LA-UR-98-4870

Los Alamos National Laboratory

Science Education Program Annual Report

October 1, 1997 - September 30, 1998

LOS ALAMOS NATIONAL LABORATORY

SCIENCE EDUCATION PROGRAM

ANNUAL PROGRESS REPORT

October 1, 1997 - September 30, 1998

Most of the Science and Mathematics Education Programs described in this report were funded by the United States Department of Energy.
These programs were implemented by the Los Alamos National Laboratory.

This Report is Submitted by

Dennis H. Gill

Program Manager for Science Education

Los Alamos National Laboratory

Mail Stop F671

Los Alamos, New Mexico 87545

505-667-8680

dgill@lanl.gov

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Los Alamos National Laboratory has a unique contribution to make to science, mathematics, engineering, and technology education. 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, Los Alamos 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 DOE 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 (Northern New Mexico). The activities in these projects during FY98 are described in this report.

FY98 was an active year for the Science Education Program at Los Alamos National Laboratory. We conducted 24 separate projects that had a total of 2323 direct participants. The indirect impact of these projects was significantly greater, because many of the direct participants were teachers, 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 FY98 to be approximately 120,000 students.

In all of the Science Education Projects we partner with other organizations and entities. We partner with the schools, teachers and administrators, with 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 of DOE are especially linked to technical areas of interest to DP and to DP goals and objectives. 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 teachers) as research interns to work alongside Laboratory scientists and engineers. Each of these interns is assigned a Laboratory staff member as a mentor. Care is taken in choosing the mentors, and training and information are provided for the mentors. These mentors provide 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 FY98, 46.7% were minority and 48.9% were female. The ethnic distribution of the participants is shown in detail in Section VI, Statistics, at the end of the report. It should be noted that this distribution is for direct participants, and the indirect participants were even more diverse. For example, some of our teacher participants are themselves Anglo, but have classrooms that are 80-100% minority.

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. We also have a few of the projects evaluated formally by external organizations.

Significant changes in the overall program in FY98 included the fact that three projects were discontinued from FY97, and three others were merged into a single project. In addition, six new projects were started, and the formats of several projects were modified extensively. For the first time in FY98, our three major teacher enhancement projects were merged into a single integrated project, TOPS (Teacher Opportunities to Promote Science). TOPS teachers from all grade levels (K-12) met together sometimes to form multilevel teams within their local districts, and when appropriate, met separately within grade levels for grade-appropriate content and pedagogy discussions. This new project structure is working very well. It has significantly improved the cooperation within districts, and provided a peer group for the TOPS teachers within their own district. The Critical Issues Forum has transitioned into almost total electronic delivery, using an interactive Web Site. The Atomic, Molecular, and Optical Physics Summer School has broadened its purview to more areas of physics, and in the future will be called the Los Alamos Physics Summer School. For FY98 only, this project ran a special student program related to the Annual Meeting of the American Physical Society Division of Atomic, Molecular, and Optical Physics. This meeting was held in Santa Fe, and coordinated by two of the principal education coordinators for the AMO Physics education project. The pilot was so successful that APS plans to duplicate the effort at some of its other divisional meetings this year.

New projects this year include the Web of Learning, EPSILON (Educational Pipeline for Student Initiatives Linked on the Network), AICSEP (American Indian Community and Science Education Partnership), ACE and TWINS (both NASA projects), and the LANSCE virtual tour project. These projects are described in the body of the report. In addition, there was one project that was for this year only. The Fifteenth Annual International Conference on Technology and Education (ICTE) was held in Santa Fe, and the Los Alamos education program office and coordinators were heavily involved in the organization and running of this conference.

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 3000 times per day in FY98, by hosts from more than 68 countries.

The Science Education Program at Los Alamos is very valuable to the Laboratory and to DOE. We are very proud of our accomplishments recorded here, and look forward to FY99 with enthusiasm. Please feel free to contact us if there is any additional information that you need.

LOS ALAMOS NATIONAL LABORATORY

SCIENCE EDUCATION PROGRAM

ANNUAL PROGRESS REPORT

October 1, 1997 – September 30, 1998

I. TEACHER/FACULTY ENHANCEMENT

A. Teacher Opportunities to Promote Science (TOPS)

Program Description

TOPS (Teacher Opportunities to Promote Science), conducted by Los Alamos National Laboratory (LANL), is a three-year teacher enhancement program which targets elementary, middle and high school math, science and technology teachers. Participant's combine to form teams with representation from all three levels, ideally within the same school district. The program goals include promoting science curriculum alignment and communication through networking and skills development. In FY98, TOPS teachers participated in Year 2 of the three-year program. The K-12 teams attended academic year workshops and a summer institute. Teachers increased their science teaching skills through the integration of mathematics, science and technology, as they developed appropriate, inquiry-driven curricula, and they modeled sound pedagogical practices, including constructivist practice, Socratic dialogue methods, and cooperative learning. LANL scientists acted as mentors and the curriculum projects tied directly to ongoing Laboratory science. The teacher-developed projects are posted on the web site (http://set.lanl.gov/programs/tops), and teachers can revise the curriculum as it is lived out in the classrooms. The projects are designed to promote communication among the regional education communities and to develop communication networks that include teachers, students, and community members.

Goals

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

- increasing teachers' knowledge of 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' districts;
- exposing teachers to the application of science, math, and technology to research at national laboratories;
- providing a mechanism for teachers to encourage students to pursue careers in science, math, engineering, and technology,
- developing a web-based communications network with the intent of developing a strong educational support network among the program participants and within and beyond their own communities.

Implementation

Participants — A total of 65 elementary, middle, and high school teachers were selected in the spring of 1997 for this three-year teacher enhancement program. By the summer of 1998, nine teachers (14%) were dropped from the program due to lack of participation**,** for reasons ranging from transfers to other schools to lack of administrative support. The remaining 56 TOPS participants teach in grades 2-12, from 15 school districts (2 of them out-of-state) at 33 public schools, 1 private school, and 5 BIA schools. Of these participants, 74% are female and 26% are male, with an ethnicity breakdown of: 74% Anglo; 21% Hispanic; and 5% Native American. The TOPS teachers serve student populations ranging from 20% to 100% minority population, with an average minority population of about 80%.

Almost half the current TOPS participants teach at BIA schools or in districts in the Four Corners area of New Mexico where the student population is majority Native American. That makes the TOPS program a means for the federal government to address many of the goals of the "American Indian and Alaska Native Education" Executive Order through an established, successful LANL science education program. In fact, at a special ceremony for Secretary of Energy Bill Richardson in Window Rock, AZ, on September 12, 1998, TOPS was given special recognition as a model program that improves the math, science, and technology education of Native American K-12 students in New Mexico.

TOPS features several well-integrated components to create a balanced, comprehensive teacher development experience for K-12 teachers. These components include science and mathematics that are relevant to the teachers' curricular needs, fit with the national standards, and highlight Laboratory science. Teachers learn how to develop curriculum that integrates science and mathematics, essential technology applications, and provides opportunities for community involvement.

Theme — The overarching theme for the three years with this cohort has been communications. Participants were introduced to the broad theme of communications through topics ranging from nonverbal communication, coded communication, wired and wireless communication, and networked communications to communication in space. LANL's Science Education Team developed an inquiry-based scenario that links to state-of-the-art science at the Laboratory by applying current communications technology to research in space.

Science — This program leverages LANL's scientific capabilities with our science education program goals by integrating our core competencies to improve the understanding of science, mathematics, engineering and technology by providing:

- partnerships between numerous Laboratory divisions (STB, Computer, Information and Communications, Physics, Nonproliferation and International Security, LANSCE) and education communities;
- resources and technical support from Laboratory personnel to schools and districts;
- electronic communications technology (web sites, email, collaborative workspaces) as one method of distributing science education materials to the public;
- the ability and means for teachers to utilize technology appropriate to the research topic;
- enhancement of teachers' use and understanding of science research methods and technology;

- enrichment opportunities for teachers in cognitive science research, workshops, and science curriculum development;
- direct and indirect enhancement of the public understanding of real world Laboratory issues; and
- LANL scientists who share their expertise and love of science with the teachers by giving them presentations, answering their questions both in-person and on-line, visiting their classrooms, providing tours, and generally assisting them in the learning and teaching of their topic.

The science component in TOPS ties directly to the efforts at Los Alamos National Laboratory. Since the overarching theme of the current program is communications, Space Science and Astrophysics was chosen to be the focus science at the Laboratory for this cohort. Basic concepts were identified and became the threads for developing each team's space science curriculum in a spiral fashion that allows teachers to scaffold the learning. The teachers work with LANL scientists who act as content experts and assist the TOPS teams in developing the online science lessons. The ultimate goal is to create an academic curriculum that replicates the authentic tasks a scientist performs in the workplace, so that the student learns science by performing it in the same context as a professional scientist. LANL scientists contribute as mentors who volunteer their time and energy to provide content and process expertise as the TOPS participants develop their curriculum projects. During FY98, LANL mentors contributed a total of 288 hours of effort for an internal indirect contribution of approximately $28,800 to the TOPS program.

Mathematics — A math component complements the science scenario. The component models for teachers how to integrate math topics and skills with science and technology through thematic units. The component demonstrates the application of the NCTM Standards to math curriculum design and the use of the standards as a tool for teachers and their students to become more reflective math practitioners. For example, at the summer institute, participants learned to use graphing calculators and the concepts of Least Squares Fitting to calculate the mass of a star. In a similar fashion, TOPS teachers learned how to model appropriately the integration of mathematics concepts and tools into their own space science curriculum projects according to the grade level they teach.

Curriculum Development — TOPS teams develop curricula for the needs of their educational communities, grade levels, and subjects taught. Teacher teams select specific topics tied directly to LANL space science and design appropriate inquiry-based projects. For example, one team formed a partnership with NIS at LANL to develop classroom lessons on the FORTE satellite project that tracks lightning strikes on the Earth's surface. All of the teacher-developed, student-based units are inquiry-driven and model the sound pedagogical practices of constructivist and Socratic methods, cooperative learning, and math/science/ technology integration.

Each curriculum unit is posted on the TOPS web site as a work in progress with fundamental lessons for all levels of students, elementary through secondary. Currently there are 12 curriculum units being developed by the participant teams with topics ranging from traveling in space to the exploration of Mars. While the TOPS participants work directly with students at their local schools, the use of the Internet allows many additional teachers and students to access the same curriculum materials. Participants can revise the lessons based on classroom experiences and the feedback from peers in the educational community.

Technology — Throughout the three-year program teachers are developing a web based communications network with the intent of creating a strong educational support network among the program participants and their communities. Each team and each teacher develops web sites that focus on math/science curriculum development tied to district, state and national standards. The projects are designed to promote communication among the local education communities, encouraging both teachers and students to become increasingly proactive in communicating with their wider communities, and involving community members in their classrooms.

Collaborative workspaces, web sites and email allow participants common areas to post information useful to team members and their colleagues alike. Anyone may naturally gravitate to one or more of these electronic communication methods over others, but with the technology for sharing, the resources available are greatly magnified. The collaborative workspace and the use of email allow participants to perform two very important tasks: gathering information as independent learners, and collaborating on findings within a virtual learning community.

Utilizing the Internet and World Wide Web, TOPS teachers share curricular materials such as problem scenarios, lesson plans, and planning guides. This can increase teachers' confidence in their abilities as instructors and problem solvers. Networks have supported electronic conversations between the school and laboratory communities, as well as being used to encourage student-scientist partnerships and mentoring. Through the technology skills gained in this program, no TOPS teacher or his/her students need feel isolated.

Student/Parent/Community Component — Participants were given the opportunity to write proposals for a student/parent/community component (SPC) to enhance their TOPS program experience. Teachers that were awarded an SPC grant also received a small stipend to implement the proposal. The SPC projects were designed to provide math, science, and technology related enrichment activities involving students, their parents, and other community and school members. Projects to be conducted in the 1998-99 school year range from establishing a community-wide science newsletter, creating school web sites, and starting a radio station to improving various learning opportunities for the school and community through family nights. SPC interim and final reports are required from all grant recipients upon completion of the project.

Workshops — A northwest regional workshop was held on February 13-14, 1998, in Kirtland, NM, for the 32 TOPS participants in the communities of Kirtland, Shiprock, Farmington, Cuba, Aztec, and Bloomfield (Four corners Group). On February 20-21, 1998, the 33 participants in the communities of Los Alamos, Santa Fe, Pojoaque, Española Valley, Jemez Pueblo, Santa Clara Pueblo, Pecos, Tierra Amarilla, and Las Vegas (Santa Fe Group) met at LANL for the north central regional workshop. At each workshop, participants established multi-grade level teams, ideally with all three levels represented in all. The teams identified the concepts their curricula would cover and their ties to the LANL science topic. In addition each teacher was asked to design a personal web page and submit it to the Program Coordinator via electronic mail or on disk. To date, 96% of the current cohort have personal web pages posted on the TOPS web site.

The second north central academic year workshop for the Santa Fe Group took place on April 17-18, 1998, at LANL and was attended by 30 teachers. The spring northwest regional workshop was held on April 24-25, 1998, in Kirtland, NM, for the 32 Four Corners Group participants. Teachers at both workshops received instruction in the use of graphing calculators, using collaborative workspaces, and evaluating web sites. Participants worked on concept maps for the planning, research, and development of their teams' summer curriculum projects, with tasks to complete before their next TOPS meeting at the Summer Institute.

Summer Institute – The second of the three 2-week Summer Institutes for this cohort took place at the Canyon School Complex at Los Alamos National Laboratory on July 13-24, 1998, with 49 TOPS teachers attending, 30 of them staying "on the hill" at the Hilltop House Hotel. The teachers were divided into two or three equal groups that kept teams intact and dictated their schedules from 8:00 AM to 5:00 PM each of the 10 weekdays. The schedule created four distinct 105-minute periods for classes or other activities: "math and science with effective pedagogy" classes; "developing computer networks and curriculum" classes; team planning and curriculum development time; "dreams + action = reality" seminars; and conferences with volunteer LANL scientist/mentors working in the area of space science. Twenty-two of the TOPS teachers took advantage of the option to earn up to 6 graduate credit hours through UNM-LA for the course work they successfully completed in this Summer Institute.

The computer lab at Canyon School Complex was kept open in the evenings from 5:00 PM to 8:00 PM, so teams could work on their website curricula, meet in informal discussion/study groups, see instructors for extra help, etc. On several evenings, opportunities were given to the teachers to tour Bradbury Science Museum, Fuller Lodge, Fenton Hill Observatory, and LANSCE. TOPS teachers were also invited to join the Los Alamos Pajarito Astronomers on their monthly "Dark Night" stargazing party at Overlook Park in White Rock one evening during the Summer Institute. Daily overview/debriefing sessions, weekly full-group curriculum update meetings, and several TOPS lunches and a cookout gave the teachers opportunities to reflect and share during the course of the Summer Institute.

Just as the work done at this Summer Institute built on the work the teachers had done over the past year, each TOPS teacher left LANL in July with several tasks to complete or continue. This included writing journal entries concerning the summer texts, (The Process of Education and Science for All Americans); completing a concept map for the team's science curriculum project; and making sufficient progress in the development of that curriculum on the web. Additionally, the teachers enrolled in TOPS for college credit had to submit a paper on their personal theory of curriculum by August 15. Thirty-nine teachers chose to submit proposals for TOPS 1998-99 Student/Parent/Community (SPC) projects by a September 1 deadline.

Program Evaluation

The TOPS program conducts formative evaluation over the duration of the program and produces a summative report at the end of the three years. The primary goal in the formative evaluation is to determine whether or not participants are making progress in connecting and transferring what they are learning in workshops and institutes to their actual classroom teaching. Formative data is collected through workshop and Summer Institute

evaluation surveys, teacher journals, written assignments produced for college credit, and interim reports on the Student/Parent/Community component.

In an evaluation study done by the University of New Mexico, the TOPS Program was shown after two years to be an effective approach for teacher professional development and enhancement. The emphasis on effective pedagogy was seen as valuable by 90% of the current participants who rated the TOPS teaching strategies and activities positively. One teacher commented that, "I am able to make science real for my students." Another teacher wrote, "TOPS has rejuvenated me. I see teaching in a much more positive way. It's like finding your first love. TOPS made me look at myself as a teacher again."

This same report concludes that participants have a high degree of satisfaction with the TOPS Program, because it provides a network of teachers that share information, resources and support. The TOPS Program is successful in increasing the technology skills of the teachers. Many participants have made tremendous gains, including the use of email to support teaching (53%) and accessing Internet resources for teaching (47%). By the end of the second year, the overall percentage for this area had risen to 74%. As a group, the teachers' self-confidence in telecommunications and technology use greatly increased.

The most recent survey given at the 1998 Summer Institute by the Science Education Team provides these statistics in reference to what the participants believe they have already achieved through TOPS:

- 59% indicate they have increased their understanding of effective pedagogy;
- 63% rate their confidence in doing math at 4 or higher on a scale of 1-5, where 5 = very confident;
- 68% say they have learned over half the skills listed as necessary to succeed in creating their own interactive web site where their team is developing a K-12 space-science related curriculum;
- 76% felt this professional development experience was positive and resulted in a gain of a lot of useful skills and techniques that can be applied to their teaching; and
- 90% credit the 1998 Summer Institute with increasing their math knowledge and understanding.

As a result of the program, participants increase their professional abilities in the areas of science teaching, curriculum development, instructional delivery, technology integration and assessment. TOPS teachers model the importance of mathematics, science, and technology to students and their parents and share TOPS program materials with colleagues in their districts.

Anecdotal Data

"My understanding of applications, computational techniques, and connections is greatly enhanced."

"The math classes helped to bring forward the math knowledge that I have had locked away."

"Computers are a big part of my curriculum. Now with our (space science curriculum) units going up, this will be a great addition."

"I'm writing a grant to design a (web) page for my school. Now I have the tools and professional development to make it possible."

"The learning was useful to me because I can now empower my students in a more timely and effective way on computer skills. Also, I am so much more hopeful that changes in technology will allow easier and easier access for my minority students, who have limited economic resources to the global society."

B. Advanced Composition Explorer (ACE)

Program Description

The ACE program provided the Science Education team an opportunity to forge new alliances within the Laboratory community this year. This project was a collaboration between the Science Education Team and Nonproliferation and International Security (NIS) to provide the educational component for a series of NASA funded programs. The Advanced Composition Explorer program (ACE), the first of several similar projects, focuses on studying the composition of the solar winds by the installation of two instruments on the Advanced Composition Explorer spacecraft, launched in August, 1997. The educational program was implemented to comply with NASA requirements that funded projects have an educational and/or outreach

component. The educational component of the ACE project involved teachers, K-14, in the development of multidisciplinary/multi-level classroom lessons and activities that focused on the scientific applications of the NASA project.

The Advanced Composition Explorer educational program was supported through Laboratory involvement by providing teachers with a scientific overview of the project, dialogue with project scientists, and through the development of classroom lessons and activities that helped to explain the project's mission. This program made it possible to enhance classroom practices by imparting skills in web page development, concept mapping and Internet research. Participant efforts were consolidated via e-mail and web-based curricula. Science Education program participants were taught how and encouraged to integrate computer technology into their classroom curricula. This was accomplished through direct instruction, modeling, and practice.

Program Objectives

The ACE Education Component was designed to enhance the overall quality of science, mathematics and technology education in northern New Mexico schools by:

- Increasing teachers' and students' knowledge of the science, math and technology involved in space physics.
- Enhancing teachers' skills in teaching the content of space physics.
- Providing hands-on activities and materials to utilize at participants' schools.
- Exposing teachers and students to the application of space physics to research at national laboratories.
- Providing a mechanism for teachers to encourage students to pursue careers in space physics and space science.

This program leverages LANL's scientific capabilities with our science education program goals by integrating our core competencies to "apply the unique resources of our National Laboratories and facilities to improve understanding of science, mathematics, engineering and technology." The ACE Education Component supports the LANL Mission in the following ways:

- Develops partnerships between LANL and the education community.
- Provides resources and technical support from Laboratory personnel to schools and districts.
- Provides electronic communications technology as one method of distributing science educational materials to the public.
- Provides access to Laboratory personnel through face to face workshops and telecommunications links.
- Enhances teachers' and students' use and understanding of science research methods and technology.
- Provides enrichment opportunities for teachers and students in cognitive science research, workshops, and science curriculum development.
- Enhances public understanding of real world Laboratory issues.

Program Implementation

A team of teachers, representing the middle, high school and post-secondary school levels in northern New Mexico were selected to participate in three workshops held at Los Alamos National Laboratory. The selected teachers worked together with Laboratory scientists to develop appropriate curriculum for their educational communities, grade levels, and subjects taught. The scientists identified the basic concepts of the content associated with the ACE project. The teachers designed appropriate activities, and then they implemented the activities in their classrooms. These teacher developed, scientist-directed, and student-based units were designed to be inquiry-driven and they modeled sound pedagogical practices including constructivist and Socratic methods, cooperative and collaborative learning, and the integration of math, science and technology.

Program quality was assured through effective telecommunications applications, workshops, and evaluation.

Telecommunications — The ACE Education Component required teachers and science education staff to develop web pages to serve as a central location for interaction and collaboration. To ensure parity among participants, schools provided participants access to the Internet, so that through the electronic medium, participants could access each other, Laboratory scientists and other researchers associated with the ACE project.

Workshops — ACE program staff and LANL science education staff met with teachers in a series of workshops to develop an effective curricular approach. The result was selection of specific concepts, provision of instruction for teachers and students in process and content, and the application of resources that required students to sharpen their critical thinking and problem solving skills through the study of space physics.

Teacher workshops were held as follows:

- May 1, 1998, at Los Alamos National Laboratory, nine teachers representing six New Mexico schools and 1 post-secondary school began the process of curriculum. In addition to the participants, four LANL mentors from the NIS-1 group provided assistance to the teachers in building content understanding. Participants established a working relationship with the LANL mentors, which was continued throughout the program.
- May 22, 1998, the program participants continued meeting with Laboratory personnel to develop content understanding that would be necessary for the development of the space science curriculum that would be implemented in their classrooms during the next academic year. In addition, the participants were introduced to design and creation of web pages.
- June 15-19, 1998, the program participants attended a five-day summer institute at Los Alamos National Laboratory to begin the development of classroom lessons and activities based on the ACE project. Laboratory mentors were available to answer questions and to provide further content as needed. The participants worked in collaborative groups based on their instructional level (elementary school, middle school, high school, and post-secondary).
- August 12-14, 1998, participants established a set of matrices as a culminating activity for development of the classroom lessons and activities. They focused on national and state education standards and determined which standards were addressed by each activity. The

activities were finalized, converted to HTML format and posted on the Science Education web server.

Program Evaluation

The evaluation was comprised of a combination of formative and summative strategies, including monitoring the development and use of the web site and an effective practices analysis of the products developed by the students of the participating teachers during the program. The program contributed to the overall approach for the implementation of an educational program and its interface with technological components with other programs. Development of specific educational technology applications and assessment were a significant portion of the teacher's responsibilities in this program.

Program Summary

The ACE program provided real and ongoing interaction among Science Education staff, Laboratory personnel and program participants. Through the Science Education Web Server and the ACE program web site (http://set.lanl.gov/programs/ace), program participants were able to exchange and compare data, maintain communications among teachers, scientists and Laboratory education specialists, and provided information about Laboratory research to the educational community locally, and nation wide. The participants investigated the programs' current topics through assignments, participated in workshops, and published their work on the Science Education Web.

Nine teachers representing New Mexico schools (K-14) participated in this program; two were females (22.2%) and seven were males (77.7%). All the participants were Anglo-American (100%). In addition to these participants, Laboratory mentors and Science Education staff members helped implement various aspects of the program, including web page design, HTML programming, network planning and implementation, Internet research, design of curriculum integrating computer technology, selection and use of appropriate content.

This program would not have been practical or cost effective without the use of telecommunications. A centralized platform within a technology environment used for development and exchange of educational information allowed the ACE program to be a presence in the rapidly evolving educational technology arena. ACE increased the amount of educational material focused on Laboratory science. This material was housed on the Science Education (SE) server. Through the use of this server to disseminate developed curricula, a larger and more diverse audience was reached. A total of 29 lessons or activities were developed and published for the ACE project (16 elementary school level, 5 middle school level, 5 high school level, and 3 post-secondary level).

II. CURRICULUM IMPROVEMENT

A. Risks, Rewards and Responsibilities

The Risks, Rewards, and Responsibilities curriculum was completed in beta form and distributed (over 300 sets) during FY97. The premise of the curriculum was that one takes risks to obtain rewards, but in so doing responsibilities are incurred. The curriculum used radiation as a vehicle for examining radiation and addressing issues related thereto. During FY98, the curriculum was examined with a view of what is required to make the curriculum more embraceable across a broader range of topics.

One of the central themes of the R3 curriculum is the assessment of risk. Unfortunately, most risk assessment materials are targeted at the collegiate level and beyond. Exploring the Internet, one finds little material regarding risk assessment other than professional societies and risk assessors purveying their wares. At the same time, one finds a great deal of mathematical tools related to risk assessment (e.g., probability and statistics) available for teachers of almost any level. For example, the following web site contains a broad selection of individual tools available to teachers:

http://scrtec.org/track/index/math.html.

The presentation of tools allows teachers to pick and choose those with which they are most comfortable for support of existing, standard curricula. Based on this cursory analysis, it appears that two things are needed to broaden the appeal of the R3 curriculum.

First, a risk assessment curriculum is needed to incorporate the concepts of probability, statistics, and value assessment. Second, the curriculum must dovetail with current curricula to supplement, rather than replace, existing materials. While not a requirement for the curriculum, per se, focus should also be given to the distribution medium. Content and supporting tools should be distributed by CDROM as an alternative to Internet availability.

As was reported in the mid-year report, the Lab's MegaMath (http://www.c3.lanl.gov:80/mega-math) program demonstrated through its treatment of discrete mathematics that many of the concepts of risk assessment can be understood without the need for rigorous and complex mathematical development. It appears prudent to take this path as well as bringing MegaMath up to date (its web presentation is over five years old). Unifying these two needs suggests a program that places greater emphasis on mathematics in the science, mathematics, engineering, and technology array. Through these avenues, Defense Programs work can be emphasized since risk assessment is directly related to public understanding of many DP issues.

B. AIMS Fluid Instabilities Curriculum Development

Program Description

The goal of this project is to educate students and the public about fluid instabilities and their consequences in the everyday world. We are developing a book of hands-on activities intended for grades 5-9 but also suitable for high school. Also, we are striving to interest science museums in fluid instability exhibits and we continue to do presentations for students and teachers.

The behavior of interfaces between different fluids provides a delightful set of activities to arouse students' interest in fluids, both gases and liquids. We made substantial progress during FY98 on the book in progress, Spills and Ripples, that 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 (Fresno CA) during the last four years.

The focus of the book shifted to 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. We began Spills and Ripples with the philosophy that it would be exclusively devoted to fluid instabilities, but feedback from teachers, peers and students convinced us that activities about fundamental fluid properties in the same volume is preferable.

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

Program Implementation

Five RTI activities have been developed for Spills and Ripples and two 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 Prof. Sheila Widnall, which can be used in schools for women's history studies. The third lesson, "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.

Another facet of this project is educating the public about this fluid instability and its effects. We are attempting to adapt the classroom demonstrations and lessons to a format suitable for a science museum exhibit. During FY98 we began working with the exhibit development staff of a major U.S. science museum. We successfully did a feasibility demonstration for an interactive exhibit, but substantially more work is needed to render a museum-quality exhibit.

We continue to present RTI lessons to high school teachers under the

auspice of the American Physical Society. We presented to about fifty teachers at the High School Science Teachers Day (HSSTD) at the annual Fluid Dynamics Meeting (November 1997 at San Francisco) and we have trained peers at LANL so more "Rayleigh-Taylor presenters" are now available.

C. Web of Learning

Program Description

The Web of Learning program involves using the Internet, specifically 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. The web site is a place where students, teachers, and other individuals can go for information that is immediately useful, activities and events that are currently in progress, and plans in development. The site is a virtual library that is being designed in real time by the activities and information that are being contributed to reside there. For example, a contest presently planned for October will help us identify mathematically talented students; students who will both use the web site to help them prepare for the contest, as well as students whose talent will contribute to the information about mathematics at the site.

In other competitions, teams of students and teachers will be challenged to write tutorials on specific subjects in mathematics and science and the best will be put on the Web. Additional activities will be held to improve existing tutorials. This pilot project is currently restricted to tutorials based on the innovative text, *Algebra through Problem Solving* by Hillman and Alexanderson; however, in future years it will be expanded to other branches of mathematics and scientific disciplines.

Program Objectives

The goal of this project is to provide an electronic resource that can be accessed by teachers, students, and others, which focuses on the following objectives: (a) give every student in the country access to an excellent education in mathematics and science; (b) provide students a resource to study mathematics from a non-traditional and potentially more effective point of view; (c) provide students a resource for exploring mathematical and scientific research; (d) provide help on-demand for motivated students to move ahead at an accelerated pace; (e) provide teachers a means to enrich math and science content for students who need it; (f) help students who fall behind or are away from school for extended periods because of illness, injury, travel, etc.; (g) provide teachers with a tool to evaluate learning; and (h) encourage wider acceptance and use of the mathematics and science education standards.

Implementation

Our Web site, http://set.lanl.gov/programs/learning/, is up and running, and the text *Algebra through Problem Solving* by Hillman and Alexanderson can be found there. The plans for a math contest for grades 7 through 12 in the Four Corners Region are completed and implementation is scheduled for October 17. This contest and the problem set in the Web of Learning web site should produce a pool of students and teachers who can be invited to

participate in the first tutorial writing contest. Guidelines for the tutorial writing contest and a sample tutorial should be on the Web by the end of January. A workshop for teachers interested in participating in the tutorial writing contest should be possible in late February or early March. The completed tutorials are due in May, the winners announced by the end of June, and the successful entries will be on the Web by mid-August, 1999.

Partnerships

This project was generated principally from our observation that such a resource, especially one that focused on mathematics was needed and wanted. Discussion about the concept with others has generated interest and enthusiasm for partnering with us to “grow” the web site in breadth and in depth. Lawrence Livermore National Laboratory intends to construct a page linked to laser science that will link to the Web of Learning site. New Mexico State University offers a cryptography course that teaches mathematics, and which will become a resource on the Web of Learning site, as well.

Program Evaluation

Since this project is still in a "proof of concept" stage, we will evaluate how well we met our goals for the development of this site. Once the program is fully funded and goes into production, impact will be measured by the volume of activity generated on the Web, including problems submitted, tutorials developed, and by the interest generated by the contests. Data collected from on-line surveys received from teachers and students will be used to further assess impact and improve the program.

Summary

The Web of Learning is an ambitious project that has the potential of making a significant positive impact on math and science teaching in the U.S. Although the program is developmental, the progress to date, and interest demonstrated in the concept are encouraging. A September press release about the Web of Learning and the mathematics contest in the four corners area (the first sponsored activity) has generated interest at Los Alamos from scientists who are interested in contributing time for mentoring and tutoring students. This is the next step to making this virtual site a reality.

D. LANSCE Educational Tours

Program Description

This project contracted to the Science Education Team by the Los Alamos Neutron Scattering Center (LANSCE) was a significant collaboration on the part of the LANSCE staff, the Science Education Team, and local teachers to develop an educational tour for the Center. Beginning on June 8 through August 14, 1998, teachers from Pojoaque, Espanola, Belen and Jemez Valley school districts met with Science Education and LANSCE staff to develop the program. Two elementary teachers, one middle school teacher, and a high school teacher were physically located at the LANSCE facility in order to meet each day for ten weeks to design and develop a classroom package of education materials. Led by a science educator, the teachers spent half of each day with scientist mentors, and the other half working together as a team to create the tour curriculum to be used by other teachers who will be bringing their students on a tour of the facility in FY99.

The project was designed to highlight many research uses and practical applications of the linear accelerator at LANSCE. The classroom package consists of the following:

- A classroom activity book with pre-visit activities such as video, printed materials, hands on activities, and a web site.
- A guide for the tour of different sections of the LANSCE facility.
- Post-visit activities that include hands-on experiments, Web searches, and links back to the Laboratory.

Other scientific topics that were included are: an introduction to subatomic particles, radioisotopes, materials science, particle dynamics, nuclear stockpile, experiment design, inventing tools for science, circuits, fields, radio frequency generation and electrical engineering.

Implementation and Evaluation

Implementation of the program is expected to begin this fall, with the distribution of the pre-visit materials to those teachers who schedule a tour. LANSCE staff is waiting for the graphic artists in the Computing Division (CIC) to complete the package materials so that the program can get off the ground. LANSCE staff expects to be fully involved in the tours when the first buses from area schools arrive at the LANSCE center. An assessment of the effectiveness of the materials, the tours themselves, and the post visit activities will be administered to visiting schools at the end of their visit. A formative evaluation after the first several tours will contribute to the overall understanding of the effectiveness of the project and any modifications that may be called for. In effect, these first tours will be a field test for the project.

LANSCE has committed resources to conducting these tours because staff want the public to learn more about the science that is conducted there, especially the applied programs such as Accelerator-Produced Tritium, Science-Based Stockpile Stewardship, and Accelerator Transmutation. Also of interest are the LANSCE research programs: Nuclear Physics, Manuel Lujan Jr. Neutron Scattering Center, Neutron Science, and Radioisotopes. The LANSCE staff agrees with science educators that children are the audience to capture if scientific curiosity is to be cultivated in the interest of creating our future scientific workforce. The Science Education Team’s role

as facilitators of the educational tours project development for LANSCE has allowed us to demonstrate that we can provide the type of service with the level of quality that professional science educators at the Laboratory can be expected to provide for technical groups.

III. STUDENT SUPPORT

A. American Indian Community and Science Education Partnership (AICSEP)

Introduction

Nationwide there is a great concern that American Indian students 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 seldom choose careers in the fields of math, science, and technology. The American Indian Community and Science Education Partnership (AICSEP) is a program implemented in FY98, that makes LANL a collaborator in a comprehensive project to enhance mathematics and science teaching and learning experiences for American Indian high school students and their teachers. AICSEP is a partnership between LANL and Santa Fe Indian School's (SFIS) Community Based Education Model program (CBEM).

Goals

The Laboratory's goals in creating this program include: reaching more traditionally underserved students and teachers; increasing the number of minority professionals in math and science; encouraging and supporting systemic reform beyond the scientific community; and fostering an understanding of the Laboratory's mission to maintain and safeguard the nuclear stockpile.

SFIS implemented the CBEM program about two years ago as an elective course of study to increase students' academic interest and achievement in math, science, and technology. The program has its foundation in community 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 pueblo communities are involved in identifying the thematic issues for curriculum development and are called upon to be teachers and mentors when their children are conducting science studies in their communities. CBEM allows SFIS students to learn and use math, science, and technology experimentally towards a resolution of real-world community issues and problems, providing them positive experiences in science, and demonstrating its relevance to Native Americans' lives and cultures. The combined efforts of the AICSEP partners permits SFIS and LANL to achieve their goals together with greater benefit to the participating American Indian high school students and their communities.

Late in 1997 the Science Education Team Leader and the Native American Education Programs Coordinator discussed the need for a high school science education program specifically for the pueblos surrounding the Laboratory. It was determined that such a program could be created through a partnership between SFIS and LANL. The Laboratory would benefit from the pueblos' already established trust and working relationship with SFIS, while SFIS gained LANL support to add a summer component and physics content to its CBEM curriculum. In numerous meetings over the next 4 months, educators from the CBEM program, members of the Science Education Team, staff from the Nuclear Materials Technology (NMT) division, the Native American Education Programs Coordinator, and environmental staff members from two pueblos collaborated to develop the curriculum and

objectives for the new program. The American Indian Community and Science Education Partnership (AICSEP) was created.

Program Description

For six weeks, June 22-July 31, 1998, AICSEP provided two teams of high school students, their teachers, and environmentalists at Jemez and Santa Clara Pueblos the opportunity to participate in tours, lectures, and demonstrations about the nuclear science and related research conducted at the Laboratory. One day each week the teams of students and CBEM educators came to LANL. Pueblo community leaders, elders, and environmentalists who wanted to learn more about nuclear science and to observe the work being done at LANL usually accompanied the student teams. The CBEM/SFIS science educator followed up LANL visits with reinforcement of the science content by going to each Pueblo every week for a half-day discussion of the topics just covered at the Laboratory. The students worked as interns with the environmental staff at their respective pueblos 2 1/2 days each week, continuing baseline ecology studies begun during the previous school year through the CBEM program.

Participants

Student AICSEP participants were chosen among applicants who had completed at least one semester of the CBEM program at SFIS, which assured that they had met the prerequisites for that class: algebra II, biology, and computer literacy. Their previous participation in CBEM meant they additionally had the knowledge, skills, and fieldwork experience gained from that course. Since the students live at home during the summer, they had to be members of one of the two pueblos chosen to support AICSEP teams in the summer of 1998: Santa Clara and Jemez. Each team was made up of 4 or 5 students and several staff environmentalists from the students' respective pueblos. The total numbers of participants were: 9 high school students, ranging in age from 15-18 years (all Native Americans, 4 girls and 5 boys); 3 CBEM educators from SFIS (1 male Native American, 1 female Hispanic, and 1 male Anglo); and 5 pueblo environmentalists from the students' home communities (all Native American; 1 female and 4 male).

LANL Component — Each Tuesday during the six weeks, the two AICSEP teams came to LANL, accompanied by pueblo community leaders and elders who wanted to learn more about nuclear science and the work being done at LANL. The AICSEP participants and pueblo guests went to the Bradbury Science Museum, TA-55, the Ecology Group, LANSCE, Area G at TA-54, and the Tsierege ruins. The teams and their guests also participated in presentations by LANL experts on such topics as: sustainability and stewardship; history of Los Alamos; Rio Grande basin modeling; basic radiation science, detection, and protection; preservation of archeological sites; and ecology studies being conducted both at the Laboratory and in surrounding areas.

A significant feature of our program this year was the participation and commitment of staff from the Nuclear Materials Technology (NMT) division. They were actively involved in the planning of the AICSEP curriculum, and two of the six LANL visits were to TA-55. Experts at NMT Division spent one entire day teaching and answering questions about nuclear science, radiation, safety, and the purpose and method of the work conducted at that maximum-security LANL site. In addition to learning about nuclear science

and safety, this first visit also served to prepare the teams to be escorted into the plutonium facility (PF-4) itself, the following week. Important details were covered such as proper dress, required badges, explanations and demonstrations of the various alarms, sizing everyone for the protective gear the Laboratory would provide, and routine radiation monitoring procedures. On the next visit, even the youngest students were escorted into PF-4, where all the AICSEP participants were able to practice glove-box simulations in the same Training Center used for this purpose with LANL employees. Finally, the teams were escorted to see two of the actual Laboratories within the plutonium facility, where many of the same glove box techniques they had just tried themselves are routinely and safely used by LANL specialists in the performance of their jobs.

Early in the planning stages of AICSEP, it was suggested that pueblo community members be invited to come along with the teams to LANL site visits to participate with their children in the activities being conducted by LANL scientists. As a result, the weekly visits to the Laboratory almost always included respected elders and government leaders from Santa Clara and Jemez Pueblos who wanted to see and learn more about LANL for themselves. Many of them accompanied the AICSEP teams when they toured the plutonium facility on July 7, 1998. The AICSEP students saw first-hand that their pueblo leaders believed this program offered valuable education opportunities, and that learning is a life-long activity. The days' presentations at LANL always began with a prayer offered by a pueblo elder, demonstrating to the students the respect neighbors should have for one another. AICSEP proved to be an excellent opportunity for people of varied ages, cultures, backgrounds, and occupations, to meet, get to know, and learn from one another. Many of the Native Americans' fears and misconceptions about LANL, nuclear science, and radiation safety were addressed through question-and-answer sessions during each visit.

Community Internships — The AICSEP team at Jemez Pueblo worked on projects there that included ecological land surveying, plant identification to create a botanical field guide, and studies of the aquatic habitat on the Jemez River. In addition, the interns assisted in taking down wind towers in Cuba, conducting archeological field work at a pueblo site, and doing instrument calibration and computer data entry work for an on-going water analysis study. The team of 4 students generally stayed together as a group on these projects as they worked under the direction of the 2 AICSEP pueblo participants. Jemez Pueblo was able to conduct several special projects with the additional staff AICSEP provided and, on three occasions, LANL scientists were invited there to give the team additional assistance.

The 5 students on the Santa Clara Pueblo AICSEP team were usually each assigned to work on a different task with a different pueblo staff member each day they interned in their community. With the supervision of the 3 AICSEP environmentalists, the students were rotated through a variety of on-going projects to enable them to learn and contribute to a range of activities. Among those projects were studies of the air quality, ground water analysis, evaluation of possible archeological sites, and evaluating the feasibility of a dam being built at a particular pueblo location.

When the Oso Complex Fire required the concentrated effort of Santa Clara Pueblo to contain it and finally put it out, the students worked in the environmental office to be out of danger in the field and to relieve the adults there to fight the fire. Afterwards, the AICSEP team helped with studies to

assess the massive fire damage, especially the effects of ash on the surface water and fish. Through AICSEP these students were unexpectedly able to make important contributions to their community in a time of crisis, as they saw first-hand just how fragile the environment is and the role science plays in its protection and restoration.

Program Evaluation

The Science Education Team is conducting formative and summative evaluations of the program in collaboration with its partner, SFIS. Evaluation data were gathered, and in some cases are still being gathered, through site visits, portfolios, surveys, observations, student presentations, and interviews with individuals and the teams as a whole. Team products and the effectiveness of the pueblo/LANL/SFIS interactions will be critical factors in the program evaluation. The pilot program ended on July 31, 1998, so summaries of the evaluation reports are incomplete at this time. Ongoing discussions between the partners have already led to constructive changes that will improve AICSEP in FY99.

Summary

LANL is surrounded by fifteen American Indian communities who represent 12% of the population in northern New Mexico, yet little more than 2% of the Laboratory workforce is American Indian, and less than that is from the neighboring pueblos. The Laboratory occupies historic Native American land and the tribes have long expressed concerns about LANL operations and environmental and cultural impact on their communities. American Indian students are the future leaders of their communities, and their education and work experience will influence their relationship with the Laboratory. They are recognized as an important resource to LANL, both for the workforce, as well as for the development of literate, well-informed neighbors that contribute to, and understand, the activities at the Laboratory.

As CBEM succeeds in motivating SFIS students to pursue careers in science, the students will find that an understanding of physics is fundamental to understanding all the other sciences, including biology, ecology, and health. AICSEP intends for CBEM to expand and enrich its curriculum by adding a strong physics component to its pueblo-based science education program. As the physics is taught at LANL, the SFIS students, most of whom are from pueblos that surround the Laboratory, will be exposed to a broader career focus in other science-related fields than just environmental studies, and hopefully many will strive for workforce opportunities at LANL.

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 many of the education programs developed and conducted by Los Alamos National Laboratory (LANL): “improve ... mathematics; improve science education; and expand the use of educational technology.” A Task Force was established by this Order that includes representatives of the Department of Energy, which, through its Defense Programs (DP) division, funds the education programs conducted by LANL. AICSEP is a LANL science education program now in place that allows the Federal government to promptly address many of the goals of the “American

Indian and Alaska Native Education" Executive Order in a relevant and effective way.

B. Summer of Applied Geophysical Experience (SAGE)

Program Description

SAGE, the Summer of Applied Geophysical Experience, is a month-long, field-based course in geophysics for graduate students, upper-level undergraduate students, and selected professionals. The goals of the program are to enhance students' education in the earth sciences, to expose them to research, to encourage them to continue career advancement in earth science and related fields, and to expose them to career opportunities. 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 (see next section), by integrating data from a variety of techniques, and by presenting their results in oral and written format. 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 form an integrated interpretation in a geologic context. Teamwork, essential to SAGE, is emphasized throughout the program. In the field, students work in field teams to collect data. After data are downloaded to the laboratory, students work simultaneously as part of disciplinary teams (e.g., seismic refraction technique) and as multidisciplinary teams (focused on a specific topic) to process and interpret the geophysical data. 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 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.

Norm R. Carlson, Chief Geophysicist of Zonge Engineering, instructs students in collection of data using the transient-electromagnetic technique. This technique is sensitive to the earth's shallow electrical structure and is particularly useful for hydrological and mining applications.

SAGE 1998 students Tim Sodergren (Univ. Utah) reads a gravity meter while Christine Mann (right) (Univ. Nevada, Reno) records the location using Global Positioning System equip-ment. Both are under the watchful eye of Teaching Assistant Lisa McBee (Cal State, Long Beach), a student in SAGE 1997. Their project was part of a seismic, gravity, and magnetic study of the Rio Grande rift, which will have important implications for continental tectonics and for the hydrology of this rapidly growing region.

Some students come from universities that have strong geophysics programs. Others, however, are from smaller universities or colleges which do not have 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 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 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 be received by registering with the University of California (Riverside) Extension Program.

SAGE recruits nationally by means of an annual mailing to all geoscience departments in the U. S., a world-wide web site (see below), publications, 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 received some students through other coordination with educational programs at Los Alamos.

Logistics — SAGE is based at the College of Santa Fe (CSF) 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.

SAGE 1998 — In 1998, SAGE brought together 27 undergraduate and graduate students representing 22 institutions from the United States,

Mexico, and Germany (Table 1). 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 1998 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 (Fig. 2), 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 Office and the Santa Fe County hydrologist. The research goal, in part, was to help constrain hydrologic models in this water-starved and rapidly developing area. 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 (Fig. 1), and total-field magnetics was undertaken to study a Manhattan-era waste-disposal trench at Los Alamos National Laboratory. This study completed a project begun last year at SAGE. 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 1998 students declared an interest in environmental geophysics.

Visitors to SAGE this year included personnel from Kennecott Exploration Co., Texaco, Sensors & Software, Electromagnetic Instruments, Inc., Geometrics, Exxon, Chevron, the U. S. Geological Survey, Lawrence Berkeley National Laboratory, and Santa Fe County. The visitors gave lectures and worked with students in the field. Direct contact with scientists from industry is invaluable to students planning careers in geophysics. As in previous years, support both in dollars and in-kind 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, SAGE held two week-long workshops for NSF/REU undergraduate students from SAGE 1997. 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, combined, 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.

Jiracek and Baldridge 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 1998 "News" — (1) The Research Experiences for Undergraduates (REU) program of the National Science Foundation renewed its support of

the SAGE program for five more years. This funding provides a welcome continuity, and allows SAGE to continue to offer extra support to undergraduate students, including the midyear workshops in seismic and gravity/magnetic techniques (see above).

(2) Sandia National Laboratories (SNL) in Albuquerque, New Mexico, provided partial support for Dr. David Alumbaugh to join the SAGE program as Adjunct Faculty (Table 2). Alumbaugh, who took SAGE in 1986 as an undergraduate, received a Ph.D. from the University of California at Berkeley. Now a staff member at SNL, he is an expert in electrical/magnetic methods and an exceptional teacher. We hope to make this relationship permanent.

(3) An article summarizing some of the SAGE 1997 geophysical work at the MDA-B environmental site at the Los Alamos National Laboratory was published in Eos, the Transactions of the American Geophysical Union.

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

Evaluation — Students complete a detailed evaluation form at the conclusion of SAGE. Results of this evaluation constitutes 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. We maintain a data base of all former students (over 300) and of their current positions and affiliations, as best these are known. We have found that informal contacts at technical meetings and information from former SAGE students themselves are the best way of tracking SAGE students. All of the 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, and several work for the National Laboratories.

Information about SAGE — 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.

TABLE 1
Institutions Represented by Students Attending SAGE 1998

University of California, Riverside
University of California, Santa Barbara
University of California, San Diego
Boston University
State University of New York at Fredonia
University of Wisconsin
Centenary College of Louisiana
University of Nevada, Reno
Purdue University
University of W rzburg
Northern Illinois University

University of Southwestern Louisiana
Humboldt State University
Case Western Reserve University
University of Toledo
Georgia Institute of Technology
Universidad Nacional Autonoma de Mexico (UNAM)
Wofford College
University of Utah
University of Texas at Dallas
Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE)
Carleton College
University of Delaware

TABLE 2
SAGE Faculty

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
Dr. David Alumbaugh Adjunct Faculty	Sandia National Laboratory

C. Critical Issues Forum (CIF)

Program Description

The Critical Issues Forum 1998 focused on students' abilities to examine global concerns about issues surrounding the topic of terrorism in the nuclear age. The program targeted high school teachers and students throughout New Mexico and challenged them to examine the issue as it deals with nuclear materials and possible terrorist activities Participants examined every facet of this complex subject using various resources, including Laboratory personnel. Scientists at Los Alamos National Laboratory were able to interact with schools throughout the state through a Laboratory maintained Internet Web Server. The teams researched the political, economic, social/cultural, and scientific domains of this critical issue, compiled their research into meaningful documents, and demonstrated their understanding through a variety of multimedia presentations at a student conference on terrorism.

Goals

The goals of the Critical Issues Forum are to (1) provide opportunities to develop and apply critical thinking and problem solving skills on a complex problem of global significance; (2) promote cooperative learning through successful teamwork; (3) develop the connections between scientific concepts and everyday life; (4) increase understanding of the science process; and (5) increase public understanding of the issues related to the future of the nuclear world.

The program leverages LANL's scientific capabilities and resources by integrating our core competency in nuclear materials management stockpile support, and stockpile stewardship. The Critical Issues Forum supports the DP education mission by contributing to systemic improvement in science, mathematics, engineering and technology education, and by enhancing scientific and technical literacy.

Implementation

The Critical Issues Forum program is designed as a project-based research experience where teams of students and teachers gather information and begin to make sense of it in the context of a current global issue. To enable research teams to make recommendations, they must have a conceptually correct understanding of an issue. The CIF curriculum was designed this fiscal year to include a series of benchmarked assignments that develop a multidisciplinary approach to the study of terrorism in the nuclear age. Each benchmark engaged the student teams in research, critical thinking, communicating thoughts, and making connections. The benchmarks also provided a mechanism for assessment, both for the participants and for the classroom teacher as they built upon the previous skills and knowledge base. The work of each team was published in the form of an electronic portfolio, which appears on the CIF web site. The fact that the student teams wrote for an audience that included fellow students, teachers, scientists and educators (as well as anyone with Internet access) helped to increase the intrinsic motivation of the students to produce a well-researched and well-thought out position on the given assignment.

The student research teams had an opportunity to dialogue with world class scientists, both from research laboratories and from the academic world, who volunteered to act as “electronic mentors.” Twenty-one scientists from LANL contributed by answering student questions, provided relevant resources, and delivered content information at workshops. The participating divisions included STB, NIS, NMT, ESH, S, and NMSM. Communication between the students and the mentors took place through a question and answer area on the web page, over E-mail, and with an occasional face-to-face meeting at a number of regional workshops. The electronic mentors helped to guide the student research teams toward an understanding of the scientific process and the enhancement of their critical thinking skills.

As a culminating activity, the teams of students came together to demonstrate their learning using a multi-media presentation at the student conference. Students were required to apply to present at the conference, as for any professional conference. They utilized a variety of formats including poster sessions, web page presentations, position papers, video or other types of presentation media. Students were evaluated through the use of a scoring rubric that allowed everyone at the conference to provide feedback.

Workshops

The Critical Issues Forum was designed to best match Laboratory expertise with the needs of New Mexico high schools through a unique educational program. The CIF program provides an opportunity to apply multiple disciplines to a singular topic of current national interest. Through the CIF program, Laboratory personnel provided instruction and resources for students and teachers in process and content. This enabled teams to sharpen their critical thinking and problem solving skills on a real world problem of global concern.

Teacher and team workshops were held as follows:

- October 31-November 1, 1997 at Los Alamos National Laboratory, twenty-two teachers representing fourteen New Mexico high schools continued the process of curriculum development, which began in September. In addition to the participants, ten LANL mentors from the plutonium facility (TA-55) provided assistance to the teachers in building content understanding. Participants established a working relationship with the LANL mentors, which would be continued throughout the program.
- December 5-6, 1997, the program participants finalized the curriculum that would be implemented in their classrooms during the spring semester. The content of the curriculum was formatted in HTML for web publication. The curriculum consisted of 8 benchmark areas culminating with a student conference on terrorism held at Los Alamos National Laboratory in early May 1998.
- January 7-9, 1998, the program coordinators delivered a three day workshop at Lawrence Livermore National Laboratory (LLNL) to a group of teachers and program coordinators representing a number of California high schools and LLNL who were participating in the Critical Issues Forum. The Lab benefited from this collaboration effort because this allowed the Critical Issues Forum to be tested outside Los Alamos, thus helping to increase public understanding of the Lab's mission. In addition, Southern Regional High School in Princeton, NJ also used the Lab-developed, web-based, Critical Issues Forum program.
- January 23-24, 1998, student/teacher workshops were held in Albuquerque and Las Cruces. There were 120 students and 21 teachers and administrators in attendance at both workshops. The thrust of the workshops was to provide students and teachers with collaborative practice and skills in conducting brainstorming, organizing and questioning sessions. These skills were necessary as the student/teacher teams began to address the program benchmarks.
- March 20-21, 1998, the second student/teacher workshops were held in Albuquerque and Las Cruces. There were 100 students and 16 teachers and administrators in attendance at both workshops. The workshops were held to synthesize the material from the first half of the spring semester. Through dialogue groups, student teams established a set of matrices as a culminating activity for Benchmarks 1-4. They focused on regional and local acts of terrorism and determined the causes and considerations for each event. This activity was designed to allow students to demonstrate their understanding of the material to date.

Student Conference — The Student Conference on Terrorism was held at the Oppenheimer Study Center in Los Alamos on May 8, 1998. Ninety students, teachers, and administrators were in attendance at the conference. This final activity provided students the opportunity to demonstrate their acquired knowledge within the topic area. In addition to synthesizing and evaluating the knowledge learned through their research during the past semester, the students had to prepare their presentations using a variety of techniques. Concurrent sessions included the use of PowerPoint, web pages, video, lectures, and combinations of the above. Laboratory and community professionals involved with security issues, were invited to attend the conference and delivered presentations as part of the day’s program.

Site Visits — Each participating school was visited twice during the academic year. These visits 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, were provided with time to pursue the topic and that any on-site problems relating to the program could be addressed.

Web Server — To ensure parity among participants, the Science Education Team set up an Internet server as the central location for interaction and collaboration. Through the CIF web site located on the server, participants could access program staff, Laboratory scientists, and outside web sites, as resources. Users extended their scope of contact to include organizations and resources throughout the world, as their skills in telecommunications grew. Collaborative intrastate communications occurred between the students and teachers in New Mexico, California, and New Jersey. Team research via the Internet included both national and international postings.

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

Products — Each team produced web-disseminated products based on their work on the topic. In FY98, the teachers from each team worked on the development of the core curriculum incorporating issues of nuclear materials disposition, storage, use, and monitoring. The students examined a specific real world problem, addressing themes within the four domains (political, economic, social/cultural, and scientific), and their work was published in electronic portfolios on the CIF web site. These final dissemination products included poster displays, web-based poster presentations, and concurrent sessions where students used multimedia materials.

Demographics

Student Participants **-** In FY98, the total number of student participants was 265. There were 142 females (53.6%) and 123 males (46.4%). One hundred thirty (130) were Anglo-American (49%), 70 Hispanic American (26.4%), 6 Native American (2.2%), 3 African American (1.1%), 22 Asian American (8.6%), and 33 (12.4%) students did not specify ethnicity.

Teacher Participants **-** In FY98, a total number of 26 teacher participants were comprised of 10 females (38.5%) and 16 males (61.5%). The ethnicity breakdown for teachers was 20 Anglo-American (76.9%), 5 Hispanic American (19.2%), and 1 African American (3.8%).

Evaluation

The Critical Issues Forum program was evaluated through a combination of formative and summative strategies, including monitoring Internet use and an analysis of student products (e.g., position papers, presentation materials, etc.). These products were used to assess the extent to which students developed critical thinking skills and ability to work cooperatively in teams to acquire and understand issues such as non-proliferation. A variety of evaluation tools were used to measure the extent to which the program met its objectives. These tools included process feedback forms, student surveys, teacher surveys, evaluation of student written position papers, evaluation of student oral presentations, evaluation of student products, and observation protocols used by educators.

Recent research studies have shown the impact of networking technologies on learning, as well as the role that networking plays in the learning process. A recent national study shows that students with online access perform better on key information management, communication and presentation skills [Scholastic, 1997]. Survey results from the Critical Issues Forum program support these findings.

Within the CIF framework, students used telecommunications as tools for research and the application of knowledge. Significant increases were reported in using the computer and telecommunications as valuable tools for sharing information ($p<.05$) and doing schoolwork ($p<.01$). For research purposes, students showed significant increases in how to access information in science ($p<.0001$), science issues ($p<.0003$) and topics other than science ($p<.05$).

As a model for teaching critical thinking and problem solving, CIF's use of technology in a distance education framework allowed the teacher to reach beyond the confines of the classroom. Pre- and post-surveys administered to all participating students (265) and teachers (26) indicated increases that were directly attributable to involvement in classes utilizing this model. Evaluation results indicated that the model helped students see the relevancy of the areas of study in their lives. Highly significant increases ($p<.01$) were found in 1) how issues in science relate to global issues; 2) how issues in science relate to students' lives; and 3) how the program helps integrate understanding of science, politics, history and society. Students involved in this approach also reported a significant increase ($p<.05$) in pursuing a science major in college.

Although the CIF model emphasizes critical thinking within a given issue, much content information is discovered and made relevant for future in-depth studies. While studying the topic of "Terrorism in the Nuclear Age", students showed highly significant increases in the understanding of nuclear materials ($p<.0001$), the disposition of nuclear materials ($p<.0001$), how nuclear materials are stored ($p<.0002$) and the effects of nuclear materials on humans and the environment ($p<.0002$).

An anonymous post-program survey administered in May of 1998 captured the following responses from students: 1) I have learned how to present to others, how to use the Internet, how to work with others, and most of all, problem-solving; 2) In all of my academic classes, it helped out by seeing different points of view and the rights of people's opinions; and 3) I can't

begin to tell you how much I've grown from the program. It has allowed us to use our computers daily in the classroom, and it has also increased the demand for our school to step up with technology.

The evaluation results are used to further enhance the CIF program by identifying areas that can be strengthened.

Program Highlights

Students

- "I felt that it was a very educational experience. I learned a great deal and it changed my opinion about certain subjects."
- "I felt it was thought provoking and interesting. It was fun because it was challenging."
- "I found that the benchmarks really help bring together the understanding of terrorism."
- "It exposed me to a lot of things going on around the world."
- "I loved everything about it and learned a lot."
- "I thought it was pretty interesting to see the work the other schools did."
- "I enjoyed working with the Forum. Although my time was stretched, I always found time. I also liked the idea of a non-competitive program, it releases most pressure."
- "I feel CIF's process is efficient, especially for our generation and mentality levels."
- "The positive aspects [of the program] are that by doing all the work and research prepares you for the kind of work you'll be doing in college. "
- "I've learned how to present well for others, how to use the Internet, how to work with others, and most of all, problem solving."
- "I always seem to try to avoid the now less significant classes, now that I have attended a superior learning class, CIF."
- "I learned how to write and research papers with better preparation and care."
- "I can now present myself so much better in front of people. I know more about current issues and past issues in society. It also made me realize that one day I'd like to work here at Los Alamos National Laboratory."
- "In all my academic classes, it helped out by seeing different points of view and the rights of people's opinions."

Teachers

- "I love it. The questions lead the students in a spiral through the material."
- "The design of the web page [posting of assignments and student work] was very good. The regional workshops were helpful and informative. The emphasis on critical thinking was outstanding."
- "The Critical Issues Forum is a great way to encourage students to be informed in current issues and gives them the freedom to be creative in their own way."
- "The program really made the students stretch themselves. It also allowed them a legitimate reason to use the Internet daily."
- "This program provided many opportunities for students to expand their knowledge not only on terrorism, but on science and technology."
- "I can't begin to tell you how much I've grown from the program. It has allowed us to use our computers daily in the classroom and it has also increased the demand for our school to step up the technology."

- "Our teaching was enhanced by the established deadlines and curriculum. Our teaching was also motivated by the scope and depth of the curriculum."

D. New Mexico Supercomputing Challenge

Program Description and Objectives

The New Mexico 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. Each team receives an account on a computer at Los Alamos and an account with New Mexico Technet to access the state network and the Internet. Each team defines and works on a single computational project of its own choosing. 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 work force of the future. The program is both an educational experience and a competition that strives to (1) provide access to high-performance computers, (2) increase students' interest in science-related disciplines, (3) promote careers in science and engineering, (4) institute electronic networking among schools, and (5) expose students and teachers to computational experiences. Numerous organizations in New Mexico have joined with Los Alamos National Laboratory and New Mexico Technet since 1990 to sponsor the Challenge.

September 1998 will mark the beginning of the ninth year of the Challenge. Current information about the Challenge can be viewed on the Web at http://www.challenge.nm.org.

One goal of the Challenge is to transfer computing technology to the schools in New Mexico. The Laboratory is reaching out to New Mexico to be a good neighbor. The Challenge has provided a way to recruit future scientists for all of the sponsors as there are many bright students in New Mexico. The quality of science education in New Mexico has increased as a result of the Challenge.

The Challenge continues to provide a technology boost to schools and this past year there was a shift from emphasis on networking to an emphasis on computational science since most of the participating schools are past the networking hurdle.

Partners/Leveraging of Resources

LANL and New Mexico Technet, Inc. are the major sponsors of the Challenge, but other Labs and many universities and businesses collaborate with LANL and Technet in support of the Challenge.

During the eighth annual Challenge year, 1997-98, there were 15 sponsors and 22 contributors. The 22 contributors contributed money or in kind services up to $5,000 each. Microsoft became a sponsor this year providing several different software packages to the winning teams and they were to provide software to teams at the beginning of the ninth annual Challenge to help the teams produce their reports and presentations but that did not come through.

Implementation/Evaluation

The Challenge began the new year with a new main computer. An SGI O200 was purchased, at a discount, to replace the six year old Cray YMP/EL. Though the O200 is not a "supercomputer" class machine, it is compatible with the SGI O2000 machines that make up the new ASCI environment at LANL. The O200 is still front-ended with a Pentium-pro running Linux, which hosts student Web pages, http://mode.lanl.k12.nm.us. The official Challenge Web page is located at: http://www.challenge.nm.org

The Challenge year began with the Kickoff Conference in October that was attended by approximately 425 students and 81 teachers making up 112 teams from 46 schools. There are 106 abstracts entered on-line at http://mode.lanl.k12.nm.us/97.98/abstracts. 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. LANL provided 15 of the instructors and 14 instructors came from the other sponsors. Students have an opportunity to talk with scientists about their particular area of interest.

Data was collected about the participants. Females represented 30% of the students and 37% of the teachers. Ethnic representation for students was: 57% white, 25% Hispanic, 14% American Indian, 3% Asian, and 1% African American. Ethnic representation for the teachers was: 82% white, 11% Hispanic, 5% American Indian, 1% Asian, and 1% African American. Over half of Challenge participants are from small towns and rural areas.

During January, one day regional workshops were held at six different institutes of higher education around New Mexico where the participants were instructed on programming, Unix, the Internet, and public speaking. This year a "meet the scientist luncheon" was added where local faculty members and local scientists discussed the team's project with them over lunch. This worked well at five of the six Regionals and will be repeated and fine tuned again next year.

The Challenge competition came to a conclusion in April when about 250 participants came to Los Alamos where they were given tours that included many scientific talks given by LANL scientists. They were able to see the computers that they had been working on while walking through the Laboratory Data Communication Center machine room. Talk topics included: SGI/Cray Computers, the Network Operations Center, Robotics, TRANSIMS Animation System, Hazardous Devices Team-Equipment and Procedures, Laser-Induced Breakdown Spectroscopy, supercritical fluids, Nuclear Rockets, Particle Accelerators and their applications, Experiments on Explosives, Adventures in Uncertainty with a Statapult, Snake Awareness Program, and Subliminal Channels of Encryption. Approximately 90 LANL employees were involved with the activities in one way or another, 35 of them were escorts. A team of three girls and one boy from Las Cruces walked away with the top honors, see the press release at: http://mode.lanl.k12.nm.us/97.98/awardsday/050198.html

During the summer, the State Department of Education prints a binder of the finalists' reports and sends 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.

Teacher Training

In June, a two-week Summer Teacher Training Session was held at New Mexico Highlands University in Las Vegas, New Mexico. There were 16 teachers participating and they received 3 units of graduate credit from NMHU. They were instructed in C++, Unix, the Internet/WWW, HTML, and other topics. Although they were intense days of instruction, the teachers learned a lot and said that they would recommend the sessions to others. The teachers' pre-test and post-test scores show that they improved significantly during the two week course.

In August, a one-week Summer Teacher Training Session was held just for high school teachers who were not familiar with the Challenge but wanted to be involved in the 1998-99 Challenge. Fifteen teachers spent the week at NM Highlands University and should be well prepared to sponsor teams in the Challenge. Over half of the teachers were from schools that have not previously participated in the Challenge.

The Future

We are hoping to have a very special Tenth Annual Challenge during the 1999-2000 year. We will make an effort to involve as many past participants as possible and to produce a Ten Year Report.

The Challenge has had a positive impact on students, teachers, schools, and communities. LANL's participation has had a positive effect on participants' perception of the Laboratory.

Each year, students design the logo for the following year. Past logos are online at http://www.challenge.nm.org and http://www.challenge.nm.org/Archive.

LANL and the Challenge look forward to their contributions to the future participants and the world in which they will live.

E. Historically Black Colleges and Universities (HBCU)

Program Overview

Historically Black Colleges and Universities enjoy a history of developing young African American students through the analogy of turning chunks of coal into brilliant diamonds. The University Programs Office at Los Alamos National Laboratory (LANL) is privileged to serve as a unique contributor to the further development of those brilliant diamonds into future scientists and researchers.

From 1984 to the present, LANL’s HBCU Program has continuously ensured the mandate of the original 1981 Executive Order 12320 signed by former president Ronald Reagan to our current president, William Clinton. This Order specifically mandates the development of federal plans designed to achieve a significant increase in the participation of Historically Black Colleges and Universities in Federally sponsored programs.

Program Objectives

The HBCU Program seeks to ensure the mandate of Executive Order 12320. To that end, the University Programs Office builds toward the enhancement of career prospects of African American students and faculty in science, mathematics, engineering, and technology disciplines. This is accomplished as schools are strengthened to further produce a positive and continual impact as HBCUs expand their capability to excel in technical and scientific teaching and research.

We employ three components to effect this change in the participation of HBCUs from less to greater research in science, engineering, and technology. They are: (1) institutional collaborations toward on-site research; (2) faculty capability to extend campus research at LANL or off-site locations; and (3) internships for Junior and Senior level undergraduate students (UGSs), and graduate students (GRAs).

Program Goals

The goals of the HBCU Program are to enhance career prospects of graduates of HBCUs and to further enhance research capabilities of faculty at HBCUs, thus increasing the numbers of such graduates with degrees, undergraduate and graduate, and careers in science, engineering, and technology.

Program Development

The HBCU program at LANL recruits students to serve as research interns in divisions throughout the Laboratory. Program participants receive full-time appointments ranging from 10 weeks to 1 academic year. Both undergraduate and graduate students are recruited from HBCUs from a variety of scientific and technical areas of study such as: mechanical, chemical, and electrical engineering, computer science, mathematics, physics, material science, and chemistry.

Students are then selected by research scientists at the Laboratory, who serve as mentors. The selection is based on the students' major field of study, courses completed, and prior experience in their campus laboratory, a prior summer internship, or a National Laboratory environment. From this successful match, the mentor develops the "Student Workplan" to outline anticipated summer research.

Graduate students will also find extraordinary opportunities to expand their thesis research while in the National Laboratory environment.

There are a number of students who have continued their research beyond the summer. Southern University and A&M College in Baton Rouge, Louisiana, has contributed greatly to the accomplishments of the HBCU Program.

Four Southern University students, along with examples of their research, are listed below.

Anthony Cochran, M.S. — Southern University, Louisiana
Mr. Cochran has conducted primary research with the Liquid Scintillator Neutrino Detector (LSND) Group. His research has been facilitated at the linear accelerator located at the Los Alamos Neutron Scattering Science

Center (LANSCE). This research involves the experimental search for the exotic decay of the light mesons pi (the neutral pion) and ata decaying into two neutrinos. The term 'Exotic Decay' is used to describe a decay process not allowed by the standard model of particle physics. A theoretical approach is used to understand the sensitivities of such processes, construction of Monte Carlo simulations in order to model the production and detection of such physics, and a detailed analysis of the data collected with the LSND. Finally, the detection of an excess of events from these exotic decays would have a profound impact on the current standard model, prompting a need for modification. Given the sensitivity and amount of data collected with the LSND, it would be possible to set the world's best limit for detection of these processes if no excess of events is found.

Monikka Mann - Prier, B.S. Candidate — Southern University
Mrs. Prier's research involved the "Measurement of the Critical Current of a Bi-2223 Coil Irradiated by High Energy Protons." This research comprised a Bismuth-based High-Temperature Superconducting (HTS) coil, which has been irradiated by high-energy protons for the purpose of enhancing its ability to carry electrical current in an applied magnetic field. The superconducting properties of the coil have been measured at liquid nitrogen temperatures and applied magnetic fields of up to ~2 tesla. The team represented the method of irradiation, the measurement of the coil, and finally contrasted the improved properties of the coil with unirradiated Bi-2223 HTS materials.

Donald Prier, M.S. Candidate — Southern University
Mr. Prier's research at Los Alamos complements his master's thesis research in fuel cell technology with the Lab's Fuel Cell Research Team in the Engineering Sciences & Applications Division, Energy & Process Engineering Group (ESA-EPE).

Mr. Prier's primary goal, with the LANL Fuel Cell Research Team, is to optimize the operational performance of the Proton Exchange Membrane Fuel Cell (PEMFC), where fabrication cost, material cost, and operational costs are competitive with that of the combustion engine. At present, the PEM fuel cell is very costly to fabricate and expensive, in terms of raw materials.

At present, Mr. Prier and his research mentors have designed a bipolar plate test apparatus, also known as a Corrosion Test Jig (CTJ). This apparatus has the ability to simulate the operating conditions of a PEMFC. This jig will allow the team to accurately identify impurities that may accumulate or be expelled in the ventilation streams of a fuel cell. These impurities are responsible for bipolar plate corrosion and ultimately, PEM failure. After the completion of the bipolar plate testing with the CTJ, Mr. Prier plans to examine the surface morphology of the selected bipolar plate metals which have successfully survived the acidic environment of the CTJ.

Tommy Rockward, M.S. Candidate — Southern University
Mr. Rockward's research at Los Alamos, and his thesis topic, is "Investigative Studies on Optimizing Polymer Electrolyte Fuel Cells Performance in the Presence of Impurities in the Anode Feedstream." This study involves platinum (Pt) and platinum-based alloy, platinum-ruthenium (Pt-Ru) as electrocatalysts for anodes in polymer electrolyte fuel cells. Carbon Monoxide (CO) gas in the anode feedstream reduces the performance of fuel cells. A PEFC kinetics model developed by LANL staff members predicts changes in the level of CO tolerance with total pressure

on the anode. This suggests that lowering the partial pressure of CO improves cell performance at high CO coverage. Performance and anode excess overpotential (i.e. voltage loss) curves for both high (~0.9 mg/cm2) and low (~0.3 mg/cm2) anode loading of Pt and Pt-Ru as a function of CO concentrations and anode pressures have been determined. Experimental and modeling curves show good qualitative agreement. Findings indicate improved cell performance in the presence of CO/H2 mixtures as the anode pressure is lowered.

We also studied the effects of reformed fuels and diluted hydrogen in the anode feedstreams. Reports indicate that reformate gases may contain impurities that could possibly affect the performance of fuel cells. In particular, they probed these effects of using synthetic reformate gases containing contaminated mixtures of hydrogen with nitrogen, carbon dioxide, and small amounts of carbon monoxide. Results emphasize low catalyst loading (<0.4 mg/cm2) and high fuel utilization (>67 %). They further explored improving combinations in the anode feedstream. Suggested improvements to further dilute hydrogen in their gas feed are currently being tested.

Mr. Cochran and Mr. Rockward are returning students from the 1997 summer HBCU Program. Their research has been developed and built upon through their relationships with their mentors and the University Programs Office. They have both used the research experience at LANL to compile thesis data, a demonstrated added benefit to how successful and effective the HBCU Program has proven to be.

The above four examples show that opportunities abound in which basic and applied research are conducted using the latest state-of-the-art instrumentation, advanced computing, both proven and experimental technology, and facilities and resources unavailable to students and faculty at HBCUs.

Mentoring

National and world renowned scientists direct projects and serve, voluntarily, as student mentors, thus providing students with unlimited career experience and graduate school advantages. Mentoring is a necessary and integral component toward the success of the HBCU Program. Based on research conducted with these world renowned scientists, student researchers are provided the unique opportunity to report their scientific research results in professional scientific publications, final research papers, and through formal and poster presentations. In addition, these relationships often provide future graduate school recommendations and placement of students in professional positions.

Program Partnerships/Collaborations

Partnerships and collaborations with HBCU's are an excellent avenue to maximize human potential and monetary resources. DOE National Laboratories are an invaluable source of facilities, resources, and expertise. By this means the University Programs Office is able to provide improved quality of and diversification of the future workforce in science, engineering, and technology.

The unique partnering with HBCUs serves to further leverage resources. The HBCU Program seeks to fully develop, nurture, and maintain

relationships with in-house and external professional organizations who will cost-share elements of the Program.

To demonstrate the strengths of campus collaborations with the Lab, evidence is the best example. Lewis Thigpen, Ph.D., is currently at the Lab serving a one-year sabbatical. Funding for Dr. Thigpen is provided primarily through the group where he is conducting research, the Technology & Safety Assessment Division-Technology Modeling & Analysis Group (TSA-7). Dr. Thigpen is Professor and Chair in the Department of Mechanical Engineering at Howard University in Washington D.C., and is at the Laboratory as a Long Term Visiting Staff Member.

Dr. Thigpen's research is in the areas of web mechanics and in materials characterization at the micro-mechanics level. This research involves the development of models for the successful transport of webs through the various manufacturing processes without incurring material defects, machine downtime, and product loss. The team's approach is to model some existing and some proposed new web transport processes from first principles of mechanics. This work includes characterization and simulation of statistical variations in material properties across the web and numerical modeling to simulate a range and distribution of mechanisms that cause material defects and produce loss during web transport.

Dr. Thigpen is aware that "it is important that faculty spend some time working at national laboratories and in industry, and become collaborative research partners with scientists and engineers from these organizations. Through these interactions, faculty gain first hand knowledge on how to best prepare their students to meet the needs of future employers."

Program Implementation

In FY98, eleven young researchers at Los Alamos represented seven HBCUs. These eight campuses included: Clark Atlanta University (GA), Claflin College (SC), Hampton University (VA), Howard University (DC), Morehouse College (GA), North Carolina A&T State University (NC), Southern University and A&M College-Baton Rouge (LA).

Student breakdown was five undergraduate and six graduate students in the following majors: chemical and mechanical engineering, computer science, and physics.

In addition to eleven young researchers, the HBCU Program boasted the strong contributions and addition of one department chair from Howard University (DC) and one faculty member from NC A&T State University.

One example of faculty research, off-site, is that of William Adeniyi, Ph.D. from North Carolina A&T State University in Greensboro, NC.

Dr. Adeniyi worked with Professor Joe Wang at New Mexico State University in Las Cruces, N.M. Their collaborative research centered on the stripping voltammetric studies of heavy metals, namely, nickel, iron, yttrium, uranium, and on a couple of explosive organic molecules, for example RDX and TNT. The detection of these toxic contaminants in environmental conditions could be maximized for more sensitive and reproducible analyses.

Dr. Adeniyi acknowledged that the experience gained with Professor Wang's group is beneficiary to his research at NC A&T State University. The experience enhanced his capability in the electroanalytical techniques. The stripping analysis was unfamiliar to him before working with this group. In addition to helping to increase his scope of research, the stripping technique will be added to future undergraduate chemistry curriculum in the instrumental analysis.

Student Development

During the summer session at LANL, professional development included classes at the University of New Mexico-Los Alamos. Three classes were offered on "Ethics in Science," "Technical Writing," and "Technical Presentations." The Los Alamos campus worked collaboratively with the University Programs Office to ensure student success at the end of the course. Teaching instructions and course materials were successfully provided with the cooperation of the Continuing Education Office.

Four University Program students participated in the GEM-NIM Summer Institute on Mentoring sponsored by participating corporations with the Graduate Degrees for Minorities in Engineering and Science, Inc. (GEM) National Institute on Mentoring (NIM). The theme was "New Paradigms for Tomorrow's Technical Leaders: Strategies for Success." The Institute provided students with invaluable insight on "how to survive in graduate school when you're the only one," "building leadership skills," how to navigate graduate school," "how to prepare for the Ph.D. qualifying exam," etc.

Students are required to provide the GEM conference coordinator with papers indicating how the conference enhanced their interest toward graduate study and how it will benefit their futures in science, engineering, and technology.

Summer Speaker's Series

Howard Adams, Ph.D. was the featured luncheon guest speaker at LANL's First Annual DOE/Defense Program Summer Student Research Symposium. Dr. Adams is the innovator and author of numerous publications on mentoring and minority graduate student success. His work with The National Consortium for Graduate Degrees for Minorities in Engineering and Science, Inc.-National Institute on Mentoring (GEM-NIM) Summer Institute has been acclaimed for over 20 years in the sciences and engineering.

It is essential to expose students to persons in the fields of science and technology. It is planned to invite professionals from various scientific disciplines, campuses, and organizations to introduce students to new research ventures and avenues. This will also serve to provide future contacts for students with respect to research opportunities, graduate school preparation, etc. The Speaker's Series also allows professionals exposure to young future scientists and their interests.

Social Development

The uniqueness of Los Alamos, the town, can be interesting to students from HBCUs located primarily in the southeast, but it can also be a problem. The University Programs Office takes great care to ensure that students have a well-rounded summer experience. In addition to our efforts, the Lab's Student Association planned events each week in the evenings and on the weekends. The Student Association was an excellent avenue for HBCU students to make new connections for life.

Specific to the University Programs Office, two outings were planned and conducted: a visit to the WIPP facility in Carlsbad, N.M., and a guided, historical tour of Northern N.M. However, on their own, students visited Bandelier National Monument, White Sands, Juarez, Mexico, and many more areas unique to the state of New Mexico.

Program Evaluations and Assessment

Seven out of the eleven HBCU students have returned their "University Programs Student Evaluation," to date. Evaluations were designed using a Likert scale of one to five with 'Strongly Disagree' with the least rate of 1, to 'Strongly Agree' being the highest rate of 5. An average rating was determined and that rating was turned into a percentile with a100 percentile meaning all respondents gave that particular question the highest possible rating.

Program Summary

The surveys and final reports completed by the HBCU participants indicate the students' 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. All of the students who completed the "Questionnaire" expressed a great interest to return the following summer.

F. Underrepresented Minority/Female Initiative

Program Description

The Underrepresented Minority and Female Initiative (URMF) at the Los Alamos National Laboratory was conceived to assist underrepresented minorities and females from the Southwest to achieve parity representation in science, mathematics, engineering, and technology. The URMF program focuses on students from New Mexico, Texas, Colorado, Arizona, and California and it currently involves undergraduate and graduate university students and graduating high school students.

College enrollments of women and minorities lag behind those of 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 have been traditionally underrepresented. The primary goal of the URMF program is to encourage students from underrepresented classes to choose careers in science, mathematics, engineering, and technology to encourage them to excel in these fields, thus helping provide our nation with an essential resource: the next generation of its scientists, mathematicians, and engineers.

As a result of our global economy and global competitiveness, URMF believes that education must challenge all underrepresented minority and female students to reach their potential and must involve resources of 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 LANL and at local universities and industries.

Program Implementation

During FY98, forty-five undergraduate students and seven graduate students were placed in internships.

The URMF had three different components. One was the high school summer program at the University of New Mexico-Los Alamos Branch. Twenty graduating seniors from local area high schools commuted to attend college preparatory classes. The courses were designed to increase their skills in mathematics, an introduction to technology, provide students an opportunity to explore career options, and to 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 (NSF/AMP) Program. Three students from two-year colleges in the state of New Mexico that had completed an associate degree and are in transition to a four year institution were placed in laboratories with mentors and were assigned specific tasks. Based on this research experience, they were required to submit a final paper and to give an oral presentation to their mentors, the staff of the Alliance for Minority Participation, and the staff of URMF.

An off-site graduate student that has physical disabilities (quadriplegic) was placed at her home institution (New Mexico State University). She provided computer programming support to one of our chemistry divisions involved in the WIPP project.

The final component of URMF took place at LANL. Fourteen undergraduate and eight graduate students from colleges in the southwest were placed in research laboratories with mentors and assigned tasks. Their projects were presented in final papers and twelve of the students were selected at random to present oral presentations. The final papers will be scanned into a database for future reference.

During the summer, there were professional development seminars that included training sessions on technical presentations, technical writing, and the seven habits of highly effective people. Social events were provided to encourage interaction among the students of the different programs.

Program Evaluations and Assessments

An evaluation survey was distributed to the participants at the end of the 1997 summer session. Separate surveys for students and mentors were distributed. Evaluations were designed using a Likert scale of one to five. An average rating was determined and that rating was turned into a percentile with a 100 percentile meaning all respondents gave that particular question the highest possible rating.

Conclusions

The surveys and final reports filled out by the URMF 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 of the Graduate Research Students was offered and accepted a full time job at LANL.

Based on preliminary feedback, it is the opinion of the URMF Program staff that the format of the program is on target to achieve its educational goals.

G. Los Alamos Summer School in Atomic, Molecular, and Optical Physics/Conference Experience for Undergraduates

Program Description

The Los Alamos Summer School in Atomic, Molecular, and Optical (AMO) Physics, a joint program of the University of New Mexico (UNM) and the Los Alamos National Laboratory, constitutes an evolving educational program to attract top quality students into scientific research. For the past nine years, the School has achieved this goal through an eight-week session that combines an intense lecture and tutorial series with an individual mentored research project. This program proved impractical for the tenth year since responsibility for organizing an American Physical Society meeting and the School fell upon the same group over a similar time frame. We therefore decided for this one year to mount a new experimental program, closely associated with this meeting of the Division of Atomic, Molecular, and Optical Physics (DAMOP). This new endeavor, termed a Conference Experience for Undergraduates (CEU), promised to fill a void in the overall undergraduate research program, namely the attendance at a scientific conference. Most undergraduate research programs provide a means of locally reporting student projects through oral or poster presentations. However, no concerted, organized effort had yet arisen to give students the full flavor of participation in a major scientific conference - a very important component of any scientific career. Before presenting a detailed description of the CEU program, we provide a synopsis of the broader Summer School project since the two contain many common attributes and goals and since the CEU forms a natural extension into conference participation.

The School targets upper-level undergraduates and first-year graduate students, who will soon be making career choices, and recruits nationally to gain the most diverse possible class. Over an eight-week period, we give the students an intense exposure to basic research by concentrating on the fascinating, diverse areas of AMO physics, both through lectures by distinguished scientists on the latest developments and through mentored term projects. AMO physics provides a particularly fertile area for such an exercise since its tenets permeate a diverse set of other disciplines such as astro-, weapons, condensed-matter, plasma, bio-, and laser physics. We also have the broader goal of teaching certain basic physics skills not commonly emphasized in the university curriculum, of introducing high performance supercomputing, and of fostering a personal interaction 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 six years, the School has been funded by a National Science Foundation(NSF) Research Experience for Undergraduates(REU) site grant to UNM and by the Science Education Programs at LANL through DOE Defense Programs in addition to in-kind support from the Theoretical Directorate (LANL) and the UNM Center for Graduate Studies and the Department of Physics and Astronomy.

For the CEU, we continued the long collaboration with the University of New Mexico and again obtained joint funding from Los Alamos Educational Programs and the National Science Foundation as a special REU site. The chief goal focused on deeply involving upper-level undergraduate students in a major scientific conference, in this case, the four-day DAMOP meeting in Santa Fe. A serious question arose from both the organizers and reviewers: to what extent could undergraduate students, who have had only a basic introduction to scientific subjects, really appreciate and learn from such a professional meeting? To guarantee the greatest fulfillment, we created several auxiliary programs, designed especially for the students to aid their immersion in the conference process. Such projects required considerable supervision from a dedicated technical staff.

These special programs divided into three main areas: (1) a one-day pre-Conference Orientation and Introductory session that discussed the main scientific topics as well as the general procedures and logistics of surviving such an engagement; (2) the actual four-day Conference that included mentored follow-up and debriefing meetings at the end of each day, brief written reports by the students on and ratings of important talks, and special functions; and (3) a five-day Post-Conference set of tutorials and lectures on the principal scientific topics. This general scheme functioned extremely well in achieving these goals as gleaned from our extensive evaluations and the interest shown by other organizations, such as the American Physical Society, in planning comparable projects.

Program Implementation: FY98

Reflecting the dual nature of the sponsorship, we have co-Directors with each taking particular responsibilities for various tasks in operation and organization, based on resources, personnel, and location. For example, UNM North has excellent facilities and staff at its several locations (principally Los Alamos and Santa Fe) to handle the vital task of recruiting and to provide classroom and computer access while the Lab has the on-site technical staff from which to draw the mentors and lecturers. Professor Howard Bryant served as co-Director for the UNM side, and Dr. Lee Collins for Los Alamos. They were joined by Prof. Mike Zeilik, a co-principal investigator on the NSF grant, and Norm Magee from LANL. We also received critical help from Dr. Jim Cohen, T-4 Group Leader, who chaired the DAMOP Conference organizing committee.

As indicated above, the CEU divided into three distinct areas for which we provide more extensive details.

Pre-Conference — Most of the students had never attended a major scientific conference; therefore, considerable effort concentrated on providing them with a general impression of what to expect scientifically, socially, and logistically. We began over a month before the Conference with a mailing to each student of introductory articles on the main scientific topics extracted from pedagogically-oriented publications as *Physics World* and *Physics Today*. This allowed the students to gain some initial familiarity with the subjects. We had the students arrive two days before the Conference and lodged them all at the College of Santa Fe, the principal student residence during the meeting. This fostered a close and immediate camaraderie that served the students well throughout the proceedings. The next day we devoted to orientation on the city and especially on the general workings of the Conference. However a short series of lectures on a selected set of the major topics at the meeting consumed the largest portion of time. Since such a meeting remains extremely broad, we decided to focus the student's attention on just a few of the hottest topics that would receive the most attention at the meeting. These topics closely coordinated with the principal invited sessions, which contain talks generally intended for a broader audience and thus more approachable by students with only a general scientific background. Three main areas were selected: Bose-Einstein Condensates, Quantum Control and Manipulation, and Quantum Computing with introductory lectures on these subjects presented by staff members from UNM (Prof. Prasad) and LANL (Drs. Collins and James) active in these areas. In addition, we provided a guide to talks in these chosen subjects, listing topics, speakers, session numbers, and times. Finally, at the end of the session, the students attended the Conference Reception.

Conference — The students participated fully in all four days of the DAMOP conference in Santa Fe. However, to provide supervision and some structure to this experience, we devised several additional programs. First, we met with the students at the end of each day of the Conference at a debriefing and informational session. These meetings involved questions from the students, announcements, and feedback. In addition, speakers from the Conference would drop by to field questions and present short, informal talks on the major subjects. One of the most popular gatherings involved two former Summer School students, now in graduate school, giving their impressions of life in the graduate programs at Universities of Colorado and Nevada-Reno. These sessions allowed us to dispense new

information and to assess the level of student participation and understanding. Second, we provided the students with color-coded “report cards” on which they made comments on particular talks and gave a rating (1-7, with 7 the highest mark) on interest and comprehension. These printed 3x5 cards provided a wealth of information both anecdotal and statistical. For example, the overall interest and comprehension level remained around 5 for the duration of the conference, indicating that these undergraduate students gained considerable scientific knowledge and enjoyment from the meeting. A final treat included the Nobel Lectures on Saturday morning by Steven Chu and Bill Phillips, winners of the 1997 prize in Physics for their achievements in trapping of ions and atoms. These lectures were planned for the general public and of great fascination to the students.

Post-Conference — The Conference ended on Saturday afternoon. On Sunday, we moved the center of activities to Los Alamos, along the way stopping for a picnic at the Bandelier National Monument. The students again stayed together in one of the local hotels. Monday marked the beginning of the post-conference activities that centered on a series of lectures and tutorials on the main topics stressed at the Conference. These sessions took place on the campus of UNM at Los Alamos very near the main Laboratory site. We tried to assemble lecturers from the invited speakers of the DAMOP meeting so that the students would have continuity from the high-level scientific talks they had heard. These lectures expanded upon the topics, providing a more detailed and pedagogical exposition. The lecturers included: Prof. Ray Flannery of Georgia Tech, winner of Allis Prize for his work in atom-atom collisions, Drs. Eddy Timmermans and Robin Cote of Harvard in Bose-Einstein condensations, Drs. Richard Hughes, Daniel James, and Andy White from LANL in quantum computing and cryptography, Dr. Mike Noel from the University of Virginia in quantum control, Profs. Ivan Deutsch and Sally Siedel from UNM discussing trapping of cold ions and matter-antimatter, and Dr. Lee Collins (LANL) on quantum control and parallel computing. In addition, the students had access to the internet and computational services through the UNM computer center. As official visitors, they also had access to Laboratory sites and the main research library. The tour of the Quantum Information Laboratories at LANSCE marked one of the highlights of the week. Finally as a special feature of the program, the students received credit of one hour from UNM as a seminar course.

The CEU displayed several interesting sidelights. The first concerns Dr. Cote, who participated as a student in the School in 1992, did postdoctoral work at Harvard, has recently accepted a faculty position in AMO physics at the University of Connecticut, and has by lecturing now come full circle. The second reflects the long-term success of the Summer School in the participation of eight former students, all now graduate or postdoctoral fellows, in the scientific program of DAMOP.

The Post-Conference phase appears highly successful by giving the students a mechanism to further explore and explicate the many ideas thrown at them during the Conference. The fast-paced Conference engendered many questions and the usual amount of confusion; this follow-up period allowed an organized, relaxed program for resolving many of these issues, yielding an overall pleasing pedagogical experience for the students.

Recruitment and Student Demographics

As with the regular Summer School, we recruited nationwide employing both mail and Internet. First, we made an extensive mailing of fliers to all members of the American Physical Society Divisions of Atomic, Molecular, and Optical Physics and of Chemical Physics (about 2000). We also developed a Web site that gave general information and allowed for direct applications. The site had hot links from the Conference page as well as from those of the American Physical Society, the National Science Foundation, and the DOE Science Education Programs. In addition, advertisements appeared in the regular e-mail posting from the Division and the APS.

For 1998, we received nearly 100 applications (with over 90% submitted electronically) and admitted eighteen students. This class was very strong scholastically, filled with many honors students. We maintained our high participation of women (34 %), far above university enrollment at this educational level.

The students came from extremely diverse backgrounds and geographic locations, representing sixteen different Universities from across the country and world. Three of our students had just returned from exchange programs in England, Germany, and Finland that gave the CEU a decided international flavor in correspondence with most scientific conferences. The Universities together with their states and number of participants were as follows: Wesleyan [CT,1]; Illinois State [IL,1], Miami [OH,1], New Mexico [NM,2], Bucknell [PA,1], Missouri [MO,2], Franklin and Marshall [PA,1], University College [UK,1], State University of New York (Stony Brook) [NY,1], Connecticut [CT,1], Reed [OR,1], Harvard [MA,1], Oklahoma [OK,1], Bethel [MN,1], Toledo [OH,1], and Bryn Mawr/Seigen [PA/Germany,1].

Evaluation

We devised several evaluation mechanisms for the program that probed both the short- and long-term effects. First, as mentioned above, during the Conference period we utilized the printed report cards that yielded both a ratings system for comprehension and interest as well as comments on presentations. Collection of these at the end of each day provided a current probe of the level of student participation and understanding, allowing for adjustments should deficiencies be noted. Second, the debriefing sessions at the close of each Conference day gave the students the opportunity to voice concerns and raise logistical as well as scientific questions. Third, we provided a general evaluation of the entire program but especially the Post-Conference lecturers on a final, comprehensive form completed on the last day of the CEU. Fourth, we also obtained feedback from the lecturers and from the Conference participants, especially those attending the debriefing sessions.

Preliminary evaluation of the report cards and forms indicate a highly successful program in integrating undergraduate students into a major scientific conference. For all days of the Conference, the general comprehension and interest level achieved a score of 5, well above the average. The students turned in almost 300 cards indicating an average participation in 16 different talks. The lectures in the Post-phase received extremely high marks as did the topics.

Budget

The FY98 budget ran at $48,000 with $18,000 from the NSF-REU grant and $30,000 form Science Education programs. In addition, considerable in-kind support came from both institutions including materials, computer time, and staff. The students were paid a stipend of $1000 for the session that covers travel and subsistence. Housing costs and UNM tuition were borne directly by the CEU.

DP Mission Benefit

The School began as an internally-funded project within the Los Alamos Weapons Program to encourage greater participation by outstanding students in AMO research, deemed vital to many DP missions. While the advent of the REU component six years ago has broadened this mandate to include applied research science in general, the goals remain aimed at many aspects vital to DP 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 DP research projects. The School and the CEU foster such recruitment through contact with DP program personnel in lectures, research projects, and tours.

Conclusion

Since a CEU requires a close association with a local conference, this particular project will pass from the general Los Alamos educational programs organized by this group. Therefore, the reporting of our findings forms an extremely important aspect of this educational experiment. To this end, we are preparing a detailed article on the CEU as a contribution to one of the educational Journals in order to achieve wide dissemination. Simply by word-of-mouth, we have already received inquiries from several professional scientific organizations planning future meetings.

While the general plan and organization functioned extremely well, we would recommend a few possible adjustments for any future program: 1) lengthening the Pre-Conference phase to a full day with the afternoon exclusively devoted to scientific topics; 2) somewhat more formal structure to the end-of-day Conference session with more participation by the conference speakers; 3) shortening the Post session by a day or so. Although the five-day Post-session served our particular program well, a slightly shorter period would also suffice to equal effect for other constraints.

Overall, from our initial evaluations, the CEU constitutes an unqualified success on the part of all participants. Such a program appears ideally suited to function in conjunction with a major scientific meeting, providing a needed additional component to undergraduate research programs. The general scheme gives a template for developing and organizing an effective conference experience for undergraduate students.

H. Undergraduate Research Semester (URS)

Program Description

The Undergraduate Research Semester (URS) Program at Los Alamos National Laboratory continues the standard of excellence established in 1989 by the Science and Engineering Research Semester (SERS) Program, as part of the undergraduate education effort at each of the 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 425 undergraduate students in the URS and SERS programs. Currently, 15 students have accepted appointments for the Fall semester of 1998.

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

URS participants have access to facilities and state-of-the-art equipment at Los Alamos not ordinarily available on a university campus. The URS Program enhances and facilitates the historic interrelationship between the university community and the Department of Energy, Office of 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 (39% this year) and underrepresented minorities (32% this year) in science and engineering fields.

Goals and Objectives

The principal goal of the URS Program is to use the Department of Energy Office of Defense Program's unique 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 URS 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 students' field of study and career plans,
- Increase the diversity of students that participate in Defense Programs research.

Implementation

Forty URS 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 and approximately 20% of their time participating in the supplementary educational activities. These activities 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 LANL. These tours, lectures, and field trips also permit students

with diverse interests to get a feeling for 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 from the educational activities remains positive.

For the 1997-98 academic year, participating Laboratory divisions included Computer, Information, and Communication; Chemical Science and Technology; Earth and Environmental Sciences; Engineering Sciences and Applications Division; Los Alamos Neutron Scattering Center; Life Sciences; Materials Science and Technology; Nonproliferation and International Security; Physics; and Theoretical divisions. Each student also came into contact with many other scientists, post-doctoral students, graduate students, technicians, and other staff that provided guidance. In addition to the team of researchers that worked closely with student participants at their Laboratory sites, the URS Program Coordinator planned weekly educational activities for the students that were led by Laboratory volunteers.

The URS 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 1997-98, participating mentors found (as they did last year) 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 are typically eager to learn and contribute, and they ask important questions that allow 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 URS Program 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.

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 made 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 workshops, by their mentors, and by the program coordinator. Students discussed their poster displays with the guests at a special reception.

Students were offered an optional opportunity to take a university course offered through the University of New Mexico-Los Alamos, Center for Graduate Studies or Branch College. During the Fall 1997 and Spring 1998, approximately one third of our student participants attended the Los Alamos campus for coursework. Since the URS Program requires that students take a semester away from their home institution, the university courses help to provide an opportunity for the students to continue to move toward their academic goal of timely graduation.

Program Evaluation

To study the impact of the Laboratory program on the participants (students and mentors) a variety of tools were used 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 remarkably high retention rate. Twenty percent of the Fall students stayed on to work with their mentors at the technical sites for a year; 100 percent of the Spring semester students were invited to stay and 84 percent stayed at least through the summer.

Students identified, in FY97, that there were too many talks and not enough tours of Laboratory facilities. This was improved from the previous year by linking talks with tours more often, but students were still resistant to experiences outside their own area of interest. The mini-presentations and the adjustments to the talk/tour schedule were successful. Overall the students found the mentoring relationship and their research experience a positive one.

In response to an open-ended question about what influence (if any) the URS 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 in one semester with URS than two years of interning in industry” and “very intense, very challenging, outstanding!”

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 several cases, the mentor and student are co-authoring a journal publication. The Spring semester group was particularly strong. At site visits, the consistent message was that “this is the best undergraduate student I have ever had”, and one mentor stated, “Robin will have her own research lab in 15 years, she is exemplary.”

Seven of 22 Fall 1998 participants stayed with their mentors to continue their research and one is still here. That is a remarkable number considering most students return to college after the Fall semester. During the Spring 1998 semester, all 19 participants were asked to stay, 16 accepted, and 3 are still at LANL. While we had a strong year and particularly strong Spring semester, the mentor evaluations clearly and consistently indicated the scientists’ concern for the continued flow of such high quality students – they very much want the recruiting efforts increased.

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.

I. Regional Two-Year College Initiative (TYCI)

Program Description

The Department of Energy's objectives for the nation's economic growth build 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. DOE is looking to the community colleges to become more involved in technician training. LANL 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 (TYCI). 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, Trinidad Community College, Southwest Indian Polytechnic Institute, Little Big Horn College, Fort Peck Community College, and Salish Kootenai College.

The Two-Year College Program focuses on identified areas of advanced technology in which schools can enhance their programs and curriculum. Five technologies targeted for this program have been: advanced manufacturing, environmental restoration and waste management, biotechnology, electro-mechanical, and computer technology. The TYCI program, student and faculty teams have participated in an internship program at LANL. Student and faculty teams were placed in various technical areas with mentors who assigned specific tasks relevant to their area of technological interests. 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 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 pursuing 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 LANL gives the interns exposure to the cutting edge technology necessary to be competitive and the exposure that leads to the achievement of the objectives.

During FY98, twenty-two students and six faculty were placed in internships or worked on research contracts.

Internal students and faculty worked primarily in the following disciplines of technology: computer technologies, chemistry technicians, electro-mechanical technicians, and environmental site clean up technicians. All participants were directly tied to stockpile stewardship programs.

Recognition was given to the TYCI program from Dine' (Navajo) Community College for its "Appreciation for outstanding contributions in support of high quality science and technology programs for Native Americans." This came

as result of three years of previous support in helping Dine' implement a GIS program, as well as a new GIS/CAD facility.

The TYCI is a partner with the New Mexico Technology Advisory Council (TAC). TAC is driven by New Mexico business and industry (LANL & SNL included) folks, in conjunction with the New Mexico Association of Community Colleges. The purpose is to identify the skill standards required for entry level workers in technology-based companies in order to develop a core curriculum for community colleges in New Mexico. The main focus is to develop a strong advanced manufacturing component for New Mexico and the region. This program will benefit LANL in the long run by providing a supply of well-trained technicians for the workforce. This is very much in line with the DOE mission, whereby "DOE is looking to community colleges for more involvement in technician training."

Research contracts were awarded to two two-year institutions. They were:

- San Juan College (SJC): A faculty member and a student worked on a research project for LANL in conjunction with our Chemistry Science & Technology Division. The overall goal of this project to get started on an undergraduate summer research program at SJC relating to renewable energy, environmental science, and materials electrochemistry. Utilizing an undergraduate student researcher, methods were developed to electro-deposit silicon onto aluminum for the possible low cost manufacturing of photovoltaic cells. In addition, a cryopumped metal evaporator trainer was designed and constructed using donated equipment and monies from Intel; a scanning electron microscope, donated by Intel was installed; and an atomic absorption spectrophotometer, donated by Giant Refining, was also installed.

- Luna Vocational Technical Institute (LVTI): A faulty member and a student worked with LVTI and a LANL staff member on a plan to restructure the Department of Trades and Technology with the notion of developing new certificate and associate degree programs in pre-engineering and technology. The team evaluated the separation of the Technologies program from the Trades program, and proposed new curricula to the academic and institutional administration. The faculty member will assist in searching and screening for an appropriate director to oversee the operations of the new Technologies department.

Program Evaluations and Assessments

An evaluation survey was distributed to the participants at the end of the 1998 summer session. Separate surveys for students and mentors were distributed. Evaluations were designed using a Likert scale of one to five. An average rating was determined and that rating was turned into a percentile with a 100 percentile meaning all respondents gave that particular question the highest possible rating.

Conclusions

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 program, 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 will continue with the two-year institution administrators to further explore research activity at their respective campuses during the academic year. There are plans to establish a consortium of New Mexico community colleges that will focus on centers of excellence with an emphasis on technology.

The research contracts have proven to be a very positive way of doing business with the two-year institutions. They have challenged community colleges to develop hands-on projects that have led to enhancing existing educational programs and to new curriculum. They have also provided LANL 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 DOE in general.

J. Mentored Collaborative Research Project (MCRP)

Program Description

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

The MCRP program focuses 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” teaming ideal. The teams are usually made up of students from multiple disciplines, for example chemistry, engineering, material science, and technology. This provides additional experience of working together in a multi-discipline manner, much like the common work experience at LANL.

Program Objectives

The MCRP Program sponsored three faculty members, eleven undergraduate students, and one graduate student during the summer of 1998. Three specific student/faculty teams worked successfully on research projects. Two of the three projects involved the following:

- Stockpile Stewardship Erbia Summer Project entitled “Synthesis of bulk Er_2O_3 Single Crystals using the Xenon Optical Floating Zone.” This research involved the fundamental understanding of advanced materials such as Er_2O_3 which often requires access to research-size “custom” crystals. In response to this need, synthesis of Er_2O_3 crystals is made possible by growth in a Xenon Optical Floating Zone unit. This unit is capable of temperatures of $\geq$3000 °C. Since the crystals are synthesized

in a containerless fashion, there is less chance of contamination. Previous attempts at synthesis of Er_2O_3 single crystals revealed a "flaking" characteristic during growth in lab air which hinders the feed and seed rods from receiving the radiation directed toward them. This causes instabilities within the melt. In an attempt to stabilize the system, variations to the atmosphere, growth rate, and rotation were implemented to observe their effects. It was found that growing under a reducing atmosphere had the greatest effect of reducing the amount of flaking present. Different growth rates were tried to reduce the residual stresses on the growth crystal due to the largest thermal gradient inherent in the system. Reduction in O2 made the molten material opaque and therefore less responsive to the radiation directed toward it. This causes the inner part of the melt to solidify before the outer, and contributes to the overall instability. To address this, the counter-rotation of the feed and seed rods was increased in an attempt to increase heat convection throughout the melt. Ideal conditions for synthesis of Er_2O_3 single crystals have been growth in a reducing atmosphere (Ar/H2-6%), fast growth rate (30 mm/hr), and fast counter-rotations (50-70 rpm). The problems with residual stresses imposed by these conditions are being addressed by the design and addition of a post-heater to reduce the thermal gradient in an attempt to synthesize high quality, crack-free, Er_2O_3 single crystals. This project was a continuation of the FY96 and FY97 MCRP project.

- The Superconductivity Technology Center at LANL now has the capability to make one-meter lengths of superconducting yttrium barium copper oxide (YBCO) with the grains very well aligned. The team's research focused on the attempt to create better flux pinning yttrium superconductors by rare earth doping. The research involved the attempt to increase the flux pinning capabilities of YBCO by doping it with the rare earth's Sm, Nd, Eu, Dy, Ho and Gd. The team's research further measured a YBCO sample ($YBa^2Cu^3O^x$ where $6<x<7$) and studied similar rare earth superconductors by mixing powders of rare earth oxide, barium carbonate, yttrium oxide, and copper oxide, pressing them into pellets, and annealing the pellets at various temperatures, and in various gases through four sinters. The samples were then measured and compared using an x-ray diffractometer and magnetic susceptibility tests.

Program Evaluations and Assessments

Most of the students returned their "University Programs Student Evaluations". However, most of the MCRP students are returning students making the summer of 1998 their second or third summer conducting research at LANL.

Student/faculty team projects were monitored on an ongoing basis. Students and mentors provided feedback, via questionnaires, for each of the major program components. The purpose of the monitoring evaluation was to determine whether or not the program components were accomplishing the project's goals and what strategies should be implemented to fine tune the Program. Evaluation surveys were designed to address: job information, mentors, 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. Their research was then presented at the First Annual DOE/Defense Programs Summer Student Research Symposium.

Program Summary

Preliminary feedback continues to confirm the MCRP Program format right on target with regard to working with Laboratory researchers on project areas that have a direct relevance to LANL's stockpile stewardship mission.

Participating faculty have expressed their interest to return to continue research started last summer. Campus administrators also express the importance of the MCRP Program as one, which contributes to the betterment of the teaming concept with students and faculty working together alongside research scientists away from the campus environment. In addition, this opportunity provides faculty with enhanced scientific knowledge to share with students in the class environment.

IV. EDUCATIONAL TECHNOLOGY

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

Program Description

This program began in the fall of FY98, as a new program. Students participated in a variety of activities designed to help them increase their knowledge and ability in research process skills, the Internet, email, making web pages, and exploring career and professional goals. Participants were selected from several area high schools, middle schools and elementary schools to test the program's design. Teams participated from schools in Los Alamos, Espanola, Farmington, Pojoaque, Albuquerque, Santa Fe, Mesa Vista, and Jemez.

EPSILON was designed as a web-based program where students in grades K-12 could participate in the program from their classrooms during the academic year. Their experience culminated in a visit to the Laboratory for the younger students and a summer internship for a selected group of high school students. Students engaged in a problem-solving scenario for which they prepared a project to address a particular research topic. The students working as teams received a challenging problem scenario in a letter to the class from a scientist preceptor requesting written proposals, sketches and working models of designs that met a specific set of requirements. During the course of the academic year, a variety of web-based activities prepared the students to 1) create a specific project of their own design, 2) develop a proposal for implementing the project, and 3) present and defend their proposal to science and education professionals. This past year, a total of 86 students and 11 teachers from 12 schools participated in EPSILON.

Goals and Objectives

This student program is an effort to design and deliver a program that offers students in grades K-12 with challenging science activities that are relevant to their lives and which teach them about science in a way that is instructive as well as fun. We have taken advantage of the booming interest in computer technology to attract and engage students in a meaningful experience that can complement and enrich the science curriculum in their classrooms. We have accomplished this by (1) developing partnerships between the Laboratory and the education community by supplementing mathematics, science, and technology academic programs; (2) providing access to Laboratory personnel who serve as role models and mentors; (3) preparing students to utilize research-appropriate technology; (4) enhancing students' use and understanding of science research methods; (5) providing career development opportunities for students in the area of scientific research; (6) engaging 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; and (7) early identification of talented students creating an opportunity to mentor them and engage their interest in challenging technical opportunities at our DP Laboratories thus making them potential Laboratory recruits.

Program Implementation

Students were recruited both on-line and through site visits to the region's schools. The entire process for enrollment in the program was on-line, and students who were not able to download the application forms were sent the forms in the mail. To meet the goals for the academic year, students received instruction via email in how to improve their skills in scientific thinking, writing, graphic design, and multi-media communication. They also learned to practice effective teaming skills. WWW activities in science, mathematics, technology education, social sciences, and communication covered the basic concepts and skills needed by students to understand the principles behind the questions.

Students worked in teams to develop the experiments through which they explored science and engineering concepts central to Los Alamos National Laboratory programs. One activity challenged students to question their beliefs about science. Another activity had them explore the history of science. As they progressed in the program, students could select a topic in advanced manufacturing technologies that is relevant to their community. Such topics included use of energy, satellite communications, or waste disposal. These lessons included demonstrations and hands-on experiments examining the scientific nature of the students' particular projects.

During the academic year, students guided by the EPSILON lessons gathered information via the Internet from LANL and other sources. They conducted controlled experiments in their classrooms, explored data collection and basic research techniques and applied them to their projects, and built an electronic portfolio of their work. In addition, students learned and applied public speaking and writing skills, as they prepared a workable proposal and presentation. Students also learned more about careers in science and the importance of the work done at Los Alamos for national defense.

There were several mini-workshops performed at the schools for the teacher leaders. Intended to provide training and resources for the teachers of our student participants, these workshops included use of email, accessing the Internet, teaming skills, and basic communication skills.

The Request for Proposals and final Lessons were developed for deployment to the web site by April 15, 1998. Elementary school teams and middle school teams were invited to present their project ideas from their proposals on May 15, 1998. Students responded to the RFPs by submitting proposals that described a problem that they wished to solve, either as a project description or as a model design. Student proposals were evaluated by a group of technical and science education staff. Students received implementation awards to make their proposal a reality. As their award, the high school students selected were given the opportunity to work with a preceptor at LANL for a 6-week experience starting June 8, 1998. Final projects were presented at the Laboratory by 8 middle school students, representing 2 schools. Teachers accompanied their students. There were 4 high school students who were awarded summer internships at the Laboratory.

Laboratory scientists, staff and technicians from Physics, Material Science Technology, Chemical Science and Technology, Earth and Environmental Sciences, and Nuclear Materials Technology Divisions provided technical support and input for on-line lesson design. These scientists worked with science education staff to create requests for proposals on a variety of topics for the participating students. The program provided Laboratory

scientists 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. Approximately 550 hours of time and effort were provided for the program by the scientist preceptors and electronic mentors at LANL.

EPSILON partnered with New Mexico school districts by engaging students and promoting communication within their communities on this project. The program also established a significant partnership with International Technologies Corporation (IT), an environmental firm that provided technical staff to act as "electronic mentors" to EPSILON students by answering questions via email. This partnership provided IT the opportunity to expand its own community outreach efforts through our program and established the basis for an ongoing relationship.

Evaluation

Since its inception, EPSILON has used several evaluation tools to ensure that the program meets both programmatic goals and participants' expectations. Most of these tools are embedded in the technology and include notebook entries, portfolio development, email from participants and their parents, a pre-survey and later a post-survey on science and technology. We collected data on students' career plans, and compiled scientist preceptor feedback. Much of what we collected came from student feedback online and face to face. As was predicted, the crucial factor in whether or not students completed the program was the commitment of the teacher to the program. Despite the autonomous nature of computer technology, students found it difficult to sustain interest in their project unless the teacher also demonstrated interest. In some cases, students whose parents were interested, continued with the program but generally did not complete the RFP.

Final compilation of the impact of EPSILON has not been completed since the program ended in August. This has been a challenging task given that this is the first year of the program and we have several sources of data to cross reference, many of them requiring the development of rubrics. We expect to complete a summary of the data this fall.

Summary

EPSILON contributed to Science Education's balanced portfolio of programs in FY98. Emphasis on cross cutting effective practices such as Socratic dialogue, inquiry-based learning, assessment, and integration of technology with curriculum provided continuity among our programs to reinforce their quality and to develop a pipeline of students who benefit from a LANL experience. Epsilon students working in teams simulated how scientific problem solving is carried out in a laboratory environment. EPSILON activities were sequenced to build learning and technology skills. Computer networking technology was used as the delivery and communication system, and it provided a common thread throughout the program. Our effective use of technology for distance activities and in building networked communities of students and schools increased our contact time with students and teachers, and reduced our costs associated with traveling to sites and conducting workshops.

Overall, this new program provides a much needed student program at the K-12 level that bridges the strong programs we offer for high school students

with activities for students in the lower grades. It allows us to bring along younger students with programs that are developmentally appropriate, motivating and challenging, so that the natural interest and curiosity of these students is stimulated and nurtured in the context of their formal education. We especially appreciate the capability to apply technology through EPSILON in increasingly compelling ways to integrate learning in the classrooms.

B. Educational Networking Support (EduNets)

District technical support teams build a network in an EduNets Introduction to Networks workshop. Attendance totaled almost 600 for 47 “hands-on” Internet and networking workshops this year.

Program Description

The Los Alamos National Laboratory Educational Networking Support Program (EduNets) was developed to use Laboratory technical expertise and experience to help school districts - schools, school classrooms, libraries, and offices - establish networks with connections to Internet resources and to provide teachers, administrators, and technical teams training to use 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. It is designed to provide a coordinated networking consulting resource for school districts in the program and to establish partnerships with and provide support for community colleges, universities and departments of education to help establish regional training and technical support centers to ensure continued future support for the schools.

The current scope for direct assistance is primarily northern New Mexico school districts, with some requested consulting and training support for a few districts in Colorado, Arizona, Texas, and Oklahoma through partnership efforts and research grants. Requested advisory, technical, and training support is also provided as much as possible for other schools in related LANL support projects and other community networking efforts. Direct Participant Level: Administrators, Teachers, Staff, Faculty. Indirect Participant Level: Students and other teachers and staff in program districts whose network and training are supported by the EduNets district support team. Grade/ Faculty represented: K-14.

Primary goals 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 nationally; and, developing and testing communications, networking, and internetworking applications for education. Activities include consulting, on-site technical support, on-site training, technical mini-conferences and workshops; establishing and supporting regional training and support centers/hubs and

Internet computer labs; forming school, regional, and district Internet Education Working Groups (IEWGs); providing Internet education resources support; recognizing progress; and sharing information gained.

Principal direct support efforts for Edunets schools and hub sites include:

Consulting — Networking and computing advisement and support, network design, specifications reviews, walkthroughs.

Consulting and Onsite Technical Support

Providing networking consulting and onsite technical support and training are key components of the EduNets program. Helping design networks, testing and troubleshooting network installations, and server management support and training are some of the most requested services

On-site Support — PC, server, network installations and management, troubleshooting.

Training — Teacher and staff Internet and networking workshops, technical support team onsite training and support, train-the-trainer and technical support workshops.

September 1997 — September 1998: Direct Support Provided this Reporting Period:

Onsite PC, Server, and Network Implementation and Management Support

We provided 96 sites 1-5 days direct onsite support each this year.
- 73 schools, district offices, and technology centers in 29 public school districts,
- 13 non-public schools,
- 8 community college support hubs,
- 2 partner community support sites.

Networking Consulting, Troubleshooting, and Design Support

This year, we provided networking consulting and design support (WAN and LAN) for
- 17 public school districts,
- 6 non-public schools,
- 9 support hubs and community support partners.

Technical Support Team and Train-the-Trainer Workshops and Conferences

Workshop attendance this period included trainers, technical support staff, teachers, administrators, librarians, and school support staff:
- 588 workshop attendees (341 individuals),
- 68 schools and 13 hub campuses and support partner sites represented,
- 28 K-12 public school districts and non-public school systems sent attendees,
- 42 network managers completed NT Basics I (from 12 districts and 5 hub sites).

In addition to onsite training for technical support teams, we presented 47 workshops; 52 days (14 two-day, 15 one-day, and 18 half-day sessions). We presented the workshops in 11 mini-conferences, 3 requested 1-day district workshops and 5 inservices:

- Mini-conference (2 workshops) at Northern New Mexico Community College (NNMCC), September 9-11, 1997: Internet Research for Educators (1 day), HTML-Designing and Building Web Sites (2 day).
- Mini-conference (13 workshops) at Laredo Community College (LCC), September 15-16, 1997: Introduction to the Internet I, Introduction to the Internet II, Electronic Mail I, Electronic Mail II, Internet Research I, Internet Research II, HTML-Designing and Building Web Sites (2 days).
- Mini-conference (4 workshops) at Northern New Mexico Community College (NNMCC), January 7-9, 1998: Internet Research for Educators (1 day), HTML-Designing and Building Web Sites (2 day), Introduction to Networks (2 day), and Networking Fundamentals (1 day)
- Mini-conference (4 workshops) at University of New Mexico-Gallup, January 12-15, 1998: Internet Research for Educators (1 day), HTML-Designing and Building Web Sites (2 day), Introduction to Networks (2 day), and Internet Research for Educators (1 day - second session).
- Five two-day sessions of NT Server Basics for network managers. Four at NNMCC: January 15-16, 1998; March 16-17, 1998; March 19-20, 1998; July 20-24, 1998. One at Western Oklahoma State College (WOSC): July 27-29, 1998.
- Mini-conference (4 workshops) at Northern New Mexico Community College (NNMCC), July 20-24, 1998: Internet Research for Educators (1

day), HTML-Designing and Building Web Sites (2 day), Networking Fundamentals (1 day), and NT Server Basics (2 days).

- Mini-conference (3 workshops) at Western Oklahoma State College (WOSC), July 27-29, 1998: Internet Research for Educators (1 day), HTML-Designing and Building Web Sites (2 day), and NT Server Basics (2 days).

EduNets Mini-Conferences offer a mix of workshops - from basic workshops on using Netscape and email to technical workshops on network design, implementation, and management.

- Mini-conference (2 workshops; 2 seminars College (WOSC), August 10-13, 1998: Internet Basics (2-1 day), Networking Fundamentals Seminar (2 half-day), and on-site consulting.
- Five one-day workshops: Networking Fundamentals, January 30, 1998 at UNM-Gallup; Internet Basics, Gallup-McKinley County district in-service, February 6, 1998 at Tohatchi High School, Tohatchi, NM; Introduction to the Internet, Netscape and Search Engines, February 11, 1998 at NNMCC; Internet Basics, February 13, 1998 at NNMCC; and, Introduction to Electronic Mail, March 20, 1998 at NNMCC. One two-day workshop: HTML-Designing and Building Web Sites, July 20-21, Kirtland Technology Center.

<u>Other Support Provided this Year: ICTE Conference Technical Support</u>

March 8-11 the Fifteenth International Conference on Technology and Education (ICTE) was held in Santa Fe. Los Alamos National Laboratory was one of the main sponsors of this conference. Dennis Gill, Science Education

Outreach Program Office, was a co-chair of the event. The EduNets Program was asked to coordinate the technical support for the conference.

The job was challenging - it required networks in Santa Fe at both the Sweeney Convention Center and the historic La Fonda Hotel with a server and Internet access support for 10 presentation rooms, Sweeney Auditorium, a vendors area, two information desks, two tech support centers, an interactive education area, and an email and practice room. Each presentation room required a PC, a Macintosh, drops for laptops, a multimedia projector, video capability, and Internet access. Technical support, training on using the equipment and email support were provided throughout the conference. Over 240 talks were presented in the three days, most requiring computer and multimedia support. The nine (9) main sessions were broadcast live from the Sweeney Auditorium directly over the Internet using RealVideo.

The technical support team for the conference was praised highly and recognized many times during the conference. We were told that DOE representatives from Washington were very impressed with the LANL computer support, members of the ICTE committee and governing board thanked us profusely, many presenters told us personally that they had never had such outstanding technical support, and, in the closing session we were applauded as the best technical support the speaker had ever seen at a conference.

This was truly an International Conference - approximately 40% of the attendees and presenters were from foreign countries. The ICTE is held each year alternating between a site in North America and a site in Europe. Typically, delegates represent technology-using educators from a wide range of higher educational institutions, state departments of education, ministries of education, and school systems worldwide.

Team from Chama schools at the International Conference on Technology and Education in Santa Fe, New Mexico, demonstrate video-conferencing with students and team members in Tierra Amarilla 100 miles away. Chama, one of our newest districts, joined EduNets this year and just got their network and Internet access up a few weeks before this conference!

EduNets: Sites Supported

	K-12 Districts*	Regional Training and Support "Hubs"	Total Districts Hubs & Related Program Sites	NM K-12 Schools	K-12 Sites Provided with on-Site Support
FY95	9	5	17	102	> 50
FY96	16	11	37	124	> 80
FY97	39	19	76	194	> 160
FY98	54	21	81	199	> 180

* Includes Public School Districts and Non-public School Campuses/Districts

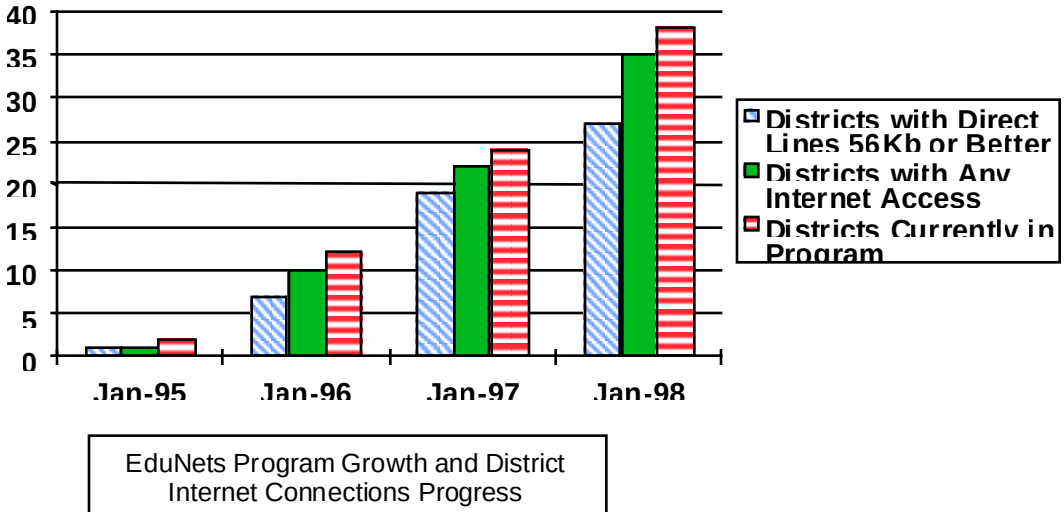
EduNets Scope: Sites Supported — Current Support and Partnerships Scope: 54 School Districts (37 public and 17 non-public; 17 limited support/research sites), 12 community colleges, 15 other (2 departments of education, 3 regional technology centers, 4 support cooperatives, 3 related LANL networking programs, and 3 community resource partners).

Current data indicates that for public school districts in New Mexico that are in the EduNets Program, over 80% of the students are in national minority populations, with 11 districts with over 90%. According to the New Mexico Department of Education reports based on census data, over 30% of the students in the public schools in our districts are classified as living in poverty.

Internet Access — New Mexico EduNets School Districts
Our primary goal is to help schools establish working and reliable Internet access.

Making a Difference

Students at St. Bonaventure Mission School in Thoreau, New Mexico, are using the Internet. When we started working with St. Bonaventure in 1995, this seemed almost like an impossible dream for the rural New Mexico school. Now they have more computers, direct Internet access, a technical support team, and a lot of very happy and excited students!



EduNets Program Growth and District Internet Connections Progress

DP Mission Benefit

This project uses the unique resources of Los Alamos National Laboratory – extensive computing, networking, and technical training expertise and experience – to help schools and school districts (primarily in remote and rural areas) get connected to the Internet and its resources. Resources on science, mathematics, engineering, and technology (never before available in many of these districts) are being accessed daily through these networks. The full potential of these resources is just beginning to be realized at our school sites.

C. Program Technology Support

Program Description

The Program for Technology Support was developed to focus on maintaining an electronic infrastructure and telecommunications environment to support teachers, students, and Laboratory personnel involved in Science Education programs through the use of computer technology and appropriate technology instruction. Establishment of a technology-ready site consisting of the proper equipment and software, development of appropriate training strategies, and the effort required for maintenance through this program, have made it possible to develop and maintain an environment that contributes to the enhancement of classroom technology practices. The practices develop participants' skills in on-line networking, web page development, integrative software for curriculum development such as concept mapping, and Internet access for research. Participant efforts are consolidated within each program via e-mail and web-based curricula. Program participants are taught and encouraged to integrate computer technology into their classroom curricula through direct instruction, modeling, and practice.

Goal and Objectives

The primary goal of this program is to support and maintain an ongoing technological infrastructure for Science Education programs by

- integrating computers and telecommunications into science and mathematics instruction,
- modeling appropriate use of educational technology in science and mathematics classrooms and creating a testbed of effective practices,
- providing appropriate training to all Science Education program participants: students, teachers, Laboratory mentors, and LANL science education program coordinators,
- providing teachers and students, locally, state wide and nationally with access to Laboratory technical resources and information,
- maintaining constructive and productive partnerships among teachers, students, university staff members, Laboratory technical staff and education specialists through electronic communication,

The Program for Technology Support leverages DOE funds by offering a variety of educational curricula focusing on Laboratory science on the World Wide Web. This increases exposure for Laboratory science to a world audience. The Program for Technology Support supports the DP education mission by

- contributing to systemic improvement in science, mathematics, engineering and technology education
- enhancing scientific and technical literacy
- providing teachers and students access to highly-technical Laboratory research and information that would be impractical without a strong technological capability
- increasing involvement of educational communities locally and nationwide in Laboratory Science Education programs by utilizing telecommunications to disseminate program-related information
- increasing dialogue between Laboratory and educational communities by providing a venue for scientists to interact with teachers and students
- providing a technology environment where telecommunications and computer technologies are introduced, developed, applied, and tested to enhance program effectiveness.

Five FY98 programs in particular - TOPS, EPSILON, Systems Modeling for Education, the WEB of Learning and the Critical Issues Forum - illustrate the crucial role of technology in Science Education programs at LANL. These programs would not be practical or cost-effective without the telecommunications component. A centralized platform within a technology environment used for development and exchange of educational information has allowed SE programs to be a presence in the rapidly evolving educational technology arena. The effective use of technology for distance learning activities and in building networked communities of teachers and scientists has reduced the cost of doing business, thus allowing SE to put more resources into participant costs.

The 1998 fiscal year saw the Program for Technology Support mature into a veritable resource that provides the Science Education team with real and ongoing interaction between Laboratory personnel and program participants. The installation of the Science Education Web Server (http://set.lanl.gov/) at Los Alamos National Laboratory, and the completion of individual program

web sites now found there, signifies a large step toward realizing a capability that puts the LANL K-12 Science Education effort ahead of many other agencies leading education efforts. Our increased emphasis on telecommunications this fiscal year represents our steady evolution as experts in educational technology. We are now viewed by our partners and by organizations and agencies at the state and national level, as being at the forefront of applications and innovations in education technology integration with curricula.

A significant element facilitated by the Program for Technology Support has been the design and development of interactive networking environments. These environments have allowed program participants to exchange and compare data, maintain communications among students, teachers, scientists and Laboratory education specialists, and to provide information about Laboratory research to the educational community, locally and nation wide. The Server, intended to be a virtual resource center for program participants, houses specific detailed versions of the Science Education programs, provides a location for on-line interactions among program participants, and is a repository for teacher developed materials. Generally, questions are posted within Science Education's individual program's web pages, and staff members send e-mail to the program coordinators, who publish the responses for everyone to read. This practice has been shown by research to be an effective tool in generating improvements in writing, editing one's own work, reading and comprehension, cognitive development and communication.

Ninety teachers from both of our flagship programs, TOPS (our teacher development program) and the Critical Issues Forum (CIF), representing New Mexico schools (K-12) were impacted this past year by technology support through this program. Participants investigated both historical and current scientific topics through benchmark assignments, participated in regional workshops, and published their work on the Science Education Web Server in electronic team portfolios. In addition, these participants, Laboratory mentors and SE staff members were instructed in

- web page design
- HTML programming
- network planning and implementation
- Internet research
- design of curriculum integrating computer technology
- development of web accessed data bases
- selection and use of appropriate educational software

A significant function of this program was to prepare numerous LANL employees to establish collaborative electronic mentoring relationships with the Science Education program participants. Electronic communication formed the link between our education programs participants and the Laboratory community that maximized the experience of a single individual during the program. The Program for Technology Support also provided a gateway for teachers and students to the vast material and human resources available over the Internet and the World Wide Web.

Through our Science Education programs, we have increased the amount of educational material focused on Laboratory science. This material, newly created or assembled by program participants, is housed on the SE server. Through the use of the SE Server to disseminate developed curricula, a larger and more diverse audience is reached, thus leveraging DOE funds. For example, Lawrence Livermore National Laboratory was able to conduct

the Critical Issues Forum in California by using the LANL developed program on the Internet.

Evaluation

In FY98, funding of the Program for Technology Support afforded us the opportunity to take on a postdoctoral student in educational technology from the University of California at Berkeley. This student contributed to the overall approach to implementation of the program and its interface with technological components of the other programs. A significant portion of the student's responsibilities in this program were development of specific educational technology applications, critical input regarding cognitive frameworks and assistance in the development of assessment structures for specific programs. These assessment structures included elements from each program, including cross-functional elements such as impact, which could be applied to understanding the contribution of technology to programs as a whole. The student contributed significantly to our ability to consolidate our evaluation tools electronically by creating an on-line repository, as well as an evaluation matrix for all of our programs.

Summary

Overall, the Program for Technology Support has allowed us to develop our capability for all of Science Education at the Laboratory. As a result of our growing reputation among the technical staff at the Laboratory for providing exemplary education programs, we had the opportunity this past fiscal year to work directly with technical programs to provide education components for their projects. Projects such as the NASA ACE and TWINS projects, and the LANSCE facility educational tours were demonstrations of our ability to advance science education at Los Alamos through the effective delivery of program products, especially those that feature technology. This capability has given us an edge over programmatic education efforts at other Laboratories and agencies by providing the necessary support to develop and implement a technology infrastructure and environment that underpin the successful implementation of our programs. We are able to implement more effective educational technology in our programs because the Program for Technology Support has allowed us to focus exclusively on the nature and deployment of electronic media, telecommunications, computer networking, applications, and infrastructure for delivery--the essential components for each program. The escalating requirement for effective use of technology in education as indicated by the E-Rate initiative, the Y2K controversy, the integration of technology into the curricula, and workforce concerns, demonstrates to us that our investment in technology support is effective and will be increasingly essential, if we are to provide relevant links to Laboratory science, and useful experiences for teachers and students beyond today's classrooms.

D.Systems Modeling for Education (SME)

Program Description

The Systems Modeling for Education program is a multifaceted project to develop web-site software for investigating basic physical science phenomena like heat transfer, sound, force, optics, etc. Targeting students and teachers in grades 7-12, the project is a web-based "dynamic text-book" allowing student experimentation in a "virtual laboratory" environment.

Recent developments in web database connectivity will allow online teacher assessment and tracking of student movement through the site. The SME web-site will be a complete, stand-alone, pedagogical package with multiple student entryways that address multiple learning styles. These are highly intra-linked pages that provide interactive content presentation, and teacher mediated learning through a database assessment and tracking environment.

Laboratory staff are using advanced technologies and programming languages to create the interactive software. Laboratory scientists and teachers will work together to develop the Graphic User Interface, computational models, and data presentation schema. Teachers will develop the science and mathematics content, classroom and laboratory curriculum, and cross content-area investigations such as the history, the environment, etc. Should connectivity in rural communities remain slow, the educational model being developed within SME is being designed for seamless transfer to a CD-ROM format.

Goals and Objectives

The goal of the SME program is to enhance science education and teaching at a national level by extending and enhancing the capacity of computer-based learning through computer modeling and simulation of physical phenomena, as well as directly applicable background information and curriculum. It will offer the national education community a stand-alone, user friendly, web (or CD-ROM) based environment that supports teacher content delivery. With references to ongoing LANL research embedded in the content, this project offers a high visibility contribution to classrooms nationwide, as technology and web-site access play an increasingly prominent role in education.

Implementation

During FY98, the SME program was in a development phase. All resources were applied to developing the educational model, integrating the model with web technology, establishing technical feasibility, creating Level-1 content, and creating the Teacher View.

Developing the Educational Model — The foundational vision of the SME program is to create an educational web site that can deliver science content with connections to LANL defense related programs in a manner which is mediated by local teachers. Unlike CIF and EPSILON, which require a central web-mediator, SME will be a stand-alone site available worldwide where a user can be locally mediated by anyone – teachers, parents, users themselves, etc. Thus, LANL has high visibility, students get rich, dynamic, real-world content delivery, and teachers get a valuable curricular resource offering both content and assessment in one package. Because the site is self-supporting and highly intra-linked, the overall site construct is best described by the following:

A teacher decides to use this site and registers her/himself and all her/his students as site users. A relational database is established that will track what activities the students have completed and document what they understand in each strand. The teacher has access to all her/his students' work through this database. Eventually, each activity will be cross-referenced with the National Standards. Thus a teacher can assign activities within the site based on the standards, as a supplemental delivery tool, or as the environment for complete content presentation.

From a student's perspective, the individual would first log into the site with a user ID and password. In her "Student Locker" she would have access to what activities she had completed well, what needed work, and what was still available to continue her learning.

When choosing a concept to research and experience, students have three choices of how to begin (of course, students are encouraged to move freely among these options during their investigation). They can:

- Enter the "Virtual Laboratory" environment for an interactive concept presentation and/or interactive, mathematically driven, simulation. This educational environment is the dynamic site component dependent upon the latest browser technologies and reasonable connection and computer speeds. When complete, this environment will pedagogically tie to the mathematics and computer modeling of the physics content.
- Read applicable, real-world events in the "Stories" section. In the case of heat transfer, the stories would range from the laser cooling of rubidium atoms at LANL to the melting of audiotapes in hot cars on sunny days. The stories will be submitted by LANL scientists, students, teachers, site users, etc., reviewed by LANL staff for appropriate and applicable content, and placed into the site collection. The "Stories" section is exclusively HTML/PDF delivered to ensure access to rural communities with limited connection and computer speeds.
- Research the concept in the local site "Library" which offers conventional text/figure content delivery. The "Library" section is also exclusively HTML/PDF delivered to ensure access to rural communities with limited connection and computer speeds.

Integrating Web Technology — Web technology is changing rapidly. When we began visioning the educational model, the language of the web was HTML v 2.0. The web programming community is now passing through HTML v4.0 and beginning to use DHTML in conjunction with many other scripting languages. In projecting forward to the future, the SME program site is being developed using DHTML, JAVA Development Kit v1.1, and Symantec Java Database Development Edition v2.0. Because we are at the cutting edge of web-based technologies, our product runs in only one, pre-release browser from Netscape, at this time. When SME is ready for dissemination in 1999, it will be part of the current technologies, not part of the past.

Establishing Technical Feasibility — The SME educational model is the most sophisticated, tightly integrated, web site we have located – by a considerable margin. Thus, like most LANL research and development efforts our focus has been on proof-in-principle that the most cutting edge technologies of today can support web-site delivery of an advanced educational model. In working with these new technologies we succeeded at all aspects of proving feasibility as a web delivered educational model. The area of greatest resistance to our efforts was database connectivity in the JAVA environment. In this area we proved feasibility, but were not able to actually construct the architecture in FY98.

For FY99, database connectivity will be the area of greatest technical effort. This area is critical to the site operating as a coherent unit of integrated strands. SME is an intensely cross-connected site and it is the database which tracks site flow, content completion, and portions of student assessment. Proof-in-principle was achieved in FY98. FY99 will seamlessly integrate the database with the site components.

Creating Level-1 Content — The SME heat transfer site is designed to deliver content at multiple levels of understanding. Level-1, the most foundational content delivery in the Virtual Laboratory strand, was completed as a prototype without database connectivity. Approximately half of the Stories and Library strand materials at this level were also completed. Now that the “look” and user interface aspects have been created, a template exists to more rapidly add content to the site.

For FY99, a substantial content development effort is planned using local educators and student programmers. With the exception of the JAVA Applets, we intend to design and deliver 85 percent of the Heat Transfer content. That is, all virtual lab experiences (except the applets), all pre-dissemination stories, and most of the library material and all DOE defense program links.

Creating the Teacher View — One of the most unique aspects of the SME site is the Teacher View. The development of this area is ongoing. A teacher will be able to register him/herself and as many students as desired. This will establish a user-invisible relational database structure that links the students with the teacher. As students progress through the site content and activities their movement within the site and their responses to questions (pre- and post- multiple choice and open-ended) are recorded within the database. When a teacher enters the site s/he can get a summary of how much of the site a student has covered and how well s/he is answering the multiple choice questions overall. A teacher can then enter into a more in-depth look at each students movement within the site and specific responses to pre- and

post-test questions. The database structure and interface pages have been completed.

For FY99, the Teacher View will be refined in its design by local educators and database connectivity will be established. More than any other aspect of the site, this component will determine who will use the site and how well it is used. This aspect of the site is also the most database intensive component and will be the final proving ground for database connectivity. This area will be addressed heavily in FY99.

Future — In addition to those areas of further development and refinement, the FY99 effort will also include the piloting of the site in northern New Mexico classrooms before final dissemination. When we look at national dissemination, we must look at software that is more perfectly written than most commercial software. We are not in the position to provide ongoing technical support to a marginal product. This site must be thoroughly tested, debugged, and tested some more before it becomes a final product.

Discussions have begun with industrial partners and academic institutions to sustain, in collaboration with LANL, the development of this educational model. These discussions will continue more heavily in FY99 to ensure that the educational model and this product are available to teachers in the 21st century and beyond. Discussions have begun about hybridizing the software where the educational model is delivered on CD-ROM, to increase delivery speed and local access to remote communities, with internet connection to some of the databases, content module updates, and DOE defense programming links.

Evaluation

Because SME is in development, rather than in a dissemination phase, it must be largely self-evaluated. Before we began with the development of this model, and regularly during FY98, we reviewed dozens of “top ranked” educational sites. None of them offer content in such a dynamic, classroom supportive manner. Most sites deliver content much like a textbook without truly taking advantage of advanced web technologies. ME is on the cutting-edge in this regard.

During FY98 we had a graduate student in Educational Technology working on model development and the design of the Virtual Laboratory strand. Her academic advisor, when reviewing the project proposal before her arrival, was reluctant to have her participate because he felt the project was too far reaching. Upon returning to school in the Fall, he was so impressed with the refined model and our progress that he asked her to continue working on it for her Fall internship requirement and to work on it again in the Winter/Spring semester to complete her site evaluation requirement. This suggests that we are doing very well and leading the way.

Anecdotally, during the Summer of 1998 several members of the TOPS cohort became familiar with the overall site vision and asked when the site would be available. Another enthusiastic teacher has already asked to participate in next summer’s site development workshop because she wants the “pilot” version for her classroom next Fall.

Summary

The SME program takes advantage of web technologies that are not yet commercially available. It offers dynamic and static content delivery for different learning styles. It relates the content to real world situations in an age-appropriate manner. It utilizes pre- and post- testing, Socratic and open-ended questioning, and a constructivist learning environment. It is a locally mediated learning tool for the classroom, and it offers teachers a method to assess students as they use the site. The tool may be used by learners at home.

E. Robotics Challenge

For four years Los Alamos National Laboratory has conducted a Robotics Workshop, intended to introduce Middle and High School students to the accessible BEAM (a multiple use acronym, with one meaning being "Biology, Electronics, Aesthetics, and Mechanics") technologies. We are focused on involving and catching the interest of youth from as many communities in Northern New Mexico as we can, and showing them the excitement of the "high tech" world. For the most part BEAM concepts include reusing discarded electronics and solar power, and the kits provided for the workshop are designed around these premises.

The Los Alamos BEAM Robotics Workshop of 1998 took place on the days of April 16-18 (Thursday through Saturday). As with last year, we again provided a graded approach to building the BEAM robots, where entry level students could build the simplest of robots, either the solaroller or the sundancer. Another set of more advanced students were given the next level robot, a two motor photovore called the photopopper. After finishing the solaroller the beginning students graduated to the photopopper. We also had purchased fifteen of last year's most advanced BEAM robot, the microcore walker. The new kit for this year was the BEAM Walker II, a four motor microcore walker, of which we ordered 10. With the advent of the four motor walking robots at the '98 Workshop, we now have the ability to take advanced students to the next level of robotics, in which the robot truly begins to interact with its environment. The setup for the '98 Workshop was a walker designed so that when it ran into an object, it backed up, then rotated (by moving the legs on one side forwards and the other side backwards), and proceeded to march forward again.

We had almost 80 students enrolled in the workshop, which was conducted as a three-day affair. In fact, we had to turn away several people, because of space and kit limitations. As with last year, there were BEAM Games, set up for attendees of the Workshop, and all the workshop energy was focused on transferring technical capability to the students. We had students from many Northern New Mexico counties (Sandoval, Los Alamos, Mora, Las Vegas), as well as Albuquerque and Las Cruces. We had students from out of state, coming from Texas, Kansas, and Arkansas. The Arkansas students were graduate students studying robotics at the University of Arkansas. There were 14 female students and a total of 24 Hispanic students participating in the Workshop.

F. Equipment for Education Program (Gift Program)

Program Description

The Laboratory's Equipment Gift Program was developed to comply with the1993 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 an MOU with the New Mexico Department of Education.

We, in Science Education, have tailored the Equipment for Education Program to meet our particular needs, and the needs of other Science Education Program initiatives at the Laboratory. This fits with the DP Mission to provide an infrastructure and the intellectual capability for stockpile stewardship. By providing excess equipment such as computers, LANL 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. We provide 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.

Program Objectives

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.

Program Implementation

In 1998, the Laboratory's K-12 science education programs through our office alone provided 65 excess items, including computers and other equipment, to 65 teachers in schools across 10 New Mexico school districts for a total value of $210,000. 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 the use and maintenance of 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.

A significant accomplishment of the Equipment for Education program this past fiscal year was the development of the Computer Refurbishment Center concept in collaboration with Española Valley School District, the Department of Energy (DOE LAAO), Johnson Controls of Northern New Mexico (JCNNM), and Northern New Mexico Community College (NNMCC). Programmatic funds were leveraged by the development of a new *school to career* project to provide training to approximately 40 area high school students per year in computer upgrade and repair. Submitted as a proposal for funding by NNMCC to the Los Alamos National Laboratory Foundation, the Computer Refurbishment Center was subsequently funded and launched. Located on the NNMCC Espanola Campus, the concurrent credit courses began this fall and are training high school students in repairing and refurbishing personal computers using repairable equipment provided by LANL to the Espanola Valley School District from gifted excess equipment for education. The refurbished equipment will be re-distributed to area school districts and other non-profit educational organizations in Northern New Mexico. This concept has generated great interest from other school districts in the local area, such as Pojoaque and Los Alamos, where programs, such as the one in Espanola, may be started.

Evaluation

Evaluation criteria contributing to a summative report are embedded in the evaluation plan of each program where equipment is gifted. In the TOPS program, the goal of “developing a web-based communications network with the intent of developing a strong educational support network among the program participants and within and beyond their own communities” never would have been possible without starting each participant in the program with equal technology resources. The ability to succeed in creating an interactive web site, where K-12 science-related curriculum was developed, was reported in FY98 by 68% of the teachers at the end of the second year of the program. This can be attributed in large measure to the computers gifted to these teachers at the beginning of TOPS.

Summary

This program contributed to the effectiveness of our technology implementation efforts that allowed us to meet the goals of our short and long-term strategic plan for K-12 science education in FY98. With the introduction of the *school to work* collaborations to create computer refurbishment centers, the Equipment for Education program has now added another milestone to its cumulative accomplishments since its origin. This program is currently the only program of its type at the DOE 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. We have had numerous requests from individuals from other agencies and the public schools outside of New Mexico, for information about how to develop a program like ours at their location.

In combination with the Program for Technology Support, there is no question that the Equipment for Education program effectively serves the specific needs of K-12 education programs. However, efforts to make the Equipment for Education program more responsive to the growing needs of

Laboratory sponsored initiatives have met with several challenges that may impact how the program is coordinated in the future A large challenge has come in the form of pressure from the LANL Community Involvement & Outreach Office to have the program serve community outreach and non-profit organizations, in addition to the existing requests to supply post-secondary institutions, as well. This past year we participated in a series of meetings and working groups to bring the issue of broadening the distribution of equipment beyond the K-12 boundaries to the attention of DOE, but without much success.

Another major challenge has been to find a coordinator who is approved by the Laboratory's Business Operations division (BUS) to facilitate the program for Science Education. Technically, this individual cannot be the coordinator of a "shadow" function of BUS, i.e., someone not in BUS who is providing similar service, but that division has been uncooperative in helping us find a person who meets both our needs and their requirements. Our solution is to find an individual who can be trained to facilitate the various tasks of the program and who can work closely with our own division's property administrator. Our operation is relatively small compared to the total volume of equipment that is generated by the Laboratory, and that is one reason why we have been able to manage this program so effectively. There is recognition that the program can continue to improve and grow in a modest way.

Ultimately, we hope to hire someone in FY99 who can effectively facilitate the program and who can also provide technical assistance in the refurbishment of the equipment. This may be an opportunity to have student interns work alongside a program coordinator. Our past experience with this arrangement indicates that it offers real potential for making the Equipment for Education program provide a much more comprehensive service to both our programs and to the Laboratory. The Equipment for Education program has inherent fiscal and operational limitations in providing the volume of equipment and breadth of services that are requested beyond its own programs. However, the Science Education Team continues to remain involved in ongoing discussions on equipment issues, from a pragmatic standpoint, and also because we have the most experience to offer about the effective facilitation of our own program.

G. International Conference on Technology and Education (ICTE)

In FY97, the Laboratory committed to co-sponsoring the 15th International Conference on Technology and Education in Santa Fe, New Mexico, March 8-11, 1998. The University of New Mexico participated as co-host for the conference. The Lab's commitment included leading the paper selection committee, review of abstracts and papers, development of special presentations, pre-conference coordination in Santa Fe and it's environs, organization and management of all conference support functions, and total operational support during the conference itself. Dr. Dennis Gill, the Lab's Program Manager for Science Education was one of the co-chairs for the conference.

Conference attendance was worldwide with 833 attendees representing 51 countries. During the conference, 237 papers were presented along with several special events. Presenters numbered 270, including the Deputy Superintendent of Moscow School, representatives of the European Commission, and the US Army's Training and Doctrine Command.

Classroom teachers shared ideas through their papers along with representatives from many university departments of education.

During one special event, Dr. William Sphorer of Apple, Inc., announced a new Apple-supported program to foster interchanges among teachers. Called the Apple Learning Interchange, it can be found at:

http://www.ali.apple.com.

The principal function of the Lab was to coordinate all aspects of the conference and ensure smooth operations through extended technical support and real-time administration during the event. Additionally, the Lab had major commitments in chairing the program committee and soliciting and coordinating invited plenary speakers. As part of the effort, the Lab generated live coverage of the plenary sessions and broadcast them over the Worldwide Web using Netcast technology.

In addition to direct Lab support, other assistance was received from US West in the form of a T-1 direct line to the 2 conference locations, and from Proxima Corporation, which donated the use of Proxima video projectors for all presentation rooms.

The Lab's efforts in technical support received many accolades both during and after the conference. A separate support room was established to ensure the presenter programs ran smoothly and to overcome technical difficulties associated with differing world standards such as PAL and NTSC compatibility. Additionally, e-mail support was provided all conference delegates as well as Web access in all presentation rooms. Finally, Lab personnel participated directly with separate presentations about Lab science education programs as well as on-site demonstrations of New Mexico-based programs.

ICTE, Inc., has requested continued Laboratory participation through the 1999 conference which will be held in Scotland. ICTE is moving toward a change in scheduling that will facilitate a US and a European conference each year. The next US conference is scheduled to be in Tampa. More information about ICTE and future conferences can be found at the ICTE web site:

http://www.icte.org.

V. PUBLIC UNDERSTANDING OF SCIENCE

A. Science Education Information On-line

This Education Information On-line project maintains a World Wide Web (WWW) Server at http://education.lanl.gov/ that provides education program descriptions and content information from Los Alamos National Laboratory. We support 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 DOE and the public about the many education projects at Los Alamos National Laboratory. This is accomplished via the World Wide Web over the Internet. Additional objectives of the project are to:

- Educate program leaders & participants on the WWW & 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.

Accomplishments in FY98

The principle project activities during FY98 included:

- upgrading the server hardware system,
- updates of the server software,
- building a database of program information with an interface on the WWW,
- providing a second "secure" WWW server to receive sensitive application information,
- expansion of information on several programs,

- participating with the LANL WWW editorial board to coordinate the education WWW site with other LANL WWW activities,
- assistance to the New Mexico State Department of Education and other external education groups and institutions.

The major activity during FY98 was to build a database of all education activities at the Laboratory and then to build an interface to that database on the WWW. The database includes all of the Education Program Office programs and other education programs at the Laboratory. We also implemented a scheme for including information about former or currently inactive programs. The URL changed for this program information. The new URL is http://education.lanl.gov/EPO/.

We also have provided a second "secure" WWW server that will allow us to collect program application and other sensitive information securely over the WWW. The URL for this server is **https://se.lanl.gov/**. The Undergraduate Research Semester (URS) program will be the first to use this new service.

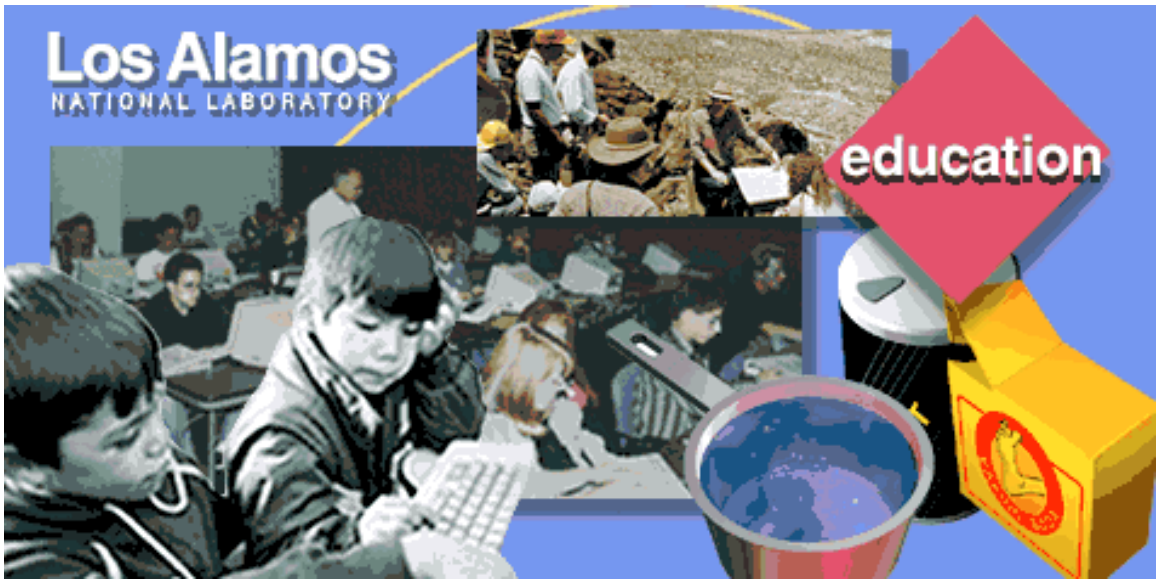
We continue to work with the New Mexico State Department of Education (NMSDE) in several areas. These efforts include assistance with their WWW server, implementation of an e-mail list-processing program (majordomo), and assistance with PPP connections to the Internet via New Mexico Technet, and teaching department personnel the Hypertext Markup Language (HTML) so that they may create WWW pages for their server. A full-day workshop on the Internet was presented in February to about 20 people from the NMSDE.

The project completed its fourth year and is currently serving an average of over 3000 requests per day, representing an average daily transfer of over 32 Megabytes of data. The server currently provides over 3700 files containing nearly 1.7 Gigabytes of information. In FY98, over 62,000 distinct hosts from over 68 countries have been served. The top ten subject areas of interest on the server for FY98 are:

- NTEP 95 project information.
- Hydrogen Project.
- Science at Home.
- Critical Issues Forum.
- Education program information & reports.
- Model-Nets project information.
- EPSILON: Educational Pipeline for Student Initiatives Linked on the Network.
- NM On-line Internet Institute (OII).
- TOPS: Teacher Opportunities to Promote Science.
- Mentors Information for Science Technology Base (STB) Programs.

Several workshops were presented to a variety of K-12 education groups including the New Mexico Technology Conference, the New Mexico State Department of Education, TOPS program participants, CIF program participants, and Northern New Mexico Community College. These presentations included:

- A basic introduction workshop on HTML
- The basics of technology in education.
- Creating WWW servers using the Apple Macintosh
- The Internet
- Model Nets: A nation-wide study of networking in K-12 education



B. Hydrogen Education Outreach Activity

Program Description

In May 1998, the Fuel Cell/Hydrogen Education Activity at Los Alamos National Laboratory received funding from the Office of Advanced Automotive Technologies (OAAT) at the U.S. Department of Energy, to begin the development of a tutorial (brochure) for high school and college students on fuel cells. Because OAAT receives numerous requests from students for information on fuel cells, it was determined this brochure should be designed for the “overachieving” and independently inquisitive student. The tutorial will 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.

Program Goals

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

Implementation

Working directly with OAAT staff, a detailed outline of the tutorial was written. It was determined that broad areas – including utility as well as transportation applications of fuel cells should be included. In addition, subjects of energy security, oil import concerns, automobile emissions, and greenhouse gases would be added.

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 aspect of this type of fuel cell were developed. Figures and charts have been designed to be integrated into the text. Introductory material about other fuel cell types is included. Information about further educational/research/career opportunities has been added throughout the text.

During the development of this project, the Fuel Cell/Hydrogen Education Activity has worked closely with the Fuel Cell Basic Research Team at LANL to insure accuracy and completeness. In addition, the draft tutorial was sent for outside review. Comments were integrated into the draft and in late September, the tutorial, containing proposed graphics and figures, along with sample page designs and suggested cover, was sent to OAAT. After receiving OAAT fuel cell team review and comment, LANL will produce a camera-ready version of the brochure for publication.

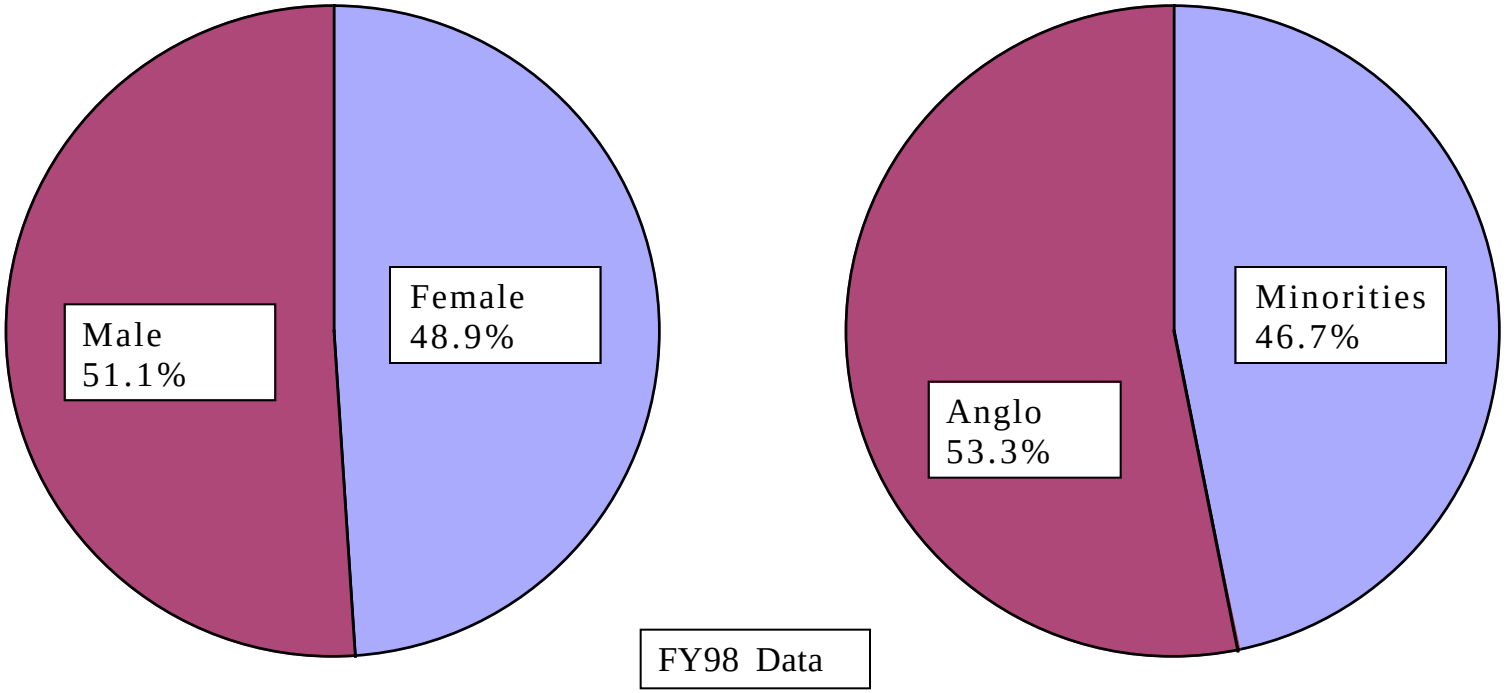
Science Education Program Statistics:

Gender and Ethnicity

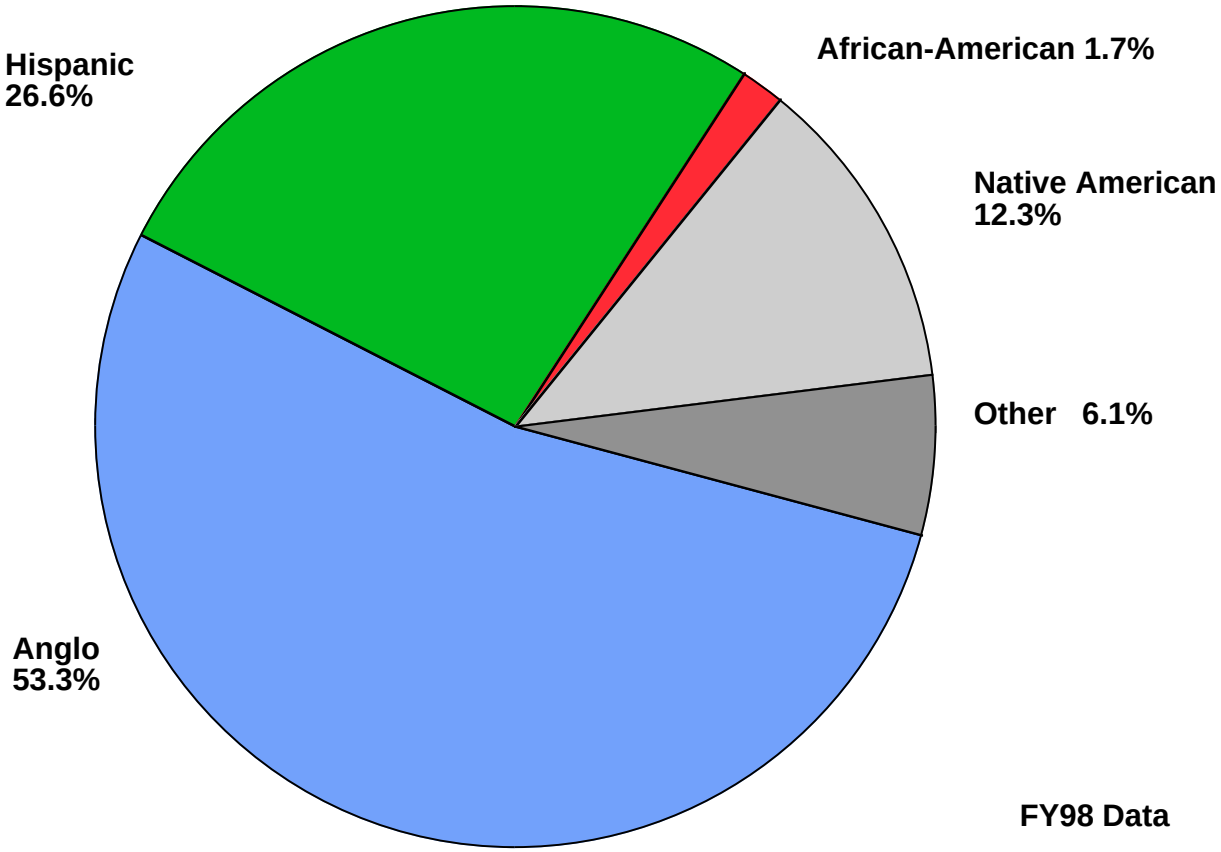
Diversity in Science Education Programs

Diversity Statistics for FY98

Gender and Ethnicity Are Important Considerations in Our Programs



Diversity in Science Education Programs at Los Alamos



Diversity Statistics FY98

Program	S/T	Total	Male	Female	Anglo Male	Anglo Fem	Hisp Male	Hisp Fem	Afr-Am Male	Afr-Am Female	Nat Amer Male	Nat Amer Female	Other Male	Other Fem	% Min	% Fem
K-12 Programs																
Teacher Opportun Promote Sci	T	66	19	47	13	36	5	8	0	0	1	3	0	0	25.8	71.2
Critical Issues Forum	S/T	288	136	152	69	79	35	40	1	2	3	3	28	28	48.6	52.8
Supercomputing Challenge	S/T	535	362	173	236	95	72	49	4	2	38	25	12	2	38.1	32.3
LANSCE	S	4	2	2	1	2	1	0	0	0	0	0	0	0	25.0	50.0
Amer. Indian Community ...	S/T	17	11	6	1	0	0	1	0	0	10	5	0	0	94.1	35.3
Educational Networking Suppor	T	1016	427	589	209	286	121	165	3	2	70	103	24	33	51.3	58.0
Educ. Pipeline/Stud. Initiatives	S/T	78	30	48	13	30	7	9	0	0	9	9	1	0	44.9	61.5
Robotics Workshop	S/F	92	78	14	57	10	20	4	0	0	1	0	0	0	27.2	15.2
ACE	T	9	5	4	5	4	0	0	0	0	0	0	0	0	0.0	44.4
Totals		2105	1070	1035	604	542	261	276	8	6	132	148	65	63	45.6	49.2

Program		Total	Male	Female	Anglo Male	Anglo Fem	Hisp Male	Hisp Fem	Afr-Am Male	Afr-Am Fem	Nat Amer Male	Nat Amer Fem	Other Male	Other Fem	% Min	% Fem
Post-Secondary Programs																
Atomic, Mol & Opt Phy Sum Sch	S	18	12	6	12	4	0	1	0	0	0	0	0	1	11.1	33.3
Historically Black Coll/Univ	S/F	16	12	4	0	0	0	0	12	4	0	0	0	0	100.0	25.0
Two-Year College Initiative	S/F	30	21	9	9	2	12	6	0	0	0	1	0	0	63.3	30.0
Undergraduate Research Sem	S	41	25	16	19	9	4	2	1	1	0	1	1	3	31.7	39.0
Summer Appl Geophy Exp	S	27	16	11	12	10	0	0	0	0	0	0	4	1	18.5	40.7
Underrepresent Min/Fem Init	S/F	68	18	50	2	11	12	35	0	1	1	3	3	0	80.9	73.5
Mentored Collab. Research	S/F	16	11	5	1	2	5	2	4	1	0	0	1	0	81.3	31.3
GEM	S	2	1	1	0	0	0	1	1	0	0	0	0	0	100.0	50.0
Totals		218	116	102	55	38	33	47	18	7	1	5	9	5	57.3	46.8
Total All Programs		2323	1186	1137	659	580	294	323	26	13	133	153	74	68	46.7	48.9