science and Technology Explorations web site utilizes an educational model that follows contemporary research and administrative protocols. While the site is an excellent source for classroom

activities and science content related to chemical combustion, its strength lies in the integration of the educational model with the classroom explorations and a visit from Laboratory High Explosives staff. After the site has been completed and approved, anyone can access it at http://set.lanl.gov/programs/DX2.

A fully participating classroom would be seeking a visit by High Explosives researchers. The visit structure developed in Phase 1 consists of a series of demonstrations on combustion and confinement; an inquiry-based dialogue on combustion chemistry; and a presentation on career opportunities at the Laboratory, particularly in energetic materials science.

In order to qualify for a visit, a participating classroom must complete scientific explorations in an inquiry-based, constructivist manner. These activities, which are clearly defined on the web site, are followed by the submission of a proposal for a classroom visit from High Explosives researchers. The proposal must include a report on the results of classroom investigations resulting from the explorations and a focused description of what they intend to learn from the visit itself. Finally, in cases where the true flavor of the educational model is captured by a classroom, ongoing contact with High Explosives staff is anticipated. This ongoing contact could be as simple as electronic mentoring or as extensive as employment. The web site offers a more complete delineation of the scientific explorations, the educational model, the direct links to the National Educational Standards, and classroom safety.

In Phase 3, anticipated for January to September 2000, plans include evaluating and refining the initial Explorations pilot project, selecting two additional core teachers, conducting a teacher summer research program at the Laboratory for the four core teachers, and producing a final report on the Explorations in Energetic Materials Science and Technology pilot.

During 1999, Explorations director Judith Bannon Snow presented “Explorations in Explosives: A Science for Everyone,” at the New Mexico Network for Women in Science and Engineering Technical Symposium and “Explorations in Energetic Materials,” at the Students and Mentors Meeting, Dynamic Experimentation Division of the Laboratory.

## Fulfilling the Educational Needs of the Nuclear Future

The Fulfilling the Educational Needs of the Nuclear Future project has established a unique undergraduate- and graduate-level course focused exclusively on the molecular chemistry of the actinide elements. The program, which is fully accredited by the University of New Mexico (UNM), features both a lecture course and selective research fellowships, and is coordinated through the Seaborg Institute for Transactinium Science (ITS). The lecture course was presented twice, once during the spring semester at UNM and again during the summer at UNM–Los Alamos (UNM–LA). The lectures provide an introduction to the chemistry of the actinide elements—an area which is frequently overlooked in most undergraduate and graduate courses. The 12-week

summer research fellowships entail participation in both the lecture course and an independent research project.

The Laboratory intends to expand the scope of the program to the point at which students will be able to take fully-accredited courses not only in f-element chemistry, but also in closely allied subjects such as radiochemistry, environmental actinide chemistry, and interfacial actinide science.

## Goals

The program's aim is to develop an internationally recognized educational program that will

- Act as a national resource for the teaching of actinide chemistry
- Complement Lawrence Livermore's summer school program in nuclear chemistry
- Provide a vehicle for recruiting the next generation of actinide scientists and engineers

This program is designed to be a pilot-level project that will lead to establishing a number of similar educational curricula in related disciplines, such as materials, interfacial, and environmental aspects of actinide science. At the conclusion of the course, the students acquire a greater appreciation of the diverse role of actinide chemistry in nuclear energy and national security. With this insight, together with the introduction to the extensive research facilities available at the U.S. Department of Energy national laboratories, Los Alamos hopes to stimulate talented young researchers toward a career in actinide or nuclear science.

The recruiting-related goal of this program is important to developing the work force needed at Los Alamos. The nuclear weapons mission of both Department of Energy, Office of Defense Programs and the Laboratory is to ensure confidence in the safety, reliability, and performance of US nuclear weapons without nuclear testing. In the absence of nuclear testing, this requires a science-based approach to stockpile stewardship. Decisions must be made based on sound technical understanding and expert judgment developed through theory, experiment, and simulation. Therefore, one of the principal long-term issues facing the Defense Programs laboratories is maintaining the quality of their scientific staff.

Of grave concern is that a large fraction of Laboratory staff could retire within the next decade (40% of Los Alamos technical staff are aged 50 or older), and their expertise and knowledge must be transferred to a new generation. From this perspective, "Modern f-Element Chemistry" is one of the crucial components of the science and technology needed to reconstitute an underground nuclear testing or nuclear weapons production capability. It is sobering to recognize that virtually all of the Laboratory's new hires over the past 20 years lack formal training in either this discipline or "Nuclear and Radiochemistry." The Nuclear Future educational program is designed to provide overlap to transfer this corporate knowledge to current Laboratory and Department of Energy staff, and to build a scientific base for future programmatic success.

## Implementation

Los Alamos has implemented the Nuclear Future program in three separate phases (1) a spring semester lecture course at UNM, (2) a summer lecture course at UNM–LA, and (3) the sponsoring

of research fellows in actinide science during the summer of 1999. Each is described below.

### *Spring Semester Course*

The spring semester course at UNM in Albuquerque, called "Modern f-element Chemistry," included "Special Topics" lectures, during which Laboratory scientists traveled to UNM to give presentations in their specialist fields: environmental chemistry, radiochemistry, and surface science.

### *Summer Lecture Course*

The Laboratory arranged with the registrar at UNM–LA to add the "Modern f-element Chemistry" course to the summer schedule for graduate and undergraduate credit. The course was taught in a classroom equipped with videoconference facilities. The signal was sent to the Waste Management Education and Research Consortium (WERC) site at New Mexico State University and then re-broadcast from there via satellite to UNM-Albuquerque, the New Mexico Institute of Mining and Technology, and the Carlsbad Environmental Monitoring and Research Center.

The Laboratory also distributed an announcement of the summer course to the students, post-docs, and technicians who work within the Chemical Science, Nuclear Materials, and Materials Science divisions at the Laboratory. The course announcement was also posted on both the student and post-doc pages on the Los Alamos web site so that it was seen by all incoming students this summer. The Laboratory had an extremely positive response to the course announcement from many employees; a significant number registered to take the course.

### *Research Fellowships*

After a nationwide mail distribution, the Laboratory selected four Seaborg Institute Research Fellows who arrived at the Laboratory at the end of May. The Research Fellows comprised one junior and one senior undergraduate, and one second year and one third year graduate student. The Research Fellows were at the Laboratory for 11-14 weeks. They attended the "Modern f-element Chemistry" course and performed independent research under the guidance of Laboratory scientists. The Research Fellows all had an extremely productive summer at the Laboratory, and there are currently seven manuscripts in preparation.

The research fellows' work is described below:

- Examining the coordination geometries of lanthanide metals within the framework of new Schiff-base ligands.
- Synthesizing carbonate complexes of the lanthanide elements as models for the behavior of actinides in carbonate-containing environmental groundwaters.
- Performing theoretical calculations to determine the possibility of preparing novel complexes which contain a direct actinide-actinide bond.
- Studying the mechanism of samarium-mediated reduction of aromatic nitro compounds to anilines.

Under the sponsorship of the Seaborg Institute, two-day short courses in radiochemistry were presented at the Laboratory in April and again in July. Both courses were heavily over-subscribed, with over 100 applications being received for the 70 available places. The level of interest shown in the subject led

the Laboratory to approach UNM–LA to propose adding a full-length 3-credit hour course in radiochemistry to their syllabus.

Institutions represented by students attending "Modern f-Element Chemistry Courses" include UNM, UNM–LA, New Mexico State University, New Mexico Institute of Mining and Technology, Wake Forest University, Virginia Polytechnic Institute, University of Memphis, Vanderbilt University, Ohio State University, Penn State University, and Tuskegee University.

## Evaluation

A combined total of 48 students registered for the spring and summer courses. Such was the interest in the course that enrollment had to be closed after 28 local students had registered for the summer course, simply because no more room was available in the teleconference classroom. In addition to the students enrolled at UNM–LA, local Albuquerque and distance-education sites coordinated through either the UNM or WERC systems led to the registration of 8 students from UNM's Albuquerque campus, 8 students at New Mexico Tech in Socorro, and 4 students at the Carlsbad Environmental Monitoring and Research Center. This course attracted a diverse audience representing a number of ethnic and minority groups. Of the students enrolled, 25 (52%) were female, of which 6 represented minority groups such as Hispanic and Asian.

In order to continually improve the quality of the program, feedback from both UNM course surveys and custom-made course evaluations is being employed. These surveys seek input on the specific course topics, potential interest in additional classes in future years, the attitudes of the students toward actinide chemistry, and the possibility of career plans within actinide or nuclear science. In addition, the Laboratory is compiling complete listings of e-mail addresses of all students participating in the courses, in order to track the future educational or employment endeavors of the students. This will enable the Laboratory to judge the potency this program has in stimulating interest among young scientists in the Nuclear Future.

Feedback from these post-course surveys has been extremely encouraging. Over 90% of respondents indicated that they would be interested in taking further courses in some area of actinide science, and there was also a strong indication from current Laboratory employees that the "f-element chemistry" course had helped them in their daily activities. Thus, in addition to acting as a resource to attract outstanding students to careers in actinide science, the program also has a significant role to play in the career development of current Department of Energy employees.

# Historically Black Colleges and Universities (HBCU)

The Historically Black Colleges and Universities (HBCU) Program at Los Alamos National Laboratory moves toward the year 2000 with the commitment to assist with increasing diversity in scientific, managerial, and technical ranks both within the Laboratory and throughout the nation. Nationwide, nearly 4,000 graduate science and engineering students enrolled in HBCUs in 1995, a 72 percent increase between 1985

and 1995. Most were African Americans. Working with this population is critical to creating a diverse population at the Laboratory. According to one of the Laboratory's program mentors, these students represent "hidden or under-appreciated talent." To keep them hidden and out of unique research initiatives is no longer an option. Thus, the success of this program depends on the openness of this Laboratory research community, and strong commitment from campus administrators, to encourage students to venture in this direction.

At Los Alamos, the HBCU program recruits students and faculty to serve as research interns in divisions throughout the Laboratory that serve the goals of Stockpile Stewardship. Program participants receive full-time appointments ranging from 10 weeks to one academic semester or year. Undergraduate and graduate students and faculty are recruited from HBCUs from a variety of scientific and technical areas of study. These include mechanical, chemical, and electrical engineering; computer science; statistics; mathematics; physics; material science; and chemistry.

Undergraduate students find the Laboratory research experience helps them to realize exactly where their research interests lie as they contemplate and plan for graduate school. Graduate students find unique and extraordinary research opportunities to expand thesis or dissertation research while in the national laboratory environment. This is one way a university partnership is established to achieve a continued student relationship.

Faculty use their summer or research sabbatical as an opportunity to enhance their campus curriculum and introduce new information in specific research and classes. This connection with Los Alamos also enhances future opportunities for their students and research advisees. This, in turn, creates awareness within the HBCU student population toward career planning in the national laboratory environment.

## Goals

The goals of the HBCU program at Los Alamos are to enhance career prospects of graduates of HBCUs and to further enhance research capabilities of faculty at HBCUs, with the ultimate result of increasing the numbers of graduates with degrees in science, engineering, and technology.

These goals have not changed since the program began at the Laboratory in 1984. However, they have been extended to create more student and faculty participation in the Laboratory's scientific community. Not only are research internships arranged for the summer, they are also offered to students during the academic semester or year. This opportunity offers the student the unique capability to compile data for thesis research or to spend a year at the Laboratory upon completing the B.S. degree in a post-baccalaureate status. This avenue further offers the student experience in the Laboratory and creates more of a unique offering of that student in the graduate school process.

## Implementation

As stated earlier, partnerships serve as an essential component toward the success of incorporating minorities into areas where there have been small numbers in the past. The Laboratory is establishing the following partnerships to

increase the population of African American students and faculty in the Laboratory-wide scientific, managerial, and technical ranks.

### *University Partnerships*

The Science and Technology Base Programs Office is working with the University Programs Office to establish Memorandums of Understanding (MOUs) with targeted majority schools with high matriculation of graduate students from HBCUs. This specific partnership will serve to ensure talented students from HBCUs will have continued access to the Laboratory. HBCU students matriculating into majority institutions for fall semester graduate study have had to turn down offers to conduct summer research at the Laboratory. This happens because some doctoral programs require students to report to campus for the summer. To avoid breaking that connection made with students at HBCUs at the undergraduate level, an MOU is necessary to work collaboratively with the students' campus advisor toward collecting thesis and dissertation data at the Laboratory for a summer, academic semester, or year.

### *Mentoring*

National and world-renowned scientists direct projects and volunteer as mentors, thus providing students and faculty with unlimited career experience and graduate school advantages. The mentors often serve as future graduate school references for students and help place students in professional positions. The mentors also provide HBCU faculty with a research contact in the Laboratory.

Without mentors this program would not be successful. Based on research conducted with the Laboratory's scientists, student and faculty researchers are provided the unique opportunity to report their scientific research results, not only at professional conferences and symposia, but at the annual Department of Energy, Office of Defense Programs Summer Student Symposium initiated by Los Alamos in the summer of 1998. This symposium moves around within the three defense laboratories: Los Alamos, Lawrence Livermore, and Sandia.

In FY99, 16 young researchers represented 11 HBCUs. These eleven campuses include Bethune-Cookman College (FL), Clark Atlanta University (GA), Florida A&M University (FL), Hampton University (VA), Howard University (DC), Lincoln University (PA), Morehouse College (GA), Norfolk State University (VA), North Carolina A&T State University (NC), North Carolina Central University (NC), and Xavier University (LA).

Student breakdown was 12 undergraduates and 4 graduate students in the following majors: chemistry, chemical, computer and mechanical engineering, computer science, mathematics, and physics.

In addition to 16 young researchers, the HBCU Program boasted the strong contributions and mentoring of 4 faculty. Faculty further serve as mentors to students they select from their various campuses to spend the summer conducting research at the Laboratory. This creates a strong research relationship between the faculty member, the student, and the Laboratory mentor.

### *Student Development*

**Academic Development.** The University Programs Office provided classes at the UNM–LA campus to enhance the student's academic and professional development. The two classes were Resume Writing & Interviewing and Technical Presentations. The Los Alamos campus worked collaboratively with the

Laboratory's University Programs Office to ensure student success at the end of the course. Teaching instructions and course materials were provided with the cooperation of the Continuing Education Office. Along with the classes offered through the Laboratory, some students took courses on their own to accrue credit hours over the summer that would count toward graduation.

**Social Development.** The University Programs Office takes great care to ensure students have a well-rounded summer experience. Specific to the University Programs Office, a guided, historical tour of Northern New Mexico is always popular. However, on their own, students visited Bandelier National Monument; White Sands; Juarez, Mexico; and many more tourist spots unique to the state of New Mexico. In addition, the Laboratory's Student Association planned events each week in the evenings and on the weekends. Along with the planned activities with the Laboratory's Student Association, mentors and church organizations are very open to inviting students to their planned events.

## Evaluation

Student and mentor evaluations are designed using a scale of 1 to 5, with "Strongly Disagree" being 1, and "Strongly Agree" being 5. An average rating is determined and that rating is turned into a percentile, with a 100 percentile meaning all respondents gave that particular question the highest possible rating.

The evaluations completed by the HBCU program participants indicated their overall satisfaction and the positive benefit of the summer experience at Los Alamos National Laboratory. Many of the students gained greater insight into their chosen major and future career expectations. The majority of the students who completed the evaluations expressed a great interest to return the following summer.

# Los Alamos Summer School

The Los Alamos Summer School, a joint program of the University of New Mexico (UNM) and Los Alamos National Laboratory, completed its tenth full year in FY99. The school targets upper-level undergraduate students, who will soon be making career choices, and recruits nationally to gain the most diverse possible class. The school gives students an intense exposure to basic research by concentrating on many fascinating areas of physics, both through lectures by distinguished scientists on the latest developments and through mentored term projects.

These areas include such diverse disciplines as astrophysics; biophysics; and condensed-matter, plasma, atomic, molecular, optical, and weapons physics. The school also seeks to teach certain basic physics skills not commonly emphasized in the university curriculum, introduce high performance supercomputing, and foster personal interactions between research scientists and students. A knowledge of the workings of scientific research, of the frontier discoveries, and of the newest computer techniques will greatly aid students, no matter what their ultimate career choice. For the past seven years, the school has been funded by a National Science Foundation, Research Experience for Undergraduates site grant to UNM. It also has been funded by the Science Education Programs at the Laboratory through a U.S. Department of Energy, Office of Defense Programs grant. In addition, the school receives in-kind support from the Theoretical Directorate at the Laboratory, the UNM Center for Graduate Studies, and the Department of Physics and Astronomy.

The School began as an internally funded project within the Los Alamos Weapons Program to encourage greater participation by outstanding students in theoretical physics research, deemed vital to many Defense Programs missions. While the advent of the Research Experience for Undergraduates component six years ago has broadened this mandate to include applied research science in general, the goals remain aimed at many aspects vital to Defense Programs initiatives and Laboratory core competency areas. The long-term efficacy of such programs as Science-based Stockpile Stewardship and the Accelerated Strategic Computing Initiative depend critically on recruiting highly talented young scientists into various Defense Programs research projects. The School fosters such recruitment through contact with Defense Programs program personnel in lectures, research projects, and tours as well as through supercomputing projects. In past years, the school has furthered such contacts through special lectures on science and weapons. This year, the two-day, all-Laboratory weapons and security program substituted for this activity.

## Goals

The goals of the school are to

- Expose students to basic research in physics
- Help students acquire certain basic physics skills not

commonly emphasized in the university curriculum
- Introduce students to high-performance supercomputing
- Foster personal interaction between research scientists and students.
- Acquaint students with the processes of scientific research and with frontier discoveries.

## Implementation

The session divides into two complementary activities involving lectures and a mentored student research project. First, the lectures focus on current "hot topics" in the field of physics, motivated from the speaker's own research projects. The lecturer introduces basic physical concepts from the perspective of ongoing research endeavors. This mode of presentation gives the students an opportunity to participate in new investigations.

Second, each student works on a research project for the whole summer term. A mentor from the senior scientific staff of the Laboratory or UNM oversees and guides the student through this endeavor. A variety of projects are available; many center heavily on high performance supercomputing. The mentors carefully craft each research project to fit the background of the student to guarantee the greatest and most effective participation. This dual track of lectures and research best stimulates the students in an active interest in science and avoids the pitfalls of a program devoted exclusively to one track or the other.

For 1999, the Laboratory and UNM extended the duration from 8 to 10 weeks, still basically concurrent with the UNM summer semester. This extension came at the behest of students and mentors, who felt the extra time led to more productive projects. The students received three hours of course credit from UNM as Physics 501. This credit has been readily transferred to home institutions and, in many cases, has substituted for a senior research project. The school held the lectures in the mornings and reserved afternoons for research, attempting to strike a balance between these two activities. Classes and research sessions were conducted on the campus of UNM at Los Alamos; the UNM computer center has a fast link to the Laboratory network while providing powerful local capabilities. The common class and computer rooms as well as the close proximity within student housing all encouraged a natural cohesiveness within the class. School directors further fostered this class spirit with tours of Laboratory facilities and of local points of interest and activities. The friendships made during the course of the school form an important, enduring feature of the program, as noted by almost all students, past and present.

While this basic formula has served the School admirably so far, the Laboratory and UNM continue each year to experiment with new educational projects and approaches. These experiments function on a small enough scale not to endanger general student performance, yet with a broad enough scope to provide reasonable extrapolation. For this past year, the school developed an extended tutorial concept based on a single topic—the rapidly evolving field of Quantum Information. The school also included a formal class in technical writing in addition to sessions on the role of science in society. These educational experiments serve each term to reinvigorate and challenge the school anew.

### *Organization*

Reflecting the dual nature of the sponsorship, the school is run by co-directors. Each takes responsibility for particular tasks in operation and organization, based on resources, personnel, and location. For example, UNM has excellent facilities and staff at its several locations to handle the vital task of recruiting and to provide classroom and computer access. On the other hand, the Laboratory has the on-site technical staff from which to draw the mentors and lecturers.

### *Mentored Research Project*

In 1999, 17 students from universities in 16 states participated in the combined curriculum of lectures and individual research projects. The school had its largest participation of mentors to date, representing 5 different Laboratory Divisions and 12 Groups. Seventeen projects, supervised by 22 mentors, covered such diverse areas as quantum computing, solitons in Bose-Einstein condensates, controlling chaos, and the phase of the early universe. Four women scientists served as mentors, which provided excellent role models for the students.

All students submitted detailed final reports, crafted along the lines of a standard scientific paper, on their research accomplishments. The papers have been bound into a Laboratory publication (LA-UR-99-5455) for general distribution.

The main emphasis of the school centers on the research experience, giving the students a taste of a hands-on technical project. The span of the program remains generally too short for the production of a finished, polished, and publishable piece of scientific research. However, several of the students plan to continue work on their projects, either as independent endeavors or as a part of their senior research course at their respective institutions. The directors anticipate publications in refereed research journals from these continuing efforts.

The topics for research projects are listed below:

- Quantum Jumps in Strontium
- Phase Transitions in the Early Universe
- Quantum Tunneling in Multiphoton Processes
- Spin Lattice Simulations with Microcontrollers
- Solitons in Bose-Einstein Condensates
- Alignment-Orientation by Elastic Scattering
- Weak Parity Non-conserving Interactions
- Solid State Quantum Computer
- Far-from-equilibrium Statistical Mechanics
- Molecular Dynamics Simulations: Metal Surfaces
- Ion Addressing in Quantum Computers
- Acoustic Measurements of Turbulence
- Penning Fusion Experiment
- Relativistic Heavy-ion Detector
- Modeling of Diffusion of Oxygen from CeO2
- Josephson Plasma Resonance in Superconductors
- Controlling Chaos
- Acoustical Measurement of Atmospheric Turbulence

### *Lectures and Extended Tutorial*

In addition, the students attended a full set of lectures on an extensive range of topics as outlined below. These were presented by distinguished lecturers from outside universities and research organizations (Prof. W. Reinhardt,

Washington; Prof. J. Eberly, Rochester; Prof. H. Fearn, Cal-Fullerton; and Dr. J. Dowling, JPL), from UNM, and from the Laboratory (three Divisions and seven Groups). The school continued its strong participation from UNM, which highlights the important ties between the University and Laboratory generated by this program. The school also continues its strong and enthusiastic participation by the junior scientific staff at Los Alamos, mainly from postdoctoral fellows. This opportunity often provides their only experience in preparing and giving lectures to a student group.

The school's "experiment" this year involved developing further the concept of an extended tutorial, first instigated as a pilot program in the 1997 School. The tutorial on Quantum Information consisted of nine integrated lectures with an introduction, followed by specific treatments of many aspects of the field such as quantum cryptography, computing, and cold-ion traps. Given by the senior scientific staffs from both institutions, this functioned well in giving the students a broad overview of an evolving scientific area.

The lecture series has been open to all other Laboratory Educational projects. This year's topics are listed below:

- Quantum Monte-Carlo Methods
- NMR quantum computing
- Quantum computing
- Ion Trapping
- Quantum Cryptography
- Lasers and Ion Traps
- Quantum Algorithms
- Quantum Optics
- Topics in High Energy Physics Quark-Gluon Plasmas
- Opacity and Astrophysics
- Molecular Dynamics Simulations
- Complementarity
- Bose-Einstein Condensation
- Rochester Interference paradoxes
- Nonlinear systems
- Light Scattering
- Introduction to Quantum Mechanics
- Statistical Methods
- Bose-Einstein Condensation

### *Activities*

In addition to the formal lecture and mentor programs, the school arranged for a wide variety of related activities for the students. One such activity centered on exchange meetings with participants at UNM in Albuquerque. The school also conducted tours of various Laboratory facilities such as the Neutron Scattering Center and quantum computing Laboratories, as well as the traditional Night at the Santa Fe Opera—this year, Carmen.

### *Recruitment and Demographics*

Unlike most Research Experience for Undergraduates sites, the school recruited nationwide with an emphasis on students from schools with little or no graduate research programs. UNM handled recruitment, consisting of an extensive mailing of fliers to all members of several American Physical Society Divisions (about 2000). In addition, UNM sent a color poster to most physics, chemistry, and astronomy departments in the United States. Special mailings went to minority-designated institutions. The school has worked closely with other efforts within Science Education at the Laboratory, including the Historically Black Colleges and Universities program. It has also developed a Web site (http://www.phys.unm.edu/LASS) that gives general information and allows direct applications. For 1999, the school received around 100 applications and

admitted 18 students, of whom 17 accepted.

This class was very strong scholastically, filled with many honors students. The students came from 17 different universities from Massachusetts to California. These ranged liberal arts colleges with small research programs to large research-oriented schools: Washington (MO), Harvard (MA), Miami (OH), Sussex (UK), Delaware State (DE), Hamilton (NY), Valparaiso (IN), Wesleyan (CT), Georgia Tech (GA), Bard (NY), Jacksonville (FL), Southern Adventist (TN), California-Davis (CA), Oklahoma Baptist (OK), Iowa (IA), New Mexico (NM), and Evergreen State (WA). The school maintained its high participation of women (41%), far above university enrollment in physics at this educational level and, this year as last, accepted equal numbers of men and women. Other under-represented groups included Hispanic (1), Afro-Americans (1), and Asian-Americans (3) participants.

## Evaluation

Evaluating such a project has always been difficult. A work-study student at the Laboratory has made extensive efforts to contact as many alumni as possible. So far, about a third of the 11-year enrollment has responded. Of these, 25% have received Ph.D. degrees in the physical sciences, principally physics; 55% are enrolled in graduate studies in science; and 20% have embarked on other professional careers in medicine, computer software, law, and market analysis. Several students have faculty appointments at such universities as Connecticut and Kansas State. The alumni all endorse the great value of the dual-track format of lectures and research projects as well as the camaraderie fostered by extended personal interactions.

The school has also performed an impact evaluation, asking the students the immediate importance of their participation in the school. The consensus this year followed remarkably closely that of previous years. The following general findings about the course emerged:

- Well organized and at about the right level
- Helped improve understanding of basic concepts in the field
- Required a reasonable amount of work
- Provided skills applicable to their careers
- Gave appreciation of high-level computer power
- Fostered an informality that nurtured interactions with renowned scientists.

The directors were gratified with the response from most of the students that the school had " renewed their interest in science and computation." Therefore, the short-run effects of the school were clearly very positive.

# Massachusetts Institute of Technology Engineering Internship Program

Based on the belief that real-world experience is an important aspect of a sound education, the MIT Engineering Internship Program combines traditional on-campus academics with off-campus work experiences at the Laboratory. By giving students an opportunity to participate in work

experiences early in their careers, they can make more informed choices from among the various on-campus educational offerings, as well as obtain a better understanding of career opportunities available after graduation. Emphasis is placed on ensuring that students in the program are placed in rewarding real world work assignments that extend the learning experience into areas that are not available at MIT. There is extensive faculty participation and advising in both the on- and off-campus components of the program.

This program provides the opportunity for the participating students to be awarded a combined B.S./M.S. degrees simultaneous upon successful completion of all degree requirements and completion of all three work phases at the Laboratory. Program participants complete a combined B.S./M.S. thesis on a topic related to their work assignment. The thesis topic is normally determined before completion of the second work assignment, and students complete their thesis primarily during the third and final work phase of the program at the Laboratory. All thesis work is completed under the combined supervision of Laboratory staff members and an MIT faculty member.

In FY99, 22 students participated in the program, representing 12 Laboratory organizations. Of the 22 participants, 4 completed their graduate work phase of the program including completion of their Masters thesis project while in residence at the Laboratory.

## Mentored Collaborative Research Project

The Mentored Collaborative Research Program is a unique teaming program offered by the University Programs Office at Los Alamos National Laboratory. This program has continued to successfully provide unique and challenging research opportunities to student and faculty teams to work alongside Laboratory scientists on “target” project areas that have a direct relevance to the Laboratory’s stockpile stewardship mission.

According to George Campbell, Jr., Ph.D., president and CEO of the National Action Council for Minorities in Engineering (NACME), Inc., “We have an enormous wealth of talent that is underdeveloped and underutilized right here at home in the minority communities” (NACME Information, “The Role of Affirmative Action in the Scientific Enterprise,” Oct. 2, 1998). In this article, Dr. Campbell is speaking directly to developing U.S.-born citizens/minorities toward careers in engineering and other sciences. The Mentored Collaborative Research Program focuses on the direct technical development of that talent.

The Mentored Collaborative Research Program was created to focus on undergraduate and graduate students and faculty from New Mexico and regional and East Coast universities. Faculty and students work as a team, building on the collaborative project ideal using state-of-the-art equipment. The teams are usually made up of students from multiple disciplines, for

example, chemistry, engineering, material science, and technology. This provides experience working on a team in a multi-disciplinary manner, much like the common research experience at the Laboratory.

Students continue to provide positive feedback to the success of their experiences as summer research interns under the Mentored Collaborative Research Program. Faculty also have a unique opportunity to work on unique research projects, which can be transferred to the classroom, thus enhancing curriculum and teaching abilities. This is an invaluable avenue to transfer knowledge from the Laboratory and scientists to the classroom, thus encouraging more students to consider the national laboratory environment as a viable option for summer research and/or career development.

## Implementation

The Mentored Collaborative Research Program sponsored 2 faculty members, 12 undergraduate students, and 1 graduate student during the summer of 1999.

Two students and one faculty team continued research on the "Synthesis of Single Crystalline $Er_2Oc$, $Er_2O_3/Y_2O_3$, and $Y_2Oc$ Using the Optical Float Zone Method." The students' abstract explains that, while crystals have been synthesized, previous methods yielded mixed results. Different growth conditions contributed to various defects, which the team sought to understand. Both of these students are returning summer research interns. Also, one is a Pre-select National Consortium for Graduate Degrees for Minorities in Engineering and Science, Inc., Fellow. Mentored Collaborative Research Program summer research interns continue to exhibit commitment to research they participate in.

## Evaluation

The Laboratory monitored student/faculty team projects on an ongoing basis. Students and mentors provided feedback through evaluations for each of the major program components. The purpose of the mentor evaluation is to determine whether or not the program components accomplish project goals and what strategies should be implemented to fine-tune the program. Evaluations were designed to address job information, mentors, the program, and housing.

Further program assessments involved students presenting their research at the end of the summer programs. Students, faculty, and their mentors worked collaboratively to prepare the students for this endeavor. A number of the Mentored Collaborative Research Program students presented their research findings at the Second Annual Tri-Lab Summer Student Symposium held at Lawrence Livermore National Laboratory. Also, a number of the students presented at the Fourth Annual Summer Student Symposium at Sandia National Laboratory in Albuquerque.

# New Mexico High School Supercomputing Challenge

The New Mexico High School Supercomputing Challenge is an academic-year program in which teams of one to five high-school students and their sponsoring teachers conduct computational science

projects using high-performance computers. Los Alamos gives each team an account on a computer, while New Mexico Technet provides access to the state computing network and the Internet. Each team defines and works on a single computational project of its own choosing. The Laboratory and New Mexico Technet, Inc. are the major sponsors of the Challenge, but other laboratories and many universities and businesses collaborate with the Laboratory and Technet in support of the Challenge. During the ninth annual Challenge year, 1998-99, 5 benefactors and 13 patrons contributed to the program. The current list of sponsors can be viewed at http://www.challenge.nm.org/sponsors.shtml

The Challenge is an example of how the Laboratory reaches out to New Mexico to be a good neighbor. The Challenge transfers computing technology to the schools in New Mexico, provides an avenue for recruiting future scientists for all of the sponsoring organizations, and raises the quality of science education in New Mexico. The Challenge continues to provide a technology boost to schools by giving them access to the latest in computing hardware architectures and software techniques.

September 1999 marked the beginning of the tenth year of the Challenge. Current information about the Challenge and sponsors can be viewed on the Web at: http://www.challenge.nm.org.

## Goals

The goals of the Challenge are to foster creativity in devising computational solutions to scientific problems and to make a positive difference in students' lives, motivating them to prepare for the workforce of the future. The program is both an educational experience and a competition that strives to

- Provide access to high-performance computers
- Increase students' interest in science-related disciplines
- Promote careers in science and engineering
- Institute electronic networking among schools
- Expose students and teachers to computational experiences

## Implementation

The main computers for the Challenge are a Pentium-pro running Linux and an SGI O200. The Linux machine front-ends the SGI O200 which is compatible with the SGI O2000 machines that make up the Accelerated Strategic Computing Initiative (ASCI) environment at the Laboratory. The winning teams for the last two years have used the Theta cluster of SGI Origin 2000 machines (true supercomputers) to come up with solutions for their projects.

*During the Kickoff Conference, students and teachers work at computer labs set up for programming instruction.*

The Challenge year began with the Kickoff Conference in October 1998 that was attended by approximately 400 students and 66 teachers making up 100 teams from 43 schools. Participants received instruction in computer networks, supercomputers, software development methods, and programming. Hands-on computer laboratory sessions give students and teachers an opportunity to try new skills in both a structured and unstructured setting. The Laboratory provided half of the 30 or so instructors, with the balance coming from the other sponsors. Students have an opportunity to talk with scientists about their particular area of interest.

Females represented 25% of the students and 47% of the teachers. Ethnic representation for students was 51% White, 18% Hispanic, 16% American Indian, 3% Asian, 1% African American, and 11% declined to indicate. Ethnic representation for the teachers was 83% white, 10% Hispanic, 5% American Indian, 0% Asian, and 2% African American. Over 75% of the students were new to the Challenge this year and 40% of the teachers were new. Over half of Challenge participants hail from small towns and rural areas.

During January, the Challenge conducted one-day regional workshops at six different institutes of higher education around New Mexico. Instructors covered programming, Unix, the Internet, and public speaking. During the workshops' "meet the scientist luncheon," local faculty members and local scientists discussed the team's project with students and teachers over lunch.

The Challenge competition concluded in April when about 225 participants came to Los Alamos. They took tours that included many scientific talks given by Laboratory scientists. The participants also saw first-hand the computers that they had been working on at the Laboratory Data Communication Center machine room. Talk topics included SGI/Cray Computers, encryption, explosion phenomenon, electrical engineering, astronomy, hazardous devices team equipment and procedures, and metallurgy. The participants also spent time at the Bradbury Science Museum. Approximately 90 Laboratory employees participated in the activities in one way or another, 35 of them as escorts.

*Figure 1. Students from around the state participate in the Supercomputing Challenge.*

At the awards ceremony, a team of five boys from Albuquerque Academy walked away with the top honors for their project, "The Evolution of Hive Intelligence Using Genetic Programming." The students on the Academy team each took home a $1,000 savings bond and Microsoft software. Their teacher received a computer for his classroom. The winning team also received the SGI High Performance Computing Award and an award from the Society for Technical Communicators for the best written report. Other teams and students also won cash prizes and software. Senator Pete Domenici sent a video tape to be

played at the Awards Ceremony congratulating the participants on their achievements.

During the summer, the New Mexico Department of Education printed a binder of the finalists' reports and sent them to all the high school libraries in the state.

Several times during the year, Challenge coordinators attended conferences and workshops to promote the Challenge and encourage participation by others. A portion of the Laboratory's booth at Supercomputing '98 was for a Challenge display. In other promotions, a booth was set up at the Goddard Science Discovery Days in Roswell, New Mexico, to promote the Challenge in the southeast part of the state. Booths were set up at Computer expositions in both Albuquerque and Santa Fe and many contacts were made. A talk about the Challenge was given at the High Performance Computer Users Group meeting in August at State University of New York, Stony Brook.

### *Teacher Training*

In June, the Challenge conducted a two-week, teacher training session at New Mexico State University (NMSU) in Las Cruces. Fifteen teachers participated, earning three units of graduate credit from NMSU. Topics included C++, Unix, the Internet/WWW, HTML, and others. Although these were intense days of instruction, the teachers learned a lot and said that they would recommend the sessions to others.

## Evaluation

The Challenge has had a positive impact on students, teachers, schools, and communities. Many past Challenge participants have been hired by the Laboratory, not just by the Computing, Information, and Communication (CIC) Division, but by other groups as well. Many have come as summer students.

The governor of New Mexico signed a proclamation that October 1999 was designated as Supercomputing Month, in honor of the Challenge. The plaque will be displayed during Challenge events throughout the year. A Laboratory employee was honored with a Certificate of Appreciation signed by the governor of New Mexico for his decade of work with the Challenge, and the affect it has had on the approximately 5,000 students who have participated in the Challenge.

# Postdoctoral Program

The Postdoctoral Program provides a means of advancing knowledge in the areas of basic and applied research and strengthening national scientific and technical capabilities. Appointees are provided the opportunity to perform research in a scientifically rich R&D environment. The Laboratory experience presents appointees the opportunity to derive significant professional accomplishment and advancement of their career goals by publishing and presenting the results of their work and participating in scientific and technical conferences while contributing to the overall research efforts of the Laboratory. Appointees provide valuable stimulus to the research efforts of

Laboratory staff and make available current university research endeavors as well as become the communication link between the Laboratory, industry, and universities. The Program also serves as a primary resource for selection of regular Laboratory technical staff.

Candidates are nominated and sponsored by a member of the Laboratory's technical staff. Selection is based on Laboratory-wide competition and is determined by the candidate's academic qualifications and research excellence.

**Postdoctoral Fellows** are provided the opportunity to pursue independent research of their own choice, while **Postdoctoral Research Associates** are provided the opportunity to pursue research directly involved with Laboratory programmatic efforts.

Within the Postdoctoral Fellow category, the program offers prestigious appointments in three Fellowship categories: J. Robert Oppenheimer, Richard P. Feynman in Theory and Computing, and Frederick Reines in Experimental Sciences.

- The Oppenheimer Fellowship is named after the first director of the Laboratory and provides the opportunity for recipients to pursue independent research of their own choice.
- The Feynman Fellowship, named after the famed theoretical physicist and winner of the 1965 Nobel Prize in Physics, provides the opportunity for recipients to pursue independent research of their own choice in the areas of theory and computing, with emphasis on modeling and simulation. This fellowship opportunity is restricted to candidates that are U.S. citizens.
- The Reines Fellowship, named after the former Los Alamos researcher who won the 1995 Nobel Prize in Physics, provides the opportunity for recipients to pursue independent research of their own choice in

| | Male | Female | Not Specified | Total |
|---|---|---|---|---|
| **Native American** | 1 | 1 | | **2** |
| **Asian** | 46 | 11 | | **57** |
| **African American** | 1 | | | **1** |
| **Anglo** | 172 | 34 | | **206** |
| **Hispanic** | 11 | 2 | | **13** |
| **Ethnicity not identified** | 24 | 3 | | **27** |
| **Gender/Ethnicity not identified** | | | 3 | **3** |
| **Totals** | **255** | **51** | **3** | **309** |

| | JRO FELLOW | FEYNMAN FELLOW | REINES FELLOW | POSTDOC FELLOW |
|---|---|---|---|---|
| **US** | 4 | 2 | 1 | 15 |
| **Non-Sensitive Countries** | 1 | | | 21 |
| **Sensitive Countries** | 2 | | | 4 |
| **TOTALS** | 7 | 2 | 1 | 40 |

*Gender, ethnicity, and citizenship of Postdoctoral Fellows and Postdoctoral Research Associates.*

experimental sciences. The awards go to outstanding experimentalists regardless of their field of study. This fellowship opportunity is restricted to candidates that are U.S. citizens.

A maximum of two fellowships in each category is offered annually. In addition to these prestigious fellowships, there are an average of 50 regular Postdoctoral Fellows at the Laboratory at any given time and approximately 250 Postdoctoral Research Associates.

Postdoctoral candidates are appointed to an initial two-year term, with an option of a third year if funding is available. The three most prestigious Fellowships appointments are for three years.

There were a total of 411 postdocs who participated in the program in FY99. As of September 30, 1999, there were 309 participants in the program.

The following summarizes some of the changes that have taken place with the program during FY99:

- Creation of the prestigious Frederick Reines Postdoctoral Fellowship in Experimental Sciences
- Selection of the first two recipients of the Richard P. Feynman Postdoctoral Fellowship in Theory and computing and the first recipient of the Frederick Reines Postdoctoral Fellowship at the December 1998 quarterly meeting.

Creation of the Postdoctoral Publication Prize in Experimental Sciences. First prize was awarded in May 1999.

# Regional Two-year College Initiative

The U.S. Department of Energy's objectives for the nation's economic growth builds on an investment that supports a highly skilled work force, a strong scientific and technological research and development community, and the development and transfer of innovative technologies. Department of Energy is looking to the community colleges to become more involved in technician training. Because Los Alamos National Laboratory technicians are part of the aging workforce, it is critical that programs like the Two-Year College Initiative play an important role in assuring the Laboratory's future technician workforce.

Los Alamos is committed to working with two-year colleges in the state and in other regional academic partnerships. This commitment was demonstrated through the development of the Two-year College Initiative Program. This year participating institutions included Luna Vocational Technical Institute, Northern New Mexico Community College, San Juan College, Navajo Community College, University of New Mexico–Los Alamos Branch, Crownpoint Institute of Technology, Santa Fe Community College, New Mexico State University–Carlsbad Branch, Hobbs Junior College, Albuquerque Technical Vocational Institute, United World College, Southwest Indian Polytechnic Institute, Little Big Horn College, Fort Peck Community College, and Salish Kootenai College.

Before the inception of the Two-Year College Initiative, the two-year colleges identified areas of advanced technology in which their schools could specialize. Technologies targeted for this program that relate to stockpile stewardship have been advanced manufacturing, environmental restoration and waste management, biotechnology, and computer technology. Under the Two-Year College Initiative program, student and faculty teams have participated in an internship program at the Laboratory. Interns were placed in various technical areas with mentors who assigned specific tasks. Along with this research experience, the program provided a seminar, lecture, and conference series. At the end of the internship, participants were required to submit an abstract and technical paper, as well as give an oral presentation of their research experience.

The objective for student development was to increase the number and quality of students pursing degrees in these emerging technologies and to motivate the students to continue their academic pursuits. The objective for the faculty was to strengthen the academic environment at the colleges by enhancing the teaching and research capabilities. Experience at the Laboratory gives the interns exposure to the cutting-edge technology necessary in this competitive world and it is this exposure that leads to the achievement of the objectives.

## Implementation

During FY99, 33 students and 6 faculty members were placed in internships or given work on research contracts. Six students from four tribal colleges worked in computer technology related areas. In addition, the Two-Year College Initiative assisted the University of New Mexico in developing a National Science Foundation grant to enhance regional community colleges chemistry programs and faculty. The Foundation awarded a grant for $1.7 million for five years.

In other activity, 6 students and 3 faculty from area community colleges participated in the computer technician training program for 10 weeks with the Laboratory's computing division.

Finally, two research contracts were awarded to

- Luna Vocational Technical Institute, with assistance from the Laboratory, developed a two-year pre-engineering program.
- San Juan College, with assistance from the Laboratory, completed its chemistry laboratory to enhance its research capabilities.

## Evaluation

An evaluation survey was distributed to the participants at the end of the 1999 summer session. Separate surveys for students and mentors were distributed. Evaluations were designed using a scale of one to five. An average rating was determined and that rating was turned into a percentile with a 100 percentile indicating that all respondents gave that particular question the highest possible rating.

The surveys and final reports completed by the Two-year College Initiative Program participants indicate that these internships are inspiring for the participants. Many of the students indicated that as a result of their experience in the programs, they have decided to pursue a higher level of education than they had planned previous to their internship. Faculty participants have stated that the program inspired them to incorporate new ideas into the courses that they

already teach and to participate in the development of new curriculum. Mentors as a whole were positive about their experience with the program. Many had helpful suggestions and were eager to participate again next year.

Collaborations are developing. The program coordinator and other high tech industries are part of a business and industry initiative known as the Technology Advisory Council. Its goal is to evaluate the needs of the New Mexico technology workforce, with an emphasis on manufacturing. There are plans to create a New Mexico two-year postsecondary consortium of New Mexico community colleges that will focus on centers of technological excellence.

The research contracts have proven to be a very positive way of doing business with the two-year institutions. They have challenged them to develop hands-on projects that have led to the enhancement of existing educational programs and to development of new curriculum. They have also provided the Laboratory with a "value added" component.

Based on preliminary feedback, it is the opinion of the program staff that the format of the program is right on target to help achieve the broader educational and economic goals of the northern New Mexico region specifically and the Department of Energy in general.

# Science and Mathematics Internship Laboratory Experience (SMILE)

The Science and Mathematics Internship Laboratory Experience (SMILE), formerly known as the Underrepresented Minority and Female Initiative, assists underrepresented minorities and females from the Southwest to achieve parity representation in science, mathematics, engineering, and technology. The SMILE program focuses on students from New Mexico, Texas, Colorado, Arizona, and California. It currently involves undergraduate and graduate university students and graduating high school students. Because Laboratory staff members are part of the aging workforce, programs like SMILE that develop a workforce pipeline play an important role in assuring the Laboratory's future staff member workforce

College enrollment by women and minorities lags behind that by white males, yet the demographics of U. S. school-age children clearly indicate that the pool of white males is shrinking. The pool of students entering the pipeline to careers in science and engineering must be expanded to include more of those who traditionally have been underrepresented. The principle goal of the SMILE program is to encourage students from underrepresented classes to choose careers in science, mathematics, and engineering and to motivate them to excel in these fields, thus helping provide our nation with an essential resource: the next generation of its scientists, mathematicians, and engineers.

SMILE believes that education must challenge all underrepresented minority and female students to reach their

potential and must involve resources at the Laboratory. To accomplish this, the program provides internships that allow direct experience in and exposure to a wide variety of science and technology at the Laboratory and at local universities and industries.

## Implementation

During FY99, 70 undergraduate and graduate students and 1 faculty member were placed in internships. SMILE had three different components. One was the high school summer program at the University of New Mexico–Los Alamos. Twenty-two graduating seniors from local area high schools commuted to attend college preparatory classes. The courses were designed to increase their skills in mathematics, present an introduction to technology, give them an opportunity to explore career options, and provide them with college survival skills.

Another portion of the project took place at the New Mexico State University campus in cooperation with the National Science Foundation/Alliance for Minority Participation Program, which works with four students from two-year colleges in the state of New Mexico that had completed an associate degree and were in transition to a four year institution. These students were placed in laboratories with mentors and were assigned specific tasks. Based on this research experience, they submitted a final paper and gave an oral presentation to their mentors, the staff of the Alliance for Minority Participation, and the staff of SMILE.

The final component of SMILE took place at the Laboratory. Forty-four undergraduate and graduate students from colleges in the Southwest and elsewhere were placed in research laboratories with mentors and assigned tasks. All students presented their projects in final papers, and 10 students were selected to present their research papers at the second annual U.S. Department of Energy, Office of Defense Programs Symposium at Lawrence Livermore National Laboratory. Final papers were to be scanned into a database for future references.

During the summer, professional development seminars included training sessions on technical presentations and technical writing. Social events encouraged interaction among the students of the different programs.

## Evaluations

Separate evaluation surveys for students and mentors were distributed to the participants at the end of the 1999 summer session. Evaluations were designed using a scale of one to five. An average rating was determined and that rating was turned into a percentile with a 100 percentile indicating all respondents gave that particular question the highest possible rating.

The surveys and final reports filled out by the SMILE participants indicate that these internships motivate the participants to continue. Many of the students indicated that as a result of their experience in the programs, they have decided to pursue a higher level of education than they had planned previous to their internship. Mentors as a whole were positive about their experience with the programs. Many had helpful suggestions and were eager to participate again next year. One student was offered and accepted a full time job at the Laboratory. Based on preliminary feedback, the Laboratory believes that the format of the program is on target to achieve its educational goals.

# Summer of Applied Geophysical Experience (SAGE)

The Summer of Applied Geophysical Experience program (SAGE) is a month-long, field-based course in geophysics for graduate students, upper-level undergraduate students, and selected professionals. The program seeks to provide students with opportunities for field research and stimulate them to consider career options. SAGE is unique and different from university courses in that students learn by collecting and interpreting original geophysical data related to a variety of applied and basic problems and by integrating data from a variety of techniques. Final oral and written presentations of their results ensure that each student "takes possession" of his/her projects. One student from SAGE 1999 commented that "although the presentation was stressful, I think it is an extremely valuable part of the program."

Students use a variety of geophysical exploration methods, including seismic refraction and reflection, ground-penetrating radar, magnetics, gravity, and several electromagnetic techniques. Students learn to combine the results of all techniques together, taking into account the different resolutions and sometimes disparate results provided by the different techniques, to derive an integrated interpretation that is compatible with the geological context. Data are processed on personal computers and work stations. Because of the students' diverse backgrounds and different educational levels, classroom lectures on all techniques are provided at the beginning of SAGE. In addition, participants in FY99 spent three days on field trips studying the geology of the Rio Grande valley to provide a context within which to interpret their geophysical results.

Teamwork is emphasized throughout the program because, in both the academic and industrial work environment, geophysical investigation and interpretation is typically done by groups of individuals working as teams. Students work in field teams to collect data. After data are brought into the laboratory, students work simultaneously as part of disciplinary teams (for example, seismic refraction technique) and as multidisciplinary teams (focused on a specific area or topic) to process and interpret the geophysical data. Each team selects a team leader, who is responsible for presenting a summary prior to, and an integration following, oral presentations by the team members.

Some students come from universities with strong geophysics programs. Others are from smaller universities or colleges lacking geophysics courses or concentrations. These students have good preparation in math and physics, and a strong interest in earth science. SAGE helps them combine their math and physics backgrounds with Earth science to expose them, many for the first time, to geophysics.

Independent, critical thinking is fostered by the fact that, although all students participate in all geophysical techniques and field projects, each must specialize on an independent project (while still working as a member of a team) for final data processing and interpretation. For some students, SAGE is

their first exposure to research. Some students continue to process SAGE data for senior theses, and many develop M.S. theses around their SAGE projects. Many of the students' home institutions award academic credit for SAGE by allowing students to register for independent study, or by substituting SAGE for a required geology field course. Formal credit may also be received by registering with the University of California (Riverside) Extension Program.

SAGE recruits nationally through an annual mailing to all geoscience departments in the U.S., a World-wide Web site (see below), peer-reviewed publications and presentations at national meetings, personal contacts by the faculty, and word-of-mouth by former students. SAGE receives international visibility primarily though its publications and through professional contacts by faculty and former students. SAGE has attracted some students through coordination with other educational programs at Los Alamos.

## Goals

The goals of SAGE are to

- Enhance students' education in the earth sciences
- Expose students to research
- Encourage students to continue career advancement in earth science and related fields
- Expose students to career opportunities through an extensive visitors' program, whereby professionals from industry interact with the students

## Implementation

SAGE is based at the College of Santa Fe in Santa Fe, New Mexico. All students and most faculty and visitors are housed in dormitories and meals are provided at the cafeteria. SAGE rents classrooms in the Science Building for lecture, computer, and storage facilities. Vehicles for field work are rented from San Diego State University, the University of California at Riverside, the GSA motor pool at Los Alamos, and through commercial companies. Strong office support is provided by the University of California's branch of the Institute of Geophysics and Planetary Physics at Los Alamos.

During FY99, a group of 23 undergraduate and graduate students representing 20 institutions from the United States, Mexico, and Ireland attended SAGE 1999. Institutions represented by students attending SAGE were

- University of California, Riverside
- University of California, Santa Cruz
- State University of New York at Fredonia
- University of Wisconsin, Milwaukee
- Purdue University
- Case Western Reserve University
- University of Toledo
- Georgia Institute of Technology
- University of Utah
- University of Texas at Dallas
- Centro de Investigación Científica y de Educación Superior de Ensenada
- Millsaps College
- University of Ireland
- San Diego State University
- Colorado State University
- University of Southern Maine
- Boise State University

- University of Massachusetts
- University of Oregon
- Western Michigan University

The SAGE faculty comprised the following individuals: Dr. W. Scott Baldridge, Co-Director, Los Alamos National Laboratory; Prof. Shawn Biehler, University of California; Riverside; Prof. Lawrence W. Braile, Purdue University; Prof. Bernard E. Gilpin, Golden West College; Prof. John F. Ferguson, University of Texas, Dallas; Prof. George R. Jiracek, Co-Director, San Diego State University; and Adjunct Faculty, Dr. David Alumbaugh, University of Wisconsin.

After the lecture program, students worked on two separate but related projects. The first was a continuation of work begun last year involving imaging of subsurface sedimentary units and buried faults in the Rio Grande rift near Santa Fe, New Mexico. New data from 1999 were integrated with last year's data, providing students with the opportunity to merge their data into a broader picture. The techniques used for this project were seismic refraction/ reflection (using a Vibroseis source), gravity, and electromagnetics methods. The Vibroseis technique used hydraulically driven vibrators mounted on a truck chassis to generate seismic waves. It is an environmentally benign technique, widely used in the petroleum exploration field as a powerful source of seismic energy.

The Vibroseis trucks were provided to SAGE on a cost-shared basis by the Colorado School of Mines. This project was undertaken in coordination with the New Mexico State Engineer's Office and the Santa Fe County hydrologist. The research goal, in part, was to help constrain hydrologic models in the water-starved and rapidly developing area south of Santa Fe. Students, many of whom have an interest in hydrological applications in geophysics, acquired experience with an important applied problem. Secondly, a small-scale survey, using seismic refraction, ground-penetrating radar, total-field magnetics, and electrical resistivity was undertaken to study a buried and capped waste-disposal trench at the Los Alamos National Laboratory. This study completed a project on which SAGE worked several years previously. Preliminary results were provided to the Environmental Restoration project at Los Alamos, which is actively investigating this site for possible remediation. The SAGE investigation helped establish the feasibility of using geophysical techniques for environmental applications, providing students with experience in a field in which many are likely to be employed. As in previous years, many of the SAGE students declared an interest in environmental geophysics.

Visitors to SAGE this year included personnel from Kennecott Exploration Co., Sensors & Software, Geometrics, Exxon, Chevron, Santa Fe County, the Office of the State Engineer, and private consultants. Most of the visitors gave lectures and worked with students in the field. Contact with scientists from industry is invaluable to students planning careers in geophysics, and was directly commented upon by several of the students in their evaluations.

As in previous years, support both in direct contributions and loans of personnel, equipment, and software from Industrial Affiliates is of key importance for the successful execution of the course.

### *Workshops and Other Activities*

In addition to the main summer program, in January of this year SAGE held two concurrent week-long workshops for National Science Foundation, Research Experiences for Undergraduates students from SAGE

1998. The workshops were in (1) processing and interpretation of seismic refraction and reflection data, and (2) interpretation of electrical and gravity data. As last year, the workshops were held at San Diego State University, which provided laboratory space, computers, and software at no cost to the SAGE program. The fact that the workshops ran concurrently allowed the two groups of students to combine their results for a more comprehensive analysis of the problems.

Two SAGE faculty members attended the annual meeting of the Society of Exploration Geophysicists (SEG), where they presented a poster on the SAGE program and an oral report to the SEG's Academic Liaison Committee. The endorsement of the SEG is important to the continued support of industrial partners.

### *SAGE 1999 "News"*

For the second year in a row, Sandia National Laboratories in Albuquerque, New Mexico, provided partial support for Dr. David Alumbaugh to join the SAGE program as Adjunct Faculty. Alumbaugh, who himself was an undergraduate student in took SAGE in 1986, received a Ph.D. from the University of California at Berkeley. Now a staff member at Sandia, he is an expert in electrical/magnetic methods and an exceptional teacher.

*Figure 2. Prof. John Ferguson of the University of Texas, Dallas (center), one of the SAGE faculty, and students install geophones at a Materials Disposal Area at Los Alamos.*

The SAGE faculty received the "Excellence in Geophysical Education Award" of the American Geophysical Union for "significant and lasting contributions to geophysics education." The award was presented at the Fall Annual American Geophysical Union meeting in San Francisco in December 1998. The nominator for the award was Professor Sarah Kruse of the University of Southern Florida. Professor Kruse was a "professional" participant SAGE 1992, along with one of her students.

## Evaluation

Students complete a detailed evaluation form at the conclusion of SAGE. Results of the evaluation constitute an agenda item at the fall faculty meeting each year, and frequently form the basis for changes in the following year's program. Long-term evaluation of SAGE is an ongoing activity. The Laboratory maintains a database of all former students (nearly 400) and of their

current positions and affiliations, as best these are known. Nonetheless, informal contacts at technical meetings and information from former SAGE students themselves are the best way of tracking SAGE students. All faculty are in informal e-mail contact with many former students. Most former students have continued in geosciences, and most work in the private sector. Some have become teachers at the university or high-school level. Several work for the national laboratories, and at least one owns a geophysical consulting company.

Information about SAGE, including photographs, published results, and a list of Industrial Affiliates, is available on the World Wide Web at http://geont1.lanl.gov/SAGE/sage.htm.

# Undergraduate Research Semester

The 1999 Undergraduate Research Semester Program at Los Alamos National Laboratory continues the standard of excellence as part of the undergraduate education effort at the four Department of Energy, Office of Defense Programs laboratories. The purpose of the research semester is to provide unique and challenging off-campus research opportunities for upper-division university undergraduate science and engineering students. To date, Los Alamos National Laboratory has hosted 450 undergraduate students in the Undergraduate Research Semester and Science and Engineering Research Semester programs. Thirteen students participated in the fall semester of 1999.

In the Undergraduate Research Semester program, students and scientists work together on a wide variety of research problems. Science mentors from across the Laboratory volunteer their time to mentor students in the fine art of research. The mentoring relationships that develop during the semester are known, in many cases, to directly influence undergraduate students' decisions to attend graduate school and pursue technical careers.

Participants have access to facilities and state-of-the-art equipment at Los Alamos not ordinarily available on a university campus. The program enhances and facilitates the historic interrelationship between the university community and the Defense Programs laboratories, thereby contributing to the national goal of strengthening the quality of science, mathematics, and engineering research and education. Supplementary educational activities that complement the research appointment enrich the participants' technical background and perspective for future career decisions. The URS Program encourages participation by women (36% this year) and underrepresented minorities (32% this year) in science and engineering fields.

## Goals

The principal goal of the program is to use the Office of Defense Program's national laboratories to develop a diverse workforce of individuals with enhanced problem solving and technical skills to enable the nation to meet current and future scientific and technical needs and to contribute to the research of the national laboratories.

The principal objectives of the program are to

- Increase students' knowledge and skills in science, math, engineering, and technology topics
- Increase students' understanding of the research process
- Attract students to Defense Programs–related areas of research
- Strengthen and focus the field of study and career plans of students
- Increase the diversity of students that participate in Defense Programs research

## Implementation

In calendar year 1999, 25 students spent 16 weeks engaged in research work and attending supplementary educational activities. Approximately 80% of their time was spent conducting research under the direction of a Laboratory scientist or engineer. Approximately 20% of their time was spent participating in the supplementary educational activities, which include a wide variety of planned events and the preparation and delivery of three presentations. The planned activities are designed to enhance the students' experience at Los Alamos and allow students to see the types of initiatives that are underway at Los Alamos. These tours, lectures, and field trips also permit students with diverse interests to become acquainted with a variety of research facilities and to have an opportunity to visit with other Laboratory personnel directly involved in a particular field. The overall feedback of the educational activities remains positive.

For the 1998-99 academic year, participating Laboratory divisions included Computer, Information, and Communication; Chemical Science and Technology; Earth and Environmental Sciences; Environment, Safety, and Health; Materials Science and Technology; Nonproliferation and International Security; Physics; and the Theoretical Division. In addition to each student's hosting scientist, he or she came into contact with many other scientists, post-doctoral students, graduate students, technicians, and other staff that provided guidance. To supplement the interaction with the team of researchers that worked closely with student participants at their Laboratory sites, the program coordinator planned weekly educational activities for the students that were led by Laboratory volunteers.

The program's appointment methodology exemplifies a total immersion into a research setting. Students are expected to be part of the research team in their respective laboratories and contribute to the best of their abilities. This hands-on approach to student learning provides valuable training and skills to the participants as well as confidence in their own abilities. Based upon evaluation data collected for 1998-99, participating mentors found (as they did for the last two years) that students can (1) make a significant contribution in moving the research effort forward, (2) provide new ideas and perspectives, (3) provide additional and valuable experimental time to a project, and (4) explore new research areas. It is striking in the mentor evaluations how much research is conducted in new areas that might otherwise go uninvestigated. The students were typically eager to learn and contribute, and they asked important questions that allowed the researcher to explain and interpret the project and results. The

students learned valuable lessons in scientific habits of mind.

The mentoring component of the program has continued to play a very important role. Mentors are prepared and supported in a variety of ways. They receive information to help them understand the intricate relationship with the student researcher and appreciate the important role they play in the success of the student.

This year, students were offered an optional opportunity to take a university course offered through the University of New Mexico–Los Alamos Center for Graduate Studies. Participation in this aspect of the program has dropped markedly (and the budget for it has correspondingly been reduced to follow the trend). This is partly due to an increasing number of graduated seniors participating in the program during a semester before graduate school. But the greater trend seems to be that students want to focus on their research. The type of cutting-edge research, the access to facilities and equipment, and the likelihood of getting published are opportunities so unique and beneficial that students appear reluctant to risk losing them because of outside commitments.

Program participants were required to present a technical talk to their sponsoring group (peers and colleagues), design and present a poster display, and prepare a technical summary of their research. In addition, participants make a team presentation on a scientific topic of their choosing. These requirements typically occur at the end of the URS appointment. Students were coached on presenting their findings through special workshops offered by Laboratory staff, by the students' mentors, and by the program coordinator. Students discussed their poster displays with the guests invited to a special reception for the occasion.

## Evaluation

To study the impact of the Laboratory program on the participants (students and mentors), the Laboratory used a variety of tools, including a student post survey (scaled and open-ended questions), a poster session, technical talks, observations from site visits, student feedback throughout the program, and mentor responses to a post survey.

Responses from the student participants indicated that the program continues to be very successful. Most believe that their experience is challenging, educational, and useful in making future professional/academic choices. This year there was a normally high retention rate. Twenty percent of the fall students stayed on for a year or more; 50 percent were back at their research during the following summer; 100 percent of the spring semester students were invited to stay with a 62 percent acceptance rate.

In FY97, students indicated that there were too many talks and not enough tours of Laboratory facilities. The Laboratory continues to improve in this area by linking talks with tours more often. The continuation of mini-presentations by students and the adjustments to the talk/tour schedule were successful. Overall the students indicated they found the mentoring relationship and their research experience a positive one.

In response to an open-ended question about what influence (if any) the program had on their career/academic plans and goals, the response was quite positive. Most felt that their URS experience provided clarity and direction in formulating technical career and academic plans. Most acknowledged that the program provided much-needed experience, knowledge, and

opportunities that they would not have received at their home university. As two students put it: "I learned more about Los Alamos National Lab than others I know who have been here for 10 years" and "this is my third internship, but it is the first where I conducted real research on important and relevant scientific matters."

The mentors were also asked to complete a post-semester program evaluation with scaled and open-ended portions. When asked if students made a positive contribution to ongoing research, all responding mentors stated that a positive contribution was made and in many cases research was conducted which never would have been accomplished otherwise. In many cases, the mentor and student are co-authoring a journal publication.

The students who participated during the spring semester were particularly strong. At the final poster session several scientists noted, "these are the most consistently excellent poster sessions we have seen from a single semester and better than those at many professional society meetings."

It is worth emphasizing that the program has very high retention rates during the associated academic year and the following summer. In FY00, the Laboratory intends to aggressively investigate longer-term retention and collaboration statistics. It is worth noting, however, that preliminary results are strong in both areas. For example,

- A male student entered the program in 1992 and is still here working on the same project with the same mentor; his doctorate is imminent.
- A female student left to finish her doctorate and is back now in the same group.
- A male student also has his doctorate and does research at his university, but he remains in contact with his mentor and is now collaborating with a current Undergraduate Research Semester student and the same mentor, on a similar project.
- Two students have been here every summer for the last three years following their spring semester URS participation and they both hope to land a full-time position after completing their respective doctorates.

When the Laboratory begin proactively seeking this sort of information, staff members expected to see exceptionally strong long-term retention statistics which are demonstrably higher than other programs that simply recruit students. It is clear from both the evaluations and the large number of proposed projects to match with students that mentors find this program both professionally and personally rewarding. It is striking how often a URS student provides a new and refreshing perspective to a project and, as a result, contributes to LANL research in a significant way.

# Educational Technology

## BEAM Robotics Workshop

Los Alamos conducted the fifth BEAM Robotics Workshop in April 1999. This Robotics Workshop followed in the footsteps of its predecessors, and was attended by scores of enthusiastic and committed students from across New Mexico and the country, with one attendee hailing from Canada. The main workshop spanned two days, while the final day gave younger students an opportunity to sample what robotics could be all about. Almost 100 students attended the two-day portion, while over 90 students came with a parent on the third day. The Laboratory conducted the workshop at the Los Alamos Senior Center in the hope of engendering more intergenerational communication, and it was exciting to see the many seniors walk through the room and talk to students about the robots they were building. The Senior Center has asked the Laboratory to return next year, as the seniors also enjoyed meeting and talking with the youth.

This year the workshop included a variety of robot kits, plus a new robotic "head," called the sun-seeker, which could be attached to a four-motor walker kit and used to seek out a light source. Several students completed building both the four motor walker and the sun-seeker kits, and were working on tuning the communications between the two as the workshop ended.

Participants included a group of 5 students and 2 teachers from Missouri; 14 engineering students from New Mexico Highlands University; students from a special public school in Las Vegas, NM; and a group coordinated through the Santa Fe Indian School. Two teachers attended from a special high school in Los Angeles that deals with "problem" youth (ADD, ADHD, etc.). They plan to use robotics as a method to catch the attention of their students. They were extremely excited at the level of focus and attention the students demonstrated (several of whom were ADD and had other learning disorders).

Overall the two-day advanced workshop included a total of 104 participants (97 students—the others were teachers). Within that total, 27 were females, 52 Hispanic, and 10 Native American. The one-day workshop included a total of 93 youth participants: 27 females; 33 Hispanics; and 16 Native Americans.

# Educational Networking Support Program (EDUNETS)

The Laboratory developed the Educational Networking Support Program (EDUNETS) to use its technical expertise and experience to help school districts establish viable networks with connections to Internet resources. It was also developed to provide technical training for teachers, administrators, and technical support teams on how to use networking and Internet tools and support these resources. The project started with a pilot district in July 1994 and was established as a formal support program in October 1994.

EDUNETS provides a coordinated networking consulting resource for school districts in the program. The program was also designed to establish partnerships with and provide support for community colleges, universities, and departments of education. These partnerships have helped provide regional training and technical support centers and they ensure continued future support resources for the schools.

The principal direct support efforts for EDUNETS schools and hub sites included:

- **Consulting**. Networking and computing advisement and support, network design, specifications reviews, network drawings, and walkthroughs.
- **On-site support.** Troubleshooting, PC support, server support, and network management, installations and testing support.

• **Training.** Train-the-trainer and technical support team Internet and networking regional workshops, local in-service workshops, and technical support team onsite training.

## Goals

The primary goals of EDUNETS include

- Providing technology planning support, consulting, and training for schools
- Helping schools and school districts determine how to get connected and plan their networking infrastructure to ensure feasible and validated networking plans and implementation
- Developing and documenting models for successfully connecting schools to the Internet
- Making information gained available for educators statewide and nationally
- Developing and testing communications, networking, and internetworking tools and applications for education.

## Implementation

EDUNETS activities include establishing and supporting regional training and support centers/hubs and Internet computer labs; forming school, regional, and district Internet Education Working Groups; providing Internet education resources and support; recognizing progress; and sharing information gained.

The scope for direct assistance has been primarily northern New Mexico school districts, with some requested consulting and training support for a few districts in Colorado, Arizona, Texas, and Oklahoma. Support outside New Mexico was funded partly through partnership efforts and research grants obtained by the requesting sites. EDUNETS also provided advisory, technical, and training support on request as much as possible for other schools in related Laboratory support projects and other community networking efforts.

Direct participants included administrators, teachers, staff, and faculty. Indirect participants included all students, teachers, and staff in the districts represented who will use the networks and be trained by the teachers and staff in the program. The grades and faculty represented kindergarten through community college.

For FY99, EDUNETS supported the following:

- 71 School Districts (51 public and 20 non-public; 43 direct onsite support, 28 limited support workshops/research sites)
- 22 community colleges and university support partners (12 direct support and training hubs—representatives from 10 additional vocational technology schools and colleges attended workshops)
- 17 other (2 departments of education, 3 regional

*Los Alamos National Laboratory*
*Department of Energy (DOE) Science Education Program*

**1994-1999 PROGRAM SCOPE**
**LANL EDUNETS - EDUCATIONAL NETWORKING SUPPORT PROGRAM**
*An Educational Networking Support Program for Northern New Mexico Since 1994*

***1999 EDUNETS Core Team: Ken Brown and Pat Eker, CIC-2; Tim Merrigan , CIC-5; Jerry Lopez, CIC-4***

**K-12 SCHOOL DISTRICTS**

**New Mexico Public School Districts**

Cuba Independent Schools
Pojoaque Valley Public Schools
Central Consolidated Schools
Dulce Independent Schools
Gallup-McKinley School District
Santa Fe Public Schools
Penasco Independent Schools
Questa Independent Schools
Espanola Municipal Schools
Mora Independent Schools
Bloomfield Public Schools
Las Vegas West Public Schools
Las Vegas City Public Schools
Pecos Independent Schools
Zuni Public Schools
Taos Municipal Schools
Mesa Vista Consolidated Schools
Aztec Municipal Schools
Jemez Valley Public Schools
Chama Valley Independent Schools
Tucumcari Public Schools
Clayton Public Schools
Los Alamos Public Schools*
Las Cruces Public Schools*
* Partial Support: 1-2 School Research/Support Sites

**New Mexico Nonpublic Schools**

St. Bonaventure Mission Schools, Thoreau
To'Hajilee Community School (BIA), Canoncito
Shiprock Alternative School, Shiprock
Crownpoint Community School (BIA)
Santa Clara Day School (BIA), Espanola, NM
Ohkay Qwingeh Community School (BIA), San Juan Pueblo, NM
Wingate Elementary (BIA), Wingate
Pine Hill Schools (BIA), Pine Hill
McCurdy Schools, Espanola
Santa Fe Preparatory School, Santa Fe
Rehoboth Christian Schools, Rehoboth, NM
Wingate High (BIA), Wingate
Rio Grande School, Santa Fe
St. Francis School, Dulce

**Other Public School Districts**

Laredo Independent Schools, Laredo, TX
South Conejos Schools, Antonito, Colorado
United Independent Schools, Laredo, TX
Frederick Schools, Frederick, OK

**Additional Public School Districts - Workshops Participation**

Jemez Mountain Public Schools
Rio Rancho Public Schools, NM
Shonto Schools, AZ
Eldorado Schools, OK
Olustee Schools, OK
Tipton Schools, OK
Snyder Schools, OK
Farmington Municipal Schools, NM
Santa Rosa Schools, NM
Red Mesa Schools, AZ
Granite Schools, OK
Duke Schools, OK
Grandfield Schools, OK
Marlow Schools, OK
Moriarty Municipal Schools, NM
Grants-Cibola County Schools, NM
Blair Schools, OK
Navajo Schools, OK
Walters Schools, OK
Davidson Schools, OK

**Additional Nonpublic Schools - Workshops Participation**

Dzilth-NA-O-DITH-HLE (BIA), Bloomfield, NM
Jemez Day School (BIA), Jemez Pueblo, NM
St. Catherine's Indian School, Santa Fe, NM
Native American Prep, Pecos, NM
San Felipe Elementary School, San Felipe Pueblo, NM
Bread Springs Community School, Bread Springs, NM

**POST-SECONDARY SITES AND PARTNERSHIP EDUCATION SUPPORT EFFORTS**

We have worked with several community colleges, education, community and university sites to help them develop support and training centers for their regions - valuable "Internet resource hubs" for their communities.

**University Sites and Community Colleges**

Northern New Mexico Community College - Espanola, NM
UNM-Gallup, Gallup, NM
UNM-Zuni, Zuni, NM
NM Highlands University, Las Vegas, NM
College of Santa Fe, Santa Fe, NM
Northern New Mexico Community College - El Rito, NM
Dine College (Navajo Community College), Shiprock, NM
Navajo Community College, Tsaile, AZ
Crownpoint Institute of Technology, Crownpoint, NM
Laredo Community College, Laredo, TX
Western Oklahoma State College, Altus, OK
Institute for American Indian Art (IAIA), Santa Fe, NM

**Other Education Support Sites and Community Support Partnerships**

New Mexico State Department of Education, Santa Fe, NM
LaPlaza de Taos Telecommunity Foundation, Taos, NM
National Indian Telecommunications Institute, Santa Fe, NM
Jicarilla Apache Department of Education, Dulce, NM
San Juan Pueblo Department of Education, Espanola, NM
Technology Learning Center, Santa Fe, NM
The Golden Apple Foundation, Albuquerque, NM
Cooperative Educational Services (CES), Alb., NM
LANL Tops Program, Los Alamos, NM
LANL Gift Program, Los Alamos, NM

**Additional Oklahoma University Sites and Community Colleges - Workshop Participation**

Ada Vocational Technology
Duncan Higher Education Center
Northern Oklahoma College
Fort Cobb Vocational Technology
Kiamichi Technology Center
Tri-County Technology Center
Tulsa Junior College
Oklahoma State Department of Vocational Technology
Northeast Vocational Technology
Cameron University
Northwestern Oklahoma State University

*A Department of Energy (DOE) Science Education Program*

technology centers, 4 support cooperatives, 4 related Laboratory outreach programs, and 4 community resource partners).

Data indicate that EDUNETS supported New Mexico public school districts, over 80% of the students were in national minority populations, with 11 districts having over 90% minority population. According to the New Mexico Department of Education reports based on census data, over 30% of the students in the participating public schools were classified as living in poverty.

### *Onsite PC, Server, and Network Management Support*

EDUNETS provided 62 sites with 1-5 days onsite support this year. That included

- 45 schools, district offices, and technology centers in 14 public school districts
- 11 non-public schools
- 6 community college support hubs

Primary on-site support this year included NT server support and training; remote access server support and training; troubleshooting networks; helping set up labs and networks; e-mail and web server set-up assistance and training; equipment upgrade consulting and training; Y2K readiness support and training; and equipment and bid specifications review and consulting. Members of the team also assisted with several Net days.

EDUNETS partnered with the Los Alamos National Laboratory Gift Program and worked with the Laboratory salvage group and US West to distribute discarded networking materials to the schools that needed them. Old hubs, scrap wire and cable, anything being thrown out that could be donated and used was recycled to the schools.

Many schools had received equipment from government programs, but they did not know how to use the equipment or could not get them operational. Working onsite at the schools, EDUNETS staff helped repair and set-up many salvaged computers.

Using gifted equipment and scrapped parts, EDUNETS set up small dial-up Internet labs of two to five networked computers in seven elementary school libraries at the most remote or poorest participating schools. Using one

computer as a proxy server, all of the computers have simultaneous access to the Internet.

### *Networking Consulting, Troubleshooting, and Design Support*

EDUNETS provided networking consulting (WAN and LAN), troubleshooting, and/or technical drawings for

- 12 public school districts
- 8 non-public schools
- 6 support hubs and community support partners

Primary on-site support this year included technical network consulting (LAN and WAN); testing and troubleshooting networks; teaching school technical support staff how to install or inspect wiring; equipment and bid specifications; assistance with Net days; technical site network drawings and layouts; and assistance with network proposals.

EDUNETS network engineers conducted many formal and informal technical "walkthroughs" to inspect wiring and offer suggestions and advice. They provided wiring diagrams and technical network drawings for many schools that could not afford them. These drawings and walkthroughs helped schools write grant proposals needed to secure funding for network installation.

Most of the participating school districts sent their technical support staff to EDUNETS networking workshops. Workshop instructors also went to almost all of the districts represented at the workshops for onsite consulting and walkthroughs. Before, during, and after installations, EDUNETS technical support team members and engineers often consulted with both the school support teams and the wiring contractors; made presentations to school boards and parent teacher organizations; and volunteered time to work at the schools on weekends and evenings.

### *Technical Support Team and Train-the-Trainer Workshops and Seminars*

In addition to onsite one-to-one training for network administrators and technical support teams, EDUNETS has developed a curriculum of Internet and networking workshops and seminars for schools' trainers and technical support staff. These workshops were designed specifically to meet the needs of the school personnel—offered as frequently as possible, offered at regional colleges for convenience, and broken into 1-2 day sessions to facilitate schedules and substitute arrangements.

The curriculum offerings increased each year. Every year EDUNETS conducted basic introduction workshops to train the trainers on Internet tools, like email and browsers. Introductory hands-on networking workshops were extremely popular; many of our schools had no technical support staff and asked teachers or librarians to manage the networks. As the teams and teachers have grown in their networking skills, EDUNETS added workshops on more advanced topics. The workshops have

been constantly modified and updated and were designed to address and use the tools that the schools could afford or had available.

The curriculum is varied and designed to fit the schools and colleges in the program (*see* EDUNETS Workshops Descriptions chart). The regular offerings have been workshops on Internet basics—email, Netscape, Internet Explorer; introduction to networking; Internet research; Hypertext Markup Language (HTML)—Web page and website development; Novell sever management (1995-1997); and NT server management (1998-1999).

The EDUNETS materials and textbooks are used by many of the trainers to teach others when they return to their districts and colleges. At a recent workshop, one teacher commented that every time she takes a workshop, EDUNETS should count her as at least 100 people, because she is responsible for teaching the material to over 100 staff members in her school district.

In FY99, EDUNETS presented 35 workshops, in-services, and seminars:

- 29 regional workshops
- 4 on-site in-service workshops
- 1 special program-wide Y2K seminar for New Mexico district coordinators
- 1 special statewide network seminar video-broadcast to 12 Oklahoma campuses
- 40 days of Internet and networking training (13 two-day, 10 one-day, and 10 half-day hands-on workshops; a 2-hour Y2K seminar session taped for future use; a 3-hour video "Networking Fundamentals" broadcast; and several special demonstrations).

Workshop and seminar attendance in FY99 included trainers, technical support staff, teachers, administrators, librarians, school support staff, and volunteers:

- 462 workshop and seminar completions
- 331 workshop and seminar attendees (one or more workshops each)
- 168 individuals completed 299 curriculum workshops (average 2.75 days/person)
- 58 individuals completed in-service training sessions at their schools
- 105 individuals attended special seminars
- 60 schools with attendees (from 26 public and 9 non-public school districts)
- 18 colleges and universities sent attendees (8 EDUNETS hub colleges; 10 other)
- 11 other community support partners sent attendees

Participants received certificates of completion for workshops.

Los Alamos distributed approximately $17,000 worth of reference books and materials to participants to use and then place the books in their school libraries or

district technical reference sets. Participants were also encouraged to use the materials and handouts in workshops for their district personnel.

Workshop feedback from 165 participants indicated that 99.4% (only one negative) found the workshop worthwhile. On a scale of 1-5, the overall workshops rating averaged 4.8.

### *Special Project Presentations, Displays, and Activities*

**CCSD Technology Fair, October 22-23, 1998.** EDUNETS was asked to be on-hand to provide tech support and to provide an interactive Internet display with video-conferencing at the Central Consolidated School District's Technology Fair in October. Approximately 100 people attended the sessions and 34 attendees actively participated in our video-conferencing with sites across the United States.

**San Juan Ribbon-Cutting Ceremonies, October 28, 1998.** The Laboratory provided on-site tech support and a display on the EDUNETS Project for a network ribbon-cutting at the Ohkay Owingeh Community School on the San Juan Pueblo. Approximately 100 people, including several congressmen, community leaders, Pueblo officials, and Los Alamos National Laboratory officials, attended the dedication.

**Awards & Recognition Day, February 16, 1999.** EDUNETS recognized New Mexico school districts, colleges, and support partners in the program for their efforts in getting schools networked and connected to the Internet. The day included a seminar on Y2K readiness and a future needs and planning luncheon before the Awards Ceremony. It was a "rewarding" event, with 26 public school districts, 13 non-public schools, and 20 colleges and support partners in Northern New Mexico being recognized.

Districts received awards for progressing levels of connectivity: Bronze, Silver, Gold, and Platinum Levels. As of January 1999, 39 EDUNETS school districts had attained Internet access for most of their schools—31 had direct lines, 56K or better, and 10 districts had reached "Gold" with direct connections to all schools, Internet training labs, and WWW and email servers. Four years ago only a few schools had dial-up lines.

Two districts—Cuba and Central Consolidated—have reached "Platinum" with over 90% of their classrooms connected. Cuba Independent Schools was EDUNETS' first pilot school district and the first Platinum Level District. Central Consolidated started with the program in January 1996 and went "Platinum" in January 1999.

**FY99 Research Sites.** Several school districts, individual schools, and hub sites have volunteered as research sites. The Laboratory has tested many technologies under consideration for the schools at these research sites to help with consulting and recommendations. The schools participate in testing, provide input on effectiveness, or do independent research studies and provide the Laboratory with the results of the study to share with other sites. At the Awards and Recognition Day in February, EDUNETS presented Research Sites Awards to 23 schools and hub sites for

proxy-server research and special research projects and sites.

## Evaluation

Participants have lavished praise on EDUNETS for its role in bringing the Internet to their schools. A sampling of comments follows:

- "Your help here . . . has had *the* greatest and most important impact of any technology grant/program in our area. My wife, a middle school science and computer teacher, and myself have found the courses and their availability to teachers to be invaluable. Your absence will be devastating."
- "The EDUNETS program has been instrumental in assisting Northern New Mexico Community College become a technological hub for students from north central New Mexico. It has been a process of one mentor (EDUNETS) teaching a student (the College), and then the student becomes a mentor to others. . . . The training EDUNETS has provided is obvious in the knowledge gained by our staff, especially the Management Information Systems staff who is the glue that keeps the technological part of the campus together."
- "EDUNETS made a difference at our school through the training that was afforded us here at Escalante High School. We were able to go on-line sooner and have been able to remain that way. The workshops were very valuable as were onsite support and training. Your program has made it possible for our district to move into the 21st century with cutting edge technology. We still have a long ways to go, and it is unfortunate that EDUNETS will not be there for us."
- "I have benefited personally and professionally from the EDUNETS workshops and support efforts. As a result of EDUNETS, I have integrated technology into my classroom activities. I have also trained district staff, created online lessons, and I have presented my classroom technology lesson, strategies, and methods to local, state, regional, and national audiences. In addition, I have been recognized by state and national organizations for my use of technology in the classroom."
- "Without the training and support of the EDUNETS team, my personal and professional accomplishments would have never come to pass. The EDUNETS efforts coupled with the district's commitment to technology changed my career and professional development program. Within the last 3 years I have completed an Education Specialist program in integrating technology in the classroom, and, I am currently involved in a cohort-doctoral

project through New Mexico State University. The Regional Educational Technology Assistance Doc-cohort Project is the first of its kind in New Mexico, and without the skills, knowledge, and confidence developed over the last five years through EDUNETS professional development programs, I would have never become involved in such an innovative project."

- "The EDUNETS Project . . . has been a tremendous benefit for our school district in terms of staff training and actual network expertise. It allowed us to create a system where schools can dial-up our file server and have access to the Internet through a modem. Our two modems and phone lines have been used daily by up to 12 different schools sites, mainly from the libraries. These schools have found themselves without any other sources for Internet access. This program has been available to them for the past four years and even though other sources for Internet have been planned, this has turned out to be the one service that has actually been available. Without the expertise of EDUNETS staff, this network with dial-up Internet would not have been made possible."
- "We have greatly appreciated all the support provided by the EduNets Program and staff and believe that this is a model program which can and should be replicated for working with rural area school districts."
- "This has been an excellent program that has been a tremendous help to our school. Two years ago our school purchased three rooms of new computers all run by NT servers. Without the NT server classes I have taken through EDUNETS, I wouldn't know anything about NT. We all know that schools have limited or no funding for teacher training so without the EDUNETS classes I would not have been able to use my new computers at all. There are NT training classes out there but they usually run approximately $500 and they do not offer the 'hands-on' training like I received with EDUNETS. The workshops I attended were excellent! . . . I truly believe that the success of my school's computer labs is due to the training myself and other teachers have received from EDUNETS. This is an extremely valuable program and I hate to see it end. Thank you for all that you have done for my school."
- "This program since its inception has seen the Internet move from being an entity which few had heard of to a pervasive tool which is used daily by millions around the world. It seems to me this program has very much been part of that transformation. I have seen teachers walk in the door at the beginning of one of these sessions with tremendous fear and doubt walk out at the end of a day with a new resolve and enthusiasm for their chosen profession because of their new skills for integrating technology into the classroom. I truly believe it has made that much of an impact. I have

seen technology coordinators who were literally at the end of their rope when beginning a consulting session with an EDUNET team leave with direction and an understanding of how to deal with multiple networking problems for their school."

# Educational Pipeline for Student Initiatives Linked on the Network (EPSILON)

The Educational Pipeline for Student Initiatives Linked on the Network (EPSILON) program is a web-based program for students in grades K–12, who participate over the Internet from their classrooms or their local community college for one academic semester. The program begins in spring for all grade levels, followed by a summer experience at Los Alamos National Laboratory for the juniors and seniors of the program. Students engage in a problem-solving scenario for which they must prepare a project to address a particular research topic. The topic for summer 1999 was robotics and the remote handling of nuclear material using robots.

By emphasizing effective practices such as Socratic dialogue, inquiry-based learning, assessment, and integration of technology with curriculum, the program sought to develop a pipeline of students who benefit from a Los Alamos experience. For example, students worked in teams that simulated how scientific problem solving is carried out in a laboratory setting. Activities included designing and building robots and using the on-line program developed on the web for EPSILON. As the delivery and communication system, computer networking technology provided a common thread throughout the program. Effectively using technology for distance activities and to build networked communities of students and schools increased the contact time with students and teachers. Using the web also reduced Laboratory costs associated with traveling to sites and conducting workshops. Evaluation results indicate that EPSILON is meeting a need in schools for innovative on-line programming for the K-12 audience and complements textbook learning.

EPSILON partners with New Mexico school districts by fully engaging students and promoting communication with their communities. School districts and community resources have leveraged Department of Energy Defense Programs funding in several ways. In FY99 67 students participated in the program: 22 in middle school and high school and 45 in elementary schools. Fifty-seven students participated in 1–2 day workshops and 10 students participated in Laboratory internships in technical divisions. The financial investment of the school districts totaled approximately $60,000 in teaching time and resources. Program dollars were also leveraged by the partnership with Northern New Mexico Community College, which volunteered the use of its computer lab for K-12 EPSILON students and allowed electronics instructors to spend time in the EPSILON classrooms. Plans are under development for EPSILON junior and

senior high students to take a topics course in robotics/electronics for concurrent high school and college credit.

## Goals

EPSILON is designed to:

- Involve participants in teamwork under the guidance of a Laboratory mentor
- Expose students to Laboratory projects and programs
- Improve communication skills of participants
- Increase participants' understanding of science, mathematics, engineering, and technology
- Encourage participants to pursue strong academic programs

This student program supports the U.S Department of Energy, Office of Defense Programs mission in the following ways:

- Develops partnerships between the Laboratory and the education community by supplementing academic programs in mathematics, science, and technology academic programs.
- Provides access to Laboratory personnel who serve as role models and mentors.
- Prepares students to utilize research-appropriate technology.
- Enhances students' use and understanding of science research methods.
- Engages partners and collaborators in opportunities that serve their need to make a contribution to education, but who don't necessarily have the infrastructure to accomplish this on their own.
- Provides early identification of talented students and creates an opportunity to mentor them and engage their interests in challenging technical opportunities at the Laboratory, making these students potential Laboratory recruits for the workshop additional educational programs.

## Implementation

Students began their EPSILON semester with goal-setting activities that encouraged team building and task identification for working on an invention. Students continued to work in teams to develop their inventions as they explored many of the science and engineering concepts central to Laboratory programs. World Wide Web activities in science, mathematics, technology education, social sciences, and communication reinforced the basic concepts and skills needed by students to enhance their understanding of the principles behind the LANL projects.

During the academic year, students in EPSILON gathered information via the Internet from Los Alamos and other sources. They conducted e-mail surveys about the use of simple machines and interpreted and graphed the results. They explored data collection and basic research techniques and applied them to their simple machines and inventions project. They also built a student web site that is a major part of the EPSILON program web site at http://set.lanl.gov/ programs/ epsilon. In addition, students learned and applied public speaking and writing skills as they prepared for their presentations on their EPSILON experience and projects. Students also learned more about careers in science and the importance of the work done at Los Alamos for national defense.

The FY99 EPSILON semester experience allowed students and teachers to develop a web-based communications network with the intent of creating a strong educational support network among the program participants and their surrounding communities. Institutions of higher learning such as Northern New Mexico Community College joined with Los Alamos and the International Technologies Corporation to provide resources and mentors for the program participants.

EPSILON students represented the program at a booth displayed at a "Student Fiesta Celebration" in Rio Arriba County, New Mexico. There, the community was invited to share the accomplishments of students from this region for the 1998-99 school year. Students displayed toothpick/marshmallow structures and demonstrated their robots for students, teachers, administrators, parents, and other community members.

The partnership with International Technologies Corporation, an environmental firm, provided technical staff to act as "electronic mentors" to EPSILON students by answering science questions via email. The Laboratory has also formed a partnership with La Jicarita, a regional organization that encourages more young people to have high expectations, stay in school, study hard and take the right courses to go to college. Through a $1.9 million grant for "Gear Up," La Jicarita will partner with project EPSILON to provide student's with a career component for EPSILON and ensure excellence and educational opportunities for all students in Northern New Mexico.

EPSILON provided Laboratory scientists and staff an opportunity to become involved in education activities that allowed them to positively impact students' understanding of scientific work and the formation of career choices. The students interacted with Laboratory mentors including Science and Technology Base Education Staff, and technical staff from Space and Atmospheric Sciences, Diversity Office, Detonation Science and Technology, Design Engineering and the Bradbury Science Museum.

## Evaluation

Since its inception, EPSILON has been evaluated to ensure that the program meets both programmatic goals and participants' expectations. The methods used to evaluate the program employ technology and include journal entries, portfolio development, E-mail from participants and their parents, and a pre- and post-program survey on science and technology. Other non-technological tools used to collect formative data have been teacher interviews, student interviews, and site visits. The Laboratory has used the results from formative and summative evaluations to improve the program.

The most recent survey given to students during the 1999 summer EPSILON experience reveals what the participants believe they have achieved through EPSILON. On a scale of 0-3, where 3 is a very positive response and 0 is negative, the survey results show that

- 100% of the students rated their knowledge in general science literacy at 3.
- 90% rated the tours at the Laboratory at 3, while 1O% rated the tours a 2.
- 80% indicated that they felt very safe, and gave the Laboratory program a rating of 3. About one fifth of the students, 20%, rated their safety at 2 and cited concerns about soldering iron fumes.

- When asked to rate the overall EPSILON experience, 90% of the participants rated the program at a 3, and 10% rated the program at a 3+.
- 90% of the EPSILON students said that the Laboratory Science Education Team was supportive, ranking the Team at 3 during their experience at LANL, and 10% rated the support given by the Science Education team at a 3+.

The Laboratory administered a pre/post test to 10 high school EPSILON students before and after their six-week summer experience to measure their basic level of knowledge as they began the program and their post-program knowledge of some concepts used in nuclear science. The content on which the students were tested was delivered in the form of lectures, tours, and research done on the Internet by the students during their summer experience. The EPSILON students averaged 46.3% on the pre-test, which was administered on the first day of program. On the post-test, the students averaged 96.3%, more than a 100% net gain. This strongly indicates that the EPSILON program effectively delivered the nuclear science content during the six-week summer program.

# Equipment for Education (Gift Program)

The Laboratory's Equipment Gift Program was developed to comply with the 1993 Presidential Executive Order 12812, requiring all federal agencies to give the highest preference to K-12 schools in the transfer or donation of excess Laboratory equipment. In addition to providing equipment for education programs offered by the Laboratory, the Laboratory Gift Program also makes available equipment to New Mexico schools through a memorandum of understanding with the New Mexico Department of Education.

The Laboratory's Science Education Team has tailored the Equipment for Education Program to meet the needs of area schools and of other Science Education Program initiatives at the Laboratory. This fits with the U.S. Department of Energy, Office of Defense Programs mission to provide an infrastructure and the intellectual capability for stockpile stewardship. By providing excess equipment such as computers, Los Alamos is providing opportunities for Laboratory science education programs to increase public access to information that raises the awareness and understanding of weapons stockpile safety and management issues. The Equipment for Education program provides excess equipment gifts to the schools of participants in science and technology education programs, such as the comprehensive K-12 TOPS program and the Critical Issues Forum.

This program contributed to the effectiveness of Laboratory technology implementation efforts that allowed us to meet the goals of its short and long-term strategic plan for K-12 science education in FY98, and was expected to show the same results in FY99. With the introduction of the school-to-work collaborations and the creation of computer refurbishment centers, the Equipment for Education

program added another milestone to its cumulative accomplishments since its origin. This program is currently the only program of its type at the Department of Energy laboratories. Its organization and facilitation provide a necessary and desirable mechanism for meeting a number of the Laboratory's performance measures, relative to the contract with the University of California. It also provides a model for how such a program can be used to meet a diversity of institutional and community needs.

## Goals

The primary objectives of the K-12 Equipment for Education Program are as follows:

- To provide teachers and students with technology that enables understanding of Laboratory research and technology, and facilitates their participation in science education programs.
- To provide schools with equipment that creates instructional opportunities for K-12 classrooms thus promoting institutional change in school systems.
- To provide computers to allow teachers to network and communicate with the Laboratory, to contribute field data from specific program research, and to share instructional strategies and resources with each other thereby reducing rural, geographic isolation prevalent in New Mexico.
- To provide technical assistance and training in the use of computer applications
- To remove the barrier of access to technology, especially for minorities, females, and in areas that may be geographically isolated.

## Implementation

In 1999, the Laboratory's K-12 science education programs worked with Johnson Controls Northern New Mexico (JCNNM) to identify and prepare 70 computers to gift to teachers in our programs. A property management coordinator was hired to assist in documenting these items to make them available to the schools. Unfortunately, due to the computer security crisis and the alleged espionage case, the Department of Energy placed a moratorium on the movement of any computer equipment regardless of its intended use. Work continued in the program, however, in expectation of a lifting of the moratorium. An agreement was made with the Santa Fe Regional Partnership for School to Careers to provide Capitol High School and the Santa Fe Academy with 60 computers with the hard drives removed to establish a computer lab at those locations.

The moratorium was not lifted in FY99, but the Laboratory stands by its commitment to provide the computer shells to the Santa Fe Regional Partnership. At this printing, the moratorium on gifting computers had been lifted by the Department of Energy, and the Laboratory was proceeding to work with JCNNM on preparations for the transfer.

In the past, the goals and objectives of the Equipment for Education Program were achieved through its alignment with the technology goals and objectives of individual programs, and ensured that program participants were involved in activities that reflected the science and technology of the Laboratory. In addition to providing individual programs with

equipment, the program provided participants with technical assistance and training in using and maintaining the equipment and use of software applications. Participants also received pedagogical strategies for classroom use; instruction on how to use web-based programs, bulletin board systems and various networks; and how to access and appropriately navigate the Internet. Computers allowed teachers and students to network with Laboratory staff and with each other.

# Program for Technology Support

The Program for Technology Support maintains the electronic infrastructure and telecommunications environment that supports the collaborative networks required by the Laboratory's Science Education Team programs. The program focuses on providing real, ongoing interaction with Laboratory personnel and program participants through the use of computer technology and appropriate technology instruction. This program makes it possible to enhance classroom practices by imparting skills in web page planning and development, file transfer protocols, concept mapping, and Internet research. Through direct instruction, modeling, and practice participants in Laboratory science education programs consolidate their work through e-mail and web-based curricula and learn how to effectively integrate computer technology into their classroom curricula and daily use.

The Program for Technology Support has leveraged U.S. Department of Energy funds by offering a variety of educational curricula focusing on Laboratory science on the World Wide Web. This increases exposure of Laboratory science to a world audience. The program supports the Department of Energy, Office of Defense Programs mission for education in several ways. The Program For Technology Support contributes to systemic improvement in science, mathematics, engineering, and technology education and enhances scientific and technical literacy. Furthermore, it allows teachers and students to become involved in Laboratory science education programs dealing with highly technical Laboratory research and information that would be impractical without a strong technological capability.

Additionally, the program increases involvement of educational communities locally and nationwide in Laboratory science education programs by utilizing telecommunications to disseminate program-related information. Thus it increases dialogue between Laboratory and educational communities by providing a conduit for scientists to interact with teachers and students. Finally, it provides a technology environment where telecommunications and computer technologies are introduced, developed, applied, and tested to enhance program effectiveness.

## Goals

The goals of the Program for Technology Support are to

- Continue ongoing technological infrastructure to support Laboratory science education programs
- Integrate computers and telecommunications into science and mathematics instruction
- Model appropriate use of educational technology in science and mathematics classrooms and pursue evidence of effective practice
- Provide appropriate training to all Los Alamos Science Education Program participants: students, teachers, Laboratory mentors, and Laboratory Science Education Program coordinators
- Provide teachers and students locally, statewide, and nationally with access to Laboratory technical resources and information
- Maintain constructive and productive partnerships among teachers, students, university staff members, and Laboratory technical staff and education specialists through electronic communication

## Implementation

In FY99, the Program for Technology Support provided the Laboratory's Science Education team with real and ongoing interaction between Los Alamos personnel and education program participants. Through the Science Education Web Server (http://set.lanl.gov/) and individual program web sites, telecommunications allowed program participants to exchange and compare data and to maintain communications among students, teachers, scientists, and Laboratory education specialists. Telecommunications also provided information about Laboratory research to the educational community locally and nationwide.

The web server houses specific detailed versions of many of the Laboratory's science education programs, provides a location for on-line interactions among program participants, is a repository for teacher-developed materials, and links to the Laboratory's education web site. The web server is intended to be a virtual resource center for program participants. The participants investigated the various programs' current topics, participated in regional workshops, and published their work on the web server in electronic team portfolios. Participants posted scientific and technical questions within web pages of the Science Education Team programs, then staff members sent e-mail answers to the program coordinators, who posted the responses for everyone to read.

Within the framework of heightened security at Los Alamos, Laboratory officials designated "Green-wall" status for the Science Education server, allowing continued public access while providing improved security for the Laboratory computer network. This move necessitated a change in access that must be invisible to the outside world to prevent interruption or additional complications for program participants in the education community. The change was completely successful.

Approximately 150 teachers from many Science Education Team programs representing New Mexico schools K-12 were impacted by technology support through this program in FY99. In addition to these participants, EPSILON students, Laboratory mentors and Science Education Team staff members learned about

- Design of curriculum integrating computer technology
- Web page design and HTML programming
- Network planning and implementation
- Internet research
- Development of web-accessed data bases
- Development of on-line program registration forms
- Development of on-line program evaluation surveys
- Selection and use of appropriate educational software

Electronic communication linked program participants with the Laboratory community, thus maximizing program benefits for each program participant. For example, numerous Laboratory employees established collaborative electronic mentoring relationships with program participants and were prepared for this role through the Program for Technology Support. Additionally, the Program for Technology Support provided a gateway to the vast material and human resources available over the Internet and the World Wide Web to teachers and students.

Six FY99 programs in particular—Teacher Opportunities to Promote Science (TOPS), EPSILON, Energetic Material, Los Alamos Space Science Outreach (LASSO), the Web of Learning, and the Critical Issues Forum—illustrate the crucial role of technology in the Laboratory's science education programs. Simply put, they would not be practical or cost effective without telecommunications. A centralized platform for developing and exchanging educational information reinforced the competitiveness of the Laboratory's science education programs in the rapidly evolving educational technology arena. Using technology effectively for distance learning activities and for building networked communities of teachers and scientists has reduced the cost of doing business, allowing the Laboratory to put more resources into the hands of participants.

The Science Education Team has thus increased the amount of educational material focused on Laboratory science. This material is housed on and disseminated through the web server, which allows science education programs to reach a larger and more diverse audience using. Programmatic funds provided by the Department of Energy were leveraged by providing Laboratory science information to a wider audience. For example, Lawrence Livermore National Laboratory conducted the Critical Issues Forum in California, Oregon, and Washington by using the Laboratory-developed program on the Internet. TOPS teachers shared their program-developed web sites with their colleagues, and a curriculum developed by LASSO teachers has also been implemented in a number of schools and is being shared through the NASA network.

## Evaluation

The Science Education Team evaluated all its programs for the effectiveness of their components, especially education technology. Each of the programs reported gains in technology-related activities. These gains reflect the effectiveness of the Program for Technology Support. For example,

- 95% of TOPS teachers say that as a result of TOPS they have greatly increased their use of computers and software to produce documents, materials, and presentations for their teaching.

- 90% of the teachers say they have greatly increased their use of the Internet in their classes.
- A student from the Critical Issues Forum said, "My science grade has sky-rocketed, as well as math. . . . The use of the computer helped with this."

# Science Education Information On-line

The Science Education Information On-line project maintains several World Wide Web Servers that provide education program descriptions and content information from Los Alamos National Laboratory. The project supports the Education Program Office by maintaining updated information on the funded education programs for each fiscal year. The server also provides a central focus for all Laboratory information that might be of interest to the education community.

The principle objective of the project is to provide information to the U.S. Department of Energy and the public about the many education projects at the Laboratory. This is accomplished via the World Wide Web over the Internet. Additional objectives of the project are to:

- Educate program leaders and participants on the World Wide Web (WWW) and Internet capabilities.
- Assist programs in providing program content information via the WWW.
- Provide training on how to maintain WWW and other Internet servers.
- Assist K-12 education with the creation and maintenance of Internet services.

The project strives to work closely with all education programs at the Laboratory and has been able to support and complement other education projects. These efforts have also formed strong working relationships with K-12 schools in New Mexico and the New Mexico State Department of Education.

This ongoing information service is available 24 hours a day, 365 days a year. The server requires weekly maintenance but daily responsiveness to support the projects and participants who want to update their program information. Reports on the usage of the server during the current month are updated every day and are available for viewing over the WWW at http://education.lanl.gov/webstat.html.

## Implementation

The principle project activities during FY99 included:

- Preparing and moving servers to "public" subnet
- Creating a web-based Undergraduate Research Semester application and review process
- Initial development of a program participants database
- Upgrading the server hardware system
- Updates of the server software
- Continued development of a database of program information with an interface on the WWW

- Expansion of information on several programs
- Assisting New Mexico Department of Education and other external education groups and institutions

The principle project activity during the first half of FY99 was preparing and moving the servers to a public section of the Laboratory unclassified network. The creation of a public subnet is part of the Laboratory effort to provide better protection for the Laboratory unclassified subnets that are connected to the Internet. Computer security continues to be of great importance and requires constant attention to ensure that the servers are not penetrated or compromised.

Another activity was creating an on-line application for the four Office of Defense Programs laboratories' Undergraduate Research Semester program. The online program collects application data including references into a database and then facilitates the distribution and review of these applications to the four laboratory coordinators that are participating in the Undergraduate Research Semester program. This is done via a "secure" web server that will protect the privacy information that is collected. The Laboratory's efforts were closely coordinated with the computer and network security team at Los Alamos. The URL for this application is at http://se.lanl.gov/urs/.

The Laboratory also developed a program participant database that would collect information on all participants of education programs in a uniform format. This database would allow the Laboratory to track participation across fiscal years and different programs. An effort to expand on the interfacing of databases with the web continues. This technology promises to reduce the level of effort needed to maintain the many web pages that are on these servers.

The development of the database of all education activities at the Laboratory continues. The database includes all of the Education Program Office programs and other education programs at the Laboratory. The Laboratory also implemented a scheme for including information about former or currently inactive programs. The URL is http://education.lanl.gov/EPO/.

The Laboratory continues to work with the New Mexico Department of Education and other education institutions in Northern New Mexico in several areas.

The project completed its fifth year and is currently serving an average of over 4,500 requests per day from over 70 countries. This program serves on average more that 2,200 new hosts each week. The server currently provides over 4,400 files containing nearly 3.1 gigabytes of information.

The top eight subject areas of interest on the server for the period were

1. Science at Home
2. National Teacher Enhancement Program
3. Hydrogen Conference
4. Undergraduate Research Semester
5. Critical Issues Forum
6. Algebra Through Problem Solving
7. Science Education program information and status reports
8. STB Mentor Information

The uniform resource locator (URL) for the WWW server is http://education.lanl.gov/

# Public Understanding of Science

## Fuel Cell Education Project

The Fuel Cell Education Project at Los Alamos includes two components, the Fuel Cell Tutorial and the Fuel Cell Video Documentary.

### Fuel Cell Tutorial

In September 1999, a 36-page, four-color publication, *Green Power—Fuel Cells* was completed. This activity began in May 1998, when the Fuel Cell Education Project at Los Alamos received funding from the Office of Advanced Automotive Technologies (OAAT) at the Office of Transportation Technology at the U.S. Department of Energy to develop a tutorial for high school and college students on fuel cells. Because OAAT receives numerous requests from students for information on fuel cells, the Laboratory determined this tutorial should be designed for the "overachieving" and independently inquisitive student. The tutorial is to be mailed directly to the student at home, so it is important that the brochure be self-contained—including references and resources for easy follow-up. OAAT asked that additional information concerning global climate change and sustainability be included. The 3M Foundation also supported this work through a financial contribution.

#### *Goals of the Tutorial*

The goals for the Fuel Cell Tutorial are to

1. Develop a "stand alone" publication containing detailed and up-to-date information on current developments in fuel cell research and technology
2. Supplement the tutorial with information on global climate change and sustainability
3. Stimulate independent inquiry by providing appropriate follow-up resources
4. Create an engaging and visually attractive brochure

#### *Implementation of the Tutorial*

Working directly with OAAT staff, a detailed outline of the tutorial was written. It was determined that broad areas—including transportation as well as utility and portable power applications of fuel cells—should be included. In addition, subjects of energy security, oil import concerns, automobile emissions, greenhouse gases and global climate change would be added. The publication would have a consistent narrative running throughout, supplemented with "tutorial boxes" containing more detailed information about the subject under discussion. In addition, references, resources, and a glossary are included.

The primary focus of the tutorial is the polymer electrolyte membrane fuel cell. This technology is most adaptable for transportation applications. Detailed descriptions of each component of this type of fuel cell were written. Figures and charts were integrated into the text. Introductory material about other fuel cell types has been included. Information about further educational, research, and

career opportunities has been added throughout the text.

During the development of this activity, the Fuel Cell Education Project has worked closely with the Fuel Cell Basic Research Team at the Laboratory to ensure accuracy and completeness. In addition, the draft tutorial was sent for outside review. Comments were integrated into the completed tutorial, containing proposed graphics and figures, along with sample page designs and suggested cover. The Laboratory then sent the draft to OAAT. After receiving OAAT fuel cell team review and comment, the Laboratory sent the final version to be printed. Distribution of the 5,000 copies of the tutorial will be done primarily through OAAT. It is expected that a second printing will be done by mid-FY00.

**Tutorial-based Web Site.** FY99 funding allowed the Laboratory Fuel Cell Education Project to develop a website based on the tutorial. The tutorial is available in PDF format that can be downloaded from the website. Hyperlinks to references and resources are included in the text. Mail comes from around the world—from students as well as businesses. Laboratory responses provide information, references, and referrals. Technical experts often assist in assuring complete and accurate answers. The site was featured in the NetWatch section of the journal Science (30 July 1999). The address is http://education.lanl.gov/resources/fuelcells

## Fuel Cell Video Documentary

It is fair to say the automobile changed the industrial and social fabric of the United States and most countries around the globe. Henry Ford epitomized "Yankee ingenuity" and the Model T helped create the open road, new horizons, abundant and inexpensive gasoline . . . and tailpipe exhaust. More people are driving more cars in 1999 than ever before—more than 200 million vehicles are on the road in the U.S. alone. But the car has contributed to our air and water pollution and forced us to rely on imported oil from the Middle East, helping to create a significant trade imbalance. Today many people think fuel cell technology will play a pivotal role in a new technological renaissance—just as the internal combustion engine vehicle revolutionized life at the beginning of the 20th century. Such innovation would have a global environmental and economic impact.

In May 1999, the OAAT tasked the Fuel Cell Education Project at the Laboratory with developing and producing a video documentary on fuel cells. The goal of the documentary is to inform a general audience about the benefits of fuel cell technology and show the exciting and challenging opportunities the technology holds for the future.

The scope of the documentary will be international. Viewers will learn about the work being done in the U.S., Europe and Japan. Demonstration projects—such as the Chicago Transit buses; Munich airport buses and refueling station; Palm Desert, California neighborhood vehicles; and the London taxi will be included. Research centers in Japan, Germany, and Canada as well as the U.S. will be visited.

The documentary will be produced at the Laboratory. Cambridge Documentary Films will serve as the executive producer on the project. The Laboratory will provide state-of-the-art technology including digital imagery for the highest quality resolution and Silicon Graphics animation. Cambridge has been making films about social issues for more than 20 years. Their numerous achievements include an Academy Award; their films have been presented

at film festivals around the world. Through their non-profit distribution company, their films have reached thousands of students and educators, community leaders and concerned citizens.

The documentary will include the history of fuel cells—with historical drawings and photographs, along with the science of fuel cells—explained by 3-D animation. The film is expected to be completed before the end of 2000. It is anticipated that OAAT will fund one-third of the production. Additional fundraising activities are underway. Contributions from Motorola and W.L. Gore have already been received.

The primary focus of the documentary will be fuel cells for transportation. Viewers will see that fuel cells are not just laboratory curiosities. While much work needs to be done to optimize the fuel cell system (remember, the gasoline internal combustion engine is nearly 120 years old and still being improved), hydrogen fuel cell vehicles are on the road—*now*. The film will show commuters living in Chicago and Vancouver who ride on fuel cell buses. The fuel cell taxi in London will be shown being refueled and picking up passengers.

The viewer will learn that because of the legislative initiative taken by California and subsequent similar regulations imposed by a number of states in the Northeast, significant progress toward the development of ultra-low and zero emission vehicles has been made. According to the California Air Resources Board, the developments of fuel-cell engines will help California in its war on smog as well as provide new consumers choices for transportation.

In addition, the documentary will show that every major automobile manufacturer in the world is developing fuel cell vehicles. The introduction of fuel cells into the transportation sector will increase fuel efficiency, decrease foreign oil dependency, and become an important strategy/technology to mitigate climate change. As fuel cell vehicles begin to operate on fuels from natural gas or gasoline, greenhouse gas emissions will be reduced by 50%. In the future, the combination of high-efficiency fuel cells and fuels from renewable energy sources could nearly eliminate greenhouse gas emissions. The early transition to lower carbon-based fuels will begin to create cleaner air and a stronger national energy security.

Viewers will also learn about additional applications for fuel cells— including utility and portable power requirements.

### *Goal of the Video Documentary*

The goal of the video documentary is to make the viewing public aware of the benefits of fuel cells technology.

### *Implementation of the Video Documentary*

A detailed time line has been developed along with a list of potential interviewees and locations. Preliminary storyboarding has begun and will be refined as interview footage is reviewed.

The first round of interviews was conducted at the Grove Fuel Cell Symposium held in London in September 1999. In addition, materials from the archives of Francis Thomas Bacon, instrumental in developing fuel cell technology in the 1950's, were photographed.

Assuming full funding, it is expected the premiere of the video will take place before the end of FY00 and efforts for commercial and/or cable distribution will be underway once a rough cut of the video is available.

# Participant Data for Science Education Programs

## Number of Pre-college Student Participants

| Program Name | Afr-Am Male | Afr-Am Female | Cauc Male | Cauc Female | Hispan Male | Hispan Female | Native Am Male | Native Am Female | Asian Male | Asian Female | Other Male | Other Female | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Am. Indian Community | | | | | | | 7 | 5 | | | | | 12 |
| Robotics Competition | | | 63 | 20 | 55 | 21 | 18 | 8 | | | | | 185 |
| Critical Issues Forum | 6 | 2 | 42 | 46 | 31 | 28 | 16 | 21 | 2 | | 4 | 4 | 202 |
| Ed. Pipeline/ Student Init. | 1 | | 29 | 11 | 16 | 10 | | | | | | | 67 |
| Science/Math Intern | | | 2 | 1 | 9 | 9 | 2 | 2 | | | | | 25 |
| Supercomputing Challenge | 2 | 1 | 168 | 39 | 46 | 24 | 35 | 22 | 10 | 3 | 33 | 11 | 394 |
| SUBTOTAL | 9 | 3 | 304 | 117 | 157 | 92 | 78 | 58 | 12 | 3 | 37 | 15 | 885 |

# Number of Undergraduate Student Participants

| Program Name | Afr-Am Male | Afr-Am Female | Cauc Male | Cauc Female | Hispan Male | Hispan Female | Native Am Male | Native Am Female | Asian Male | Asian Female | Other Male | Other Female | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Robotics Competition | | | 8 | 3 | 2 | 2 | | | | | | | 15 |
| Critical Issues Forum | | 2 | 3 | 7 | 1 | 9 | | | | | | | 22 |
| Energetic Materials | | | | 1 | | | | | | | | | 1 |
| Historically Black Colleges | 6 | 4 | | | | | | | | | | | 10 |
| Indirect Budget | | 1 | | 3 | 1 | 3 | | 1 | | | 1 | | 10 |
| Los Alamos Summer School | 1 | | 8 | 4 | 1 | | | | | 3 | | | 17 |
| Mentored Collab. Research | 2 | | 2 | 3 | 4 | 1 | | | | | | | 12 |
| Nuclear Future | | | 5 | 8 | | 2 | | | | | | | 15 |
| Oak Ridge Institute | 2 | 3 | | | | | | | | | | | 5 |
| Science/Math Intern | 1 | | 6 | 3 | 6 | 8 | 2 | 1 | 1 | | 1 | | 29 |
| Two-Year College | | | 4 | 2 | 10 | 2 | 6 | 3 | | | | | 27 |
| Undergraduate Research | 1 | | 11 | 4 | 3 | 2 | | | | 2 | 1 | | 24 |
| USA TODAY Students | | | 2 | | | | | | | | | | 2 |
| SUBTOTAL | 13 | 10 | 49 | 38 | 28 | 29 | 8 | 5 | 1 | 5 | 3 | | 189 |

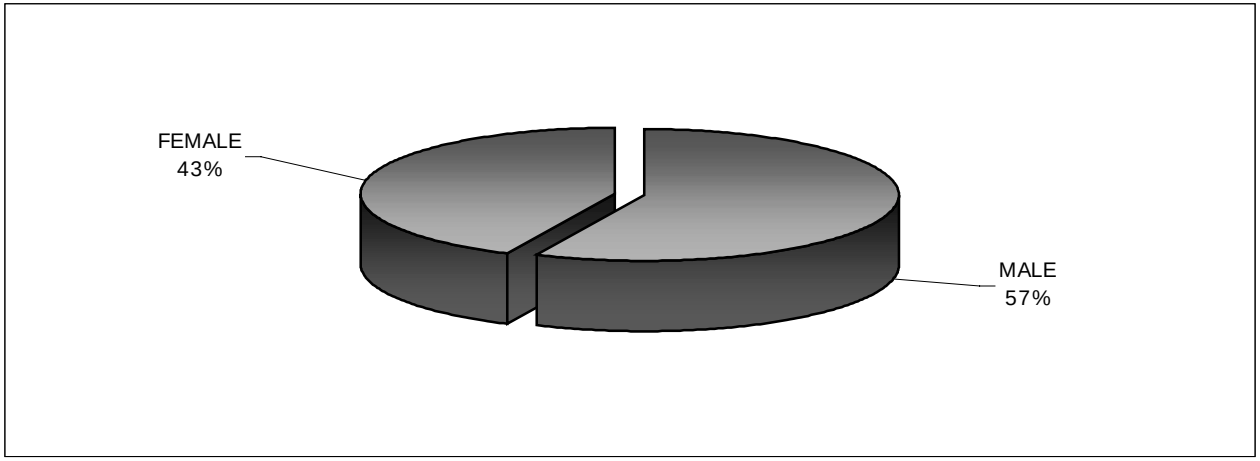
## Number of Graduate Student Participants

| Program Name | Afr-Am Male | Afr-Am Female | Cauc Male | Cauc Female | Hispan Male | Hispan Female | Native Am Male | Native Am Female | Asian Male | Asian Female | Other Male | Other Female | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Energetic Materials | | | | | 1 | | | | | | | | 1 |
| Graduate Degrees | 2 | 1 | | | 1 | 1 | | | | | | | 5 |
| Historically Black Colleges | 2 | | | | | | | | | | | | 2 |
| Indirect Budget | | | | 1 | | | 1 | | | | | | 2 |
| Mentored Collab. Research | | | | 1 | 2 | 2 | | | | | | | 5 |
| National Physical Science | | 1 | | | 1 | 3 | 1 | | | | | | 6 |
| Nuclear Future | | | 14 | 12 | 2 | | | | | 2 | 1 | 2 | 33 |
| Oak Ridge Institute | | 1 | 3 | 2 | | | | | | | | | 6 |
| South Carolina Research | | | 1 | 2 | | | | | | | | | 3 |
| Science/Math Intern | | | | 1 | 3 | 6 | 2 | | | | | | 12 |
| Two-Year College | | | | | 1 | | | | | | | | 1 |
| SUBTOTAL | 4 | 3 | 18 | 19 | 11 | 12 | 4 | | | 2 | 1 | 2 | 76 |
| TOTAL STUDENTS | 26 | 16 | 371 | 174 | 196 | 133 | 90 | 63 | 13 | 10 | 41 | 17 | 1,150 |

## Number of Teachers / Faculty

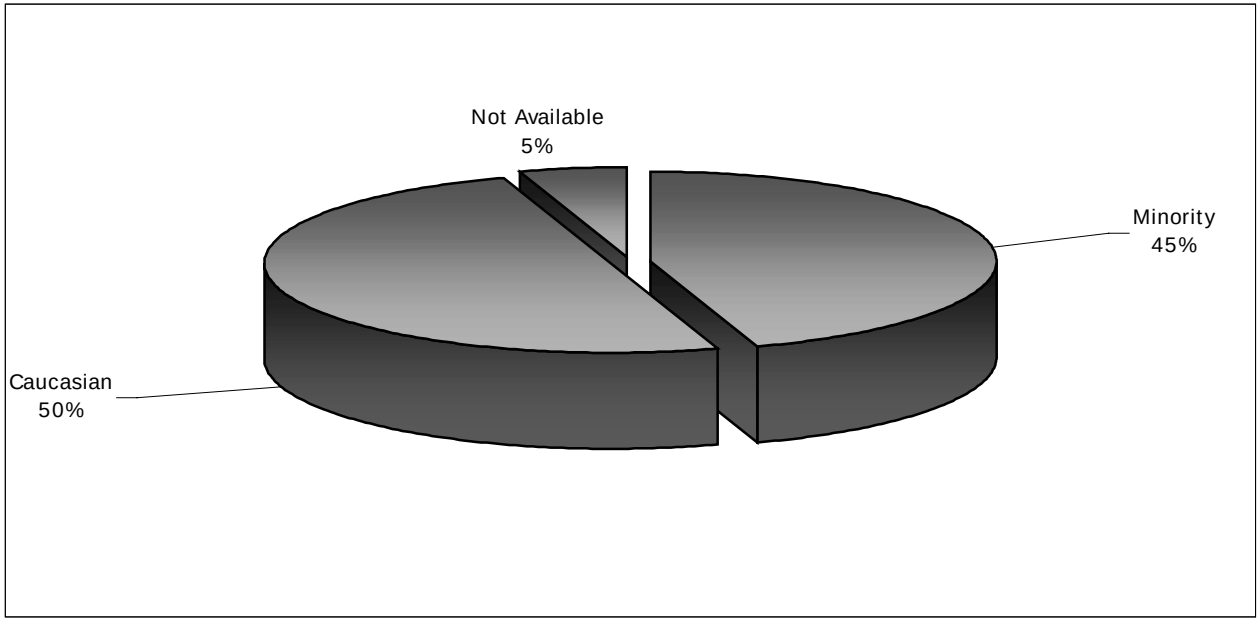
| Program Name | Afr-Am Male | Afr-Am Female | Cauc Male | Cauc Female | Hispan Male | Hispan Female | Native Am Male | Native Am Female | Asian Male | Asian Female | Other Male | Other Female | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Am. Indian Community | | | | | | 1 | 5 | 2 | | | | | 6 |
| BEAM Robotics | | 1 | 5 | 3 | 2 | 1 | | | | | | | 12 |
| Critical Issues Forum | | | 30 | 13 | 3 | 3 | 2 | 1 | | | | | 51 |
| Ed. Networking | | | 74 | 67 | 30 | 54 | 22 | 40 | | | 19 | 10 | 247 |
| Energetic Materials | | | | | | 1 | | 1 | | | | | 1 |
| Ed. Pipeline/ Student Init. | | | 1 | 7 | 2 | 2 | | | | | | | 12 |
| Historically Black Colleges | 3 | 1 | | | | | | | | | | | 4 |
| Los Alamos Science Outreach | | | 4 | 4 | | 1 | | | | | | | 9 |
| Oak Ridge Institute | 1 | | | | | | | | | | | | 1 |
| Science/Math Intern | | | 2 | | | 3 | | | | | | | 5 |
| Supercomputing Challenge | 1 | | 27 | 26 | 4 | 2 | 1 | 1 | | | 2 | 2 | 61 |
| Teacher Opportunities | | 1 | 17 | 43 | 5 | 19 | 2 | 9 | | | | | 87 |
| Two-Year College | | | | | 2 | | | | | | | | 2 |
| TOTAL TEACHER/FACULTY | 5 | 3 | 160 | 163 | 48 | 87 | 32 | 54 | 0 | 0 | 21 | 12 | 585 |
| TOTAL PARTICIPANTS | 31 | 19 | 531 | 337 | 244 | 220 | 122 | 117 | 13 | 10 | 62 | 29 | 1,735 |

## Gender—Science Education Programs

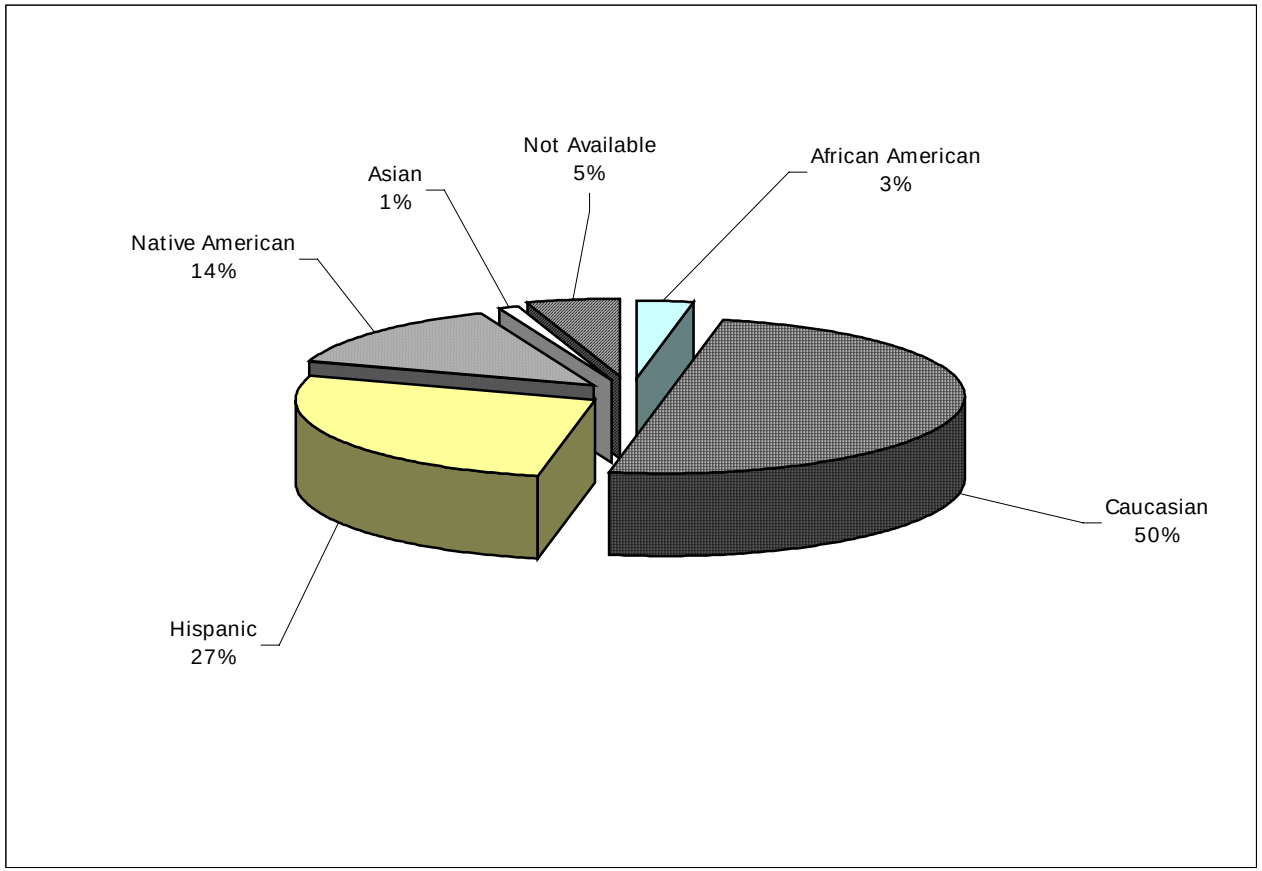



Male 57%
Female 43%

## Diversity—Science Education Programs




Minority 45%
Caucasian 50%
Not available 5%




African American 3%
Caucasian 50%
Hispanic 27%
Native American 14%
Asian 1%
Not available 5%