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ABSTRACT

Science educators and the communities they serve have made the improvement of student achievement a high priority, and they have identified more effective teaching as part of the solution to this problem. This document answers the following two questions: What does the research show about effective science teaching? and What kinds of professional development opportunities exist for science teachers? Eight collaboration ventures incorporating one or more of the principles of effective professional development are described in this document; in each case the name and address of a contact person is also supplied. These collaborations are: (1) Teachers Academy for Math and Science; The Orr School Science Connection, Chicago, Illinois; (2) Dayton Public Schools and the University of Dayton, Dayton, Ohio; (3) Delta Teachers' Academy, Lower Mississippi Delta Region; (4) Juniata College & the Central Pennsylvania Association of Chemistry Teachers, Huntingdon, Pennsylvania; (5) Scope, Sequence, and Coordination Project (SS&C), Houston, Texas; (6) Tri-State Education Initiative, Iuka, Mississippi; (7) Jefferson County Public Schools, Louisville, Kentucky; and (8) Science for Early Education Development, Caltech Pre-college Science Initiative/California Institute of Technology & Pasadena Unified School District, Pasadena, California. (PR)

Resource Document

Improving the Teaching of Science:

Staff Development Approaches

U.S. Department of Education

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Resource Document

Improving the Teaching of Science:

Staff Development Approaches

This publication is one of a number of resources the Department of Education has put together for schools and communities across the nation that are trying to meet the six national education goals. This Resource Document is intended to help communities, schools and teachers meet Goal 4: "By the year 2000, U.S. students will be first in the world in science and mathematics achievement." It describes research and activities to improve science teaching, as well as innovative programs around the country that might be adapted for use in your local community. This document was prepared from descriptions of AMERICA 2000 sites collected by Policy Studies Associates (PSA) for the U.S. Department of Education. The Office of Policy and Planning also gratefully acknowledges the directors, principals and teachers who took time out of their busy schedules to describe their programs and share their accomplishments.

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Improving the Teaching of Science:
Staff Development Approaches

Reaching National Education Goal 4: First in the World in Science and Math

When the Soviet Union launched the first man-made satellite into space in 1957, America became concerned that its young people were not being adequately prepared to design, build and use the technology of the future. After the launching of Sputnik, American schools increased the number of required science courses and worked to improve curricula and facilities in grades K-12. Despite this long-term effort, national and international tests reveal that students' science achievement remains low. Researchers and policy makers disagree about whether American students are doing worse in science than students in other countries, because different approaches to data analysis yield different judgments. However, students' test performance very often disappoints their teachers and members of the their communities. Current achievement levels do not reflect the kind of educational outcomes that costly investment in science programs should produce. Science educators and the communities they serve have made the improvement of student achievement a high priority, and they have identified more effective teaching as part of the solution to this problem.

What does the research show about effective science teaching?

Recent research[1] has investigated how teachers' knowledge of subject matter influences the way they teach. The studies show that teachers with relatively deep and extensive knowledge of their subject seemed more able to offer sound explanations and answer students' questions than teachers with minimal preparation. Understanding their subject well enables teachers to present new ideas effectively, show their relationship to what students learned before, and give examples of real-life applications familiar to students. Teachers with limited expertise in a subject often rely heavily on rules and textbooks, rather than offering the explanations and demonstrations that lead students to real comprehension.

Because the knowledge base in science is exploding, even teachers who were originally well-educated may soon lose touch with the expanding frontiers that attracted them to science in the first place. The routine demands of classroom life may quickly absorb time that they planned to spend keeping up with new developments. Providing opportunities for teachers to broaden and deepen their knowledge base in science is one key to science program improvement.

Studies show that some elements of teaching expertise are unique to a discipline. Some aspects of explaining, defining, demonstrating, and practicing are not easily transferred across different subjects. Science teachers must have skills and knowledge that apply only to science in

[1] Grossman, 1987; Grossman, Wilson, & Shulman, 1990; Kennedy, 1987; McDiarmid, 1991; Reynolds, 1987 and 1992; Shulman, 1986; and Wineberg, 1987, for example.

addition to those common to other subjects. Because the knowledge base for teaching has also been growing rapidly in the last few years, many veteran teachers may be operating with a more limited range of strategies than research on teaching now suggests is a required minimum. Effective lecturing may once have been the hallmark – and daily practice – of good science teaching, but new evidence suggests that hands-on activities, cooperative learning, and student research and writing, among other techniques, lead to greater success for more students.

What kinds of professional development opportunities exist for science teachers?

Many districts are collaborating with local and regional institutions whose work centers on science to provide professional development opportunities for science teachers. Some of these partnerships offer paid internships in which teachers work side by side with full-time scientists during the summer vacation or sabbatical periods. Others provide less formal but still stimulating professional contact, both in school and at science workplaces. During these encounters, scientists and science educators share insights and information, renewing and enlarging the knowledge base needed for effective teaching.

Other partnerships with professional science education associations, foundations, or government agencies provide opportunities for teachers to learn about current scientific developments as they create new curricula. They write new lessons, often integrating goals from several subject areas; develop materials; try out new ideas; observe and coach each other; and produce well-tested new programs that make it easier for them and their colleagues to succeed in teaching science.

Collaborations of several types are described on the following pages. Each of the projects incorporates one or more of the principles of effective staff development. For example, many provide high-quality opportunities for teachers to learn new science concepts and techniques. These help teachers understand the broader context of students' lessons. Some partnerships provide opportunities for teachers to perform research and add to the knowledge base in science. Some projects focus on classroom observations and coaching by peers or visiting experts. Some include strategies to involve colleagues from other disciplines in school- or grade-wide projects. In every case, part of improving science programs is to renew teachers' excitement about the subject by engaging them as professional scientists in the pursuit of new knowledge.

Teachers Academy for Math and Science
The Orr School Network "Science Connection"
Chicago, Illinois

The Teachers Academy for Mathematics and Science, located on the campus of the Illinois Institute of Technology, focuses on teacher training with three important features: assessing the needs of each school, having teachers take part in an intensive training session, and following up with coaching at the classroom level by a group of expert educators.

- The Teachers Academy has three important elements: assessment, intensive teacher training, and follow-up with master teachers.
- Teachers learn to use hands-on science and math techniques.
- Resource centers are linked by computer.

During the first stage of the program, a planning committee assesses the school's staff development needs in relation to its goals. The group develops a plan to meet a school's diverse needs.

In the second stage, the faculty receives specially-designed, intensive training created from Academy courses and methods. The Academy's curriculum now includes three 96-hour courses that focus on hands-on science and math for primary or upper-elementary students. Participating schools may choose the standard format – two days of classes held every other week – or arrange a combination of weekday, after school, and Saturday classes that better accommodates the demands of other work responsibilities. (Schools that choose a week-day schedule receive a grant to help cover the expense of hiring substitute teachers.) The Academy also offers a series of lecture/demonstrations and short workshops led by practicing scientists and mathematicians to update teachers on new developments in their fields.

During the third stage, the Academy's master teachers visit faculty in each school to discuss implementation of the new program and provide coaching on new skills. In addition, a liaison from each participating school maintains contact with the Academy staff to distribute new information related to training and to serve as a resident peer coach. Once a school has completed its intensive work and follow-up activities, it is eligible to become a pre-service teacher training site.

During the fall of 1992, the Academy opened three satellite resource centers to strengthen its resource network. The main center at the Academy and the three satellites are linked by computers to databases at universities, museums, and other institutions, as well as to a science teacher computer network and bulletin board. They are supplied with materials to support recommended changes in teaching. Satellites are located at the Shedd Aquarium on the lakefront, the DePaul University library on the north side, and Casals Elementary school on the west side. A teacher resource specialist, on loan from a public school, operates out of the DePaul Center, setting up workshops and demonstrations in response to requests from teachers. By the end of 1992-93, each center will have a teacher specialist in residence.

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Orr School Network's Science Connection. The Academy's satellite center at Casals will also support the "Science Connections" program recently developed by members of the Orr School Network, a partnership activity supported by Chicago's Continental Bank and a group of west side elementary and secondary schools. The inaugural activity of the Science Connections program was a week-long, hands-on science workshop to address teachers' needs. Fifty-two teachers from Network schools participated in mid-August. Follow-up included three one-day workshops spread throughout the year and shorter monthly meetings during which teachers planned for upcoming lessons.

- Science Connection provides resources and staff development for teachers.
- Urban Teacher Corps interns receive training to become teaching assistants.

The Orr Network task force that developed the Science Connection program based its plans on commitments from participating schools to provide real support in three areas: (1) high quality staff development; (2) scheduling arrangements to enable teachers to prepare to use new strategies effectively; and (3) materials and equipment for proper implementation. The Academy-sponsored resource center and specialist at Casals will support Science Connection activities, as part of its general mission.

An unusual feature of the Casals center is the use of Urban Teacher Corps interns to cover classes for teachers who want to use center resources. The interns are enrolled in an intensive, one-year, post-baccalaureate certification program at DePaul and assigned to the school on a regular, full-time basis. They are employees of the school, paid as teaching assistants, and their responsibilities increase from low-level support tasks early in the year to virtually independent teaching by the end of the year.

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Dayton Public Schools and the University of Dayton
Dayton, Ohio

- Scientists from the private sector, science teachers, and university educators and researchers work together to improve Dayton's curriculum, materials, and labs.
- Science teachers participate in weekly half-day trainings and summer workshops.
- Professional development schools have been created.
- Teachers learn to apply real-world concepts to teaching through paid summer jobs working with scientists from the private sector.

Dayton's superintendent launched the district's science reform project with a visit to the dean of the University of Dayton's School of Education. His question was direct: "What can we do together to give Dayton students the science foundation they will need as adults in the year 2000?" They developed a proposal now supported by generous local contributions and a three-year National Science Foundation grant. The project involves collaboration among scientists from the private sector, district science teachers, and university educators and researchers, who work together to improve Dayton's curriculum, materials, and labs.

Public school science teachers participate in weekly half-day training sessions in which they develop their knowledge of the material included in the new, hands-on science curriculum. They take week-long summer workshops and attend seminars on topics of special interest. Most classes are conducted by university and district teachers. Practicing scientists in the Dayton area contribute to the content of these classes. Their participation assures that teachers learn about the larger context of new science developments and about the ways elements of the new K-12 curriculum apply to adult work. Each year several teachers have opportunities for paid summer internships with local businesses, where they work with scientists from the private sector.

To provide practical short-term as well as long-term assistance, teams of university and industry scientists visited each science laboratory in the school system. Following their recommendations, the district removed outdated chemicals, installed new gas and electrical lines, and made other improvements so that labs would provide appropriate support for the new curriculum. This work has been facilitated by the community's recent passage of a referendum with funds earmarked for upgrading school science facilities.

In the newly-formed professional development schools, teachers collaborate closely with one another, university and business partners, and experts in the community through a computer network established with the help of IBM, which donated hardware and software. Teachers use the system for such things as getting answers to technical questions or learning applications of science concepts to the world of work. In addition, the district/university team has made arrangements with the National Assessment of Educational Progress to evaluate students' science knowledge regularly and chart the effects of curricular changes.

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Delta Teachers' Academy
Lower Mississippi Delta Region

The Delta Teachers' Academy, a program of The National Faculty, serves districts in the areas of Illinois, Kentucky, Missouri, Tennessee, Arkansas, Mississippi, and Louisiana that border on the Mississippi River. (The National Faculty is a project that links elementary and secondary teachers with outstanding college professors to create collaborative regional networks and improve teaching.) Launched with a grant from the U.S. Department of Education in 1991 and later supported by the BellSouth Foundation and Texas Instruments, the Delta Academy invited teachers in 10 locations (suggested by the state education agencies) to participate as Academy Associates. At each site, 10 Associates from neighboring districts and schools chose one of five core subjects on which to focus.

- Teachers expand their knowledge in core subjects through summer workshops.
- Teachers interact with practicing scientists and researchers.
- Teachers learn to integrate concepts from the various sciences.

Participating teachers extend their knowledge in core subjects through workshops offered during the summer on a university campus in the Delta region and throughout the year in local communities. Science teachers attending the summer workshops meet with practicing scientists and researchers – called collaborating scholars – to explore curriculum-related topics in depth. The collaborating scholars, members of The National Faculty, are selected for both their expertise in their field and their exceptional skill as teachers.

In the Summer 1992 session, a team that included a mathematician, a physicist, a computer specialist, and a medical doctor offered a course bringing together concepts from math, physics, and biology. They used familiar examples to show patterns among the different disciplines, and they used interactive teaching techniques that included experiments, computer applications, group work, and demonstrations as well as presentations. To high school teachers, the applications of workshop activities to their own classes was obvious. Even the kindergarten teacher attested that the workshop gave her insights that improved her teaching the following year.

During the school year, groups of teachers host several two-day workshops in each region; with collaborating scholars, they continue to study issues of special interest. In 1992-93, at Cleveland High School in Cleveland, Mississippi, teachers explored topics related to their long-term plans for interdisciplinary science teaching. One workshop centered on genetics. The visiting scholar discussed the implications of recent discoveries about the nature and structure of genes. Another workshop focused on uses of technology in the science classroom. Using topics commonly covered in science curricula across grade levels, the specialist showed how to use computers effectively in lessons. Later workshops focused on chemistry lab activities and environmental science. The cadre of Associates at this site hopes to write a proposal for funding to outfit a classroom that would integrate instruction in biology, chemistry, environmental science, and math. Teachers at several project sites have submitted grant proposals to state and local agencies to fund innovations in science education.

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Juniata College & the Central Pennsylvania Association of Chemistry Teachers
Huntingdon, Pennsylvania

Juniata College and the Central Pennsylvania Association of Chemistry Teachers (CPACT) are changing the face of chemistry teaching in one rural area of Pennsylvania. Their comprehensive program includes a mobile science unit equipped with materials for teachers to use in new lab experiences, workshops and research opportunities for teachers, and an annual science fair for high school students.

- A mobile science van equipped with materials for teachers to use in new lab experiments, workshops and research visits 25 participating rural high schools.
- High school students participate in an annual science fair.
- Summer workshops prepare teachers to use the mobile science van as a resource.
- Teachers may participate in paid summer research projects with college professors.

The Central Pennsylvania Association of Chemistry Teachers was formed in 1985 by faculty from Juniata's chemistry department and chemistry teachers from nearby high schools to revrese declining student interest in the sciences. Part of the problem, they determined, was poorly equipped secondary school labs. Teacher isolation from mainstream science also posed a problem, because small departments in rural schools did not nurture the interest in science that had originally led teachers to science education. To address these problems, CPACT members, led by the college, launched the Central Pennsylvania Chemistry Teachers' Science Education Improvement Project in 1988 with a grant from NSF. The project supports a mobile science education unit, teacher workshops and assistantships, and engaging science activities for budding scientists in the region.

The ChemVan is a mobile science laboratory staffed by a specially-trained, certified science instructor with years of experience teaching in area high schools. Equipped with state-of-the-art lab equipment, the van visits each of the 25 participating high schools an average of six times a year. Early in the school year, the regular teachers and the traveling chemist plan lessons to support course curricula. The specialist then brings the van to each school, sets up the experiments, and provides as much technical and instructional support as the host teacher requests. As they become more familiar with the equipment, teachers and students may borrow the lab sets for up to two weeks after the van leaves.

In collaborative science education workshops each summer, about two dozen teachers meet with project staff to explore new ideas for the school-year program and learn how to operate the new equipment. They expand their understanding of emerging theories, sharpen their technical skills, and develop experiments using instruments provided by the mobile unit. Associating with the college chemists generates discussion about new developments in their field and renews their sense of membership in the science profession.

During the year, participating teachers attend two seminars featuring prominent scientists or science educators. Teachers are paid to participate. To promote teachers' skill and knowledge as scientists, the project offers paid summer internships on research projects with college faculty and continuing education during the school year for teachers on sabbatical. Pre-service teachers in Juniata's teacher education program work with the project as assistants, setting up labs and helping with classroom activities.

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Scope, Sequence, and Coordination Project (SS&C)
Houston, Texas

The SS&C Project is a national effort by the National Science Teachers Association (NSTA) to improve science curriculum and instruction. Three principles govern SS&C program development: (1) "Less is more" –that is, deep and insightful understanding of a few things contributes more to student learning than a superficial understanding of many things; (2) science instruction that proceeds from the concrete to the abstract leads to greater student understanding and achievement; and (3) all science disciplines should be integrated, not taught separately.

- SS&C promotes in-depth learning of a few subjects.
- The teaching of all sciences is integrated into interdisciplinary "blocks."
- Participating science teachers take part in an intensive two-week summer institute that includes hands-on experience.
- SS&C includes a University partnership.

Houston's version of SS&C uses interdisciplinary "blocks" developed at Baylor College of Medicine. Teachers piloting the program and scientists throughout the country participate in revising the blocks. Each block consists of teacher materials for lessons that integrate chemistry, physics, biology, earth science, and space science. Seventh-grade blocks cover topics such as inventions, environment, and earth and sky. In 1991-92, the three pilot schools expanded the project to the eighth grade. Baylor developed a new set of blocks, including a block on energy developed with a $100,000 grant from the American Petroleum Institute. In 1992-93, all middle schools in the Houston Independent School District implemented the program in the seventh grade, and next year they will extend it to the eighth-grade.

Staff development plays a major role in Houston's SS&C project. Science teachers participating in the project attend an intensive two-week summer institute where they receive a complete overview of the blocks and hands-on practice of the activities. During the project's first two years, Baylor staff visited the three pilot schools weekly to conduct classroom observations, provide feedback, trouble-shoot, and help plan lessons. Although Baylor is unable to offer this level of support to all middle schools in the district, a team of lead teachers from the pilot schools acts as trouble-shooter and coach. In addition, the project sponsors monthly Saturday workshops and "open laboratories" for SS&C teachers who want to enhance their knowledge. Three grants, including one for $1.2 million from the National Science Foundation and two for $1.1 million each from the U.S. Department of Education, support all the project's curriculum development, staff development, and expansion activities.

Baylor piloted its SS&C project in Lanier, Deady, and Pershing Middle Schools, where all science teachers agreed to participate. The schools created other programs to complement SS&C activities. For example, Pershing hosts regular visits by chemists from Baker Chemicals, its business partner. The chemists give presentations, work with students on science projects, and provide professional assistance to teachers. Lanier is the home of the Rice Model Science Laboratory which provides state-of-the-art science instruction for students and will serve as a training center for Houston's middle school science teachers. Through the model science lab – which is not part of the SS&C project – eight Houston-area science teachers win scholarships to study with scientists from Rice and the corporate community.

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Tri-State Education Initiative
Iuka, Mississippi

A team of volunteers from the National Aeronautics and Space Administration (NASA) headquarters and Stennis Space Center organized representatives from 30 communities within a 50-mile radius of the Advanced Solid Rocket Motor (ASRM) facility in Iuka into task forces to address the six national educational goals. The task forces recruited the active participation of federal, state, and local agencies and private sector organizations to form the Tri-State Educational Initiative (TSEI), now housed on the campus of the Tishomingo Learning Center near Iuka. TSEI members include 11 school districts in Alabama, 12 in Mississippi, and six in Tennessee, representing 235 schools with 101,000 students in grades K-12. Other participants are five community colleges, one university, the U.S. Departments of Agriculture, Education, Labor, Energy, and Housing and Urban Development; the Appalachian Regional Commission; the Corps of Engineers; Mississippi Presidential Council on Rural Development; SouthEastern Regional Vision for Education; and the Tennessee Valley Authority.

- A community task force was created in collaboration with the local NASA facility.
- TSEI promotes the continuing education of science teachers using NASA facilities and expertise.
- Each month, 250 teachers and administrators take technology seminars at the Tri-State Learning Center.
- With the help of private sector partners, TSEI is developing a plan to link by computer each member district and eventually each school and classroom.

Among the broad range of activities initiated by TSEI in its first year are several that take advantage of the unique resources of the NASA facility and of private partners in the computer industry to promote the continuing education for science teachers. In summer 1992, 75 teachers participated in a one-week workshop on aerospace sciences. Sessions included traveling to NASA's space camp for children and building and launching rockets of their own. Some of the teachers were flown to the Kennedy Space Center to witness a shuttle launch. Teachers have had opportunities to tour the Marshall Space Flight Center and attend briefings by space shuttle crew members.

Each month more than 250 teachers and administrators take technology seminars offered at the Tri-State Learning Center. Private sector partners show how to use computer technology for daily teaching and supervision. This year TSEI will complete Phase I of the grand technology plan – every member district will be linked by means of computer systems installed in the district office and equipped to facilitate collaboration. The next stages of the plan are to add each school to the network, then to add each classroom, and finally to equip each school with a computer for every four students and software to access databases to make daily lessons more exciting.

Other activities have included on-site studies of the environment in Guyana, oceanography studies in the Gulf of Mexico, advanced technological studies at the Oakridge (TN) facility, training in and development of a geography curriculum using the Geographic Information System (Satellites) managed by NASA, and using "real time" information to predict weather and develop curriculum through the US Navy's Oceanography Command.

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The Mobile Science Show
Evergreen, Colorado

- The project mobilized broad community support.
- Led by a Nationally recognized local teacher, a Mobile Science Show visited remote areas to teach simple, hands-on science experiments.
- In collaboration with a local University, the program offered a two-week, summer workshop to train trainers of other teachers.

The teacher named by the National Science Teachers Association as Colorado's winner of the 1990 Presidential Award for excellence used her $7,500 prize for a science teacher education program that reached 1,700 colleagues around the state in its first year. Acting as a catalyst, Sue Anne Berger built a partnership team that reflected broad community interest in promoting science education. Her school district – Jefferson County – approved her request for paid sabbatical and other leave arrangements. John Trefny, coordinator of teacher education programs at the Colorado School of Mines (CSM), won Eisenhower state grant funding and, eventually, National Science Foundation funds. Colorado's Best Chevrolet and Geo Dealers contributed a van and the insurance and fees. Amoco Oil Company kept the van's gas tank full, and US WEST Cellular provided a car phone. Robert Waxman Camera supplied videotaping equipment; Apple supplied a computer and imagewriter; King Soopers and Safeway supplied simple household materials for experiments, and several other individuals and small businesses contributed the technical equipment for more complex experiments. With a total of about $300,000 in cash and in-kind support, the prize-winning teacher built a task force to change science education in Colorado school by school.

In the 1991-92 school year, Berger traveled 32,000 miles visiting remote Colorado districts and showing elementary, middle, and high school teachers how to use simple, inexpensive, hands-on experiments and demonstrations to illustrate science concepts. At each school she offered a workshop for teachers, leading them through activities and explaining the relevant principles of chemistry and physics. She shared information about professional science organizations, access to databases, and procedures to ensure students' safety.

As the first year's experience unfolded, the director realized that without substantive follow-up, the "Mobile Science Show" (as it came to be called) was more like a circus than a powerful influence on teaching practice. The show proved to teachers and students that science was exciting and relevant, but despite its array of events, one visit was too little to promote real change in attitudes and habits. Berger extended her sabbatical to include a second year of program development and implementation. With an NSF grant Berger and her colleagues from Mines offered a two-week summer workshop to train more teachers. In the summer workshops, 50 teachers began the day as an audience, watching a demonstration and listening to a lecture about the significance of a key concept. After the first hour, they moved to a laboratory, stopping along the way for supplies, and spent the rest of the day practicing demonstrations, experiments, and explanations. During the 1992-93 school year, the novice trainers offered workshops to their colleagues in nearby schools or districts. The project director observed and coached them. The project's ultimate goal is creation of a permanent, growing network of trained teachers sharing materials and ideas on teaching science.

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Jefferson County Public Schools
Louisville, Kentucky

Jefferson County science teachers have the opportunity to improve knowledge and skills through a variety of programs with different emphases, formats, and purposes.

Science Alliance Training Groups are comprised of elementary teachers and middle and senior high school chemistry, physics, and biology teachers who participate in year-round, professional development activities. In summer sessions, the groups arrange extended workshops, followed by seminars with consultants scheduled periodically during the year. Teachers exchange teaching ideas and develop student assessment strategies matched to the new content.

- Teachers at all grade levels participate in year-round professional development activities.
- Selected teachers are paired with local science-oriented industries to participate in summer internships and school-year visits.

Through the Southeastern Consortium for Minorities in Engineering (SECME), some teachers attend two-week summer institutes. They focus on teaching writing across curricula in math, science, technology, and engineering. The institutes are funded in part by the national office of SECME.

The University of Louisville (UL) collaborates with the district on two summer programs. At the university, Princeton-trained instructors offer one-week courses to extend teachers' knowledge of algebra, chemistry, biology, and physics. UL's School of Medicine offers six-week fellowships sponsored by the National Institutes of Health to teachers who study life and physical sciences. These well-paid appointments are highly competitive. The Alliance, SECME, and Woodrow Wilson activities are funded in part by federal Eisenhower grants administered by the state.

A math/science technology partnership pairs selected teachers with local science-oriented industries. Teachers engage in summer internships and school-year visits to learn more about science from private-sector scientists and get ideas for lessons that show students how science is used in the community.

In in-service training, high school teachers of chemistry, physics, and environmental and biological sciences learn about new materials and methods to teach science. In summer 1992, a group of teachers from nine JCPS high schools traveled to California for training in the Scope, Sequence, and Curriculum Project sponsored by the National Science Teachers Association and funded by the National Science Foundation. Jefferson County is not funded as a pilot site, but hopes to use the new ideas to improve the teaching of science.

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Science for Early Education Development
Caltech Pre-college Science Initiative/ California Institute of Technology &Pasadena Unified School District
Pasadena, California

The Science for Early Educational Development (SEED) project is the product of a collaboration between scientists and engineers from Caltech and teachers in the Pasadena Unified School District (PUSD). Through SEED activities, students in grades K-6 become familiar with the scientific method, begin to acquire the problem-solving skills scientists use, and develop an appreciation for the creative aspects of science. The project's success arises in part from its emphasis on involving practicing scientists in teacher training.

During training, teachers work under the guidance of a master teacher and a science professional. The master teacher is a program graduate with extensive knowledge of both the curriculum and the specific demands of teaching in PUSD. The scientist demonstrates the processes of scientific reasoning and experimentation and explains the concepts underlying each lesson. The focus is on learning to use science kits to do hands-on experiments with the students. Discussions focus on how teachers can be effective guides and resources for their students. This focus encourages teachers to use the new approaches to science, which often involve learning activities they have never tried.

Project SEED staff from PUSD and Caltech offer training workshops during the summer and at mid-year. Each week-long workshop – five days of 8 a.m. to 3 p.m. classes – covers the contents of two kits at one grade level; there are four kits for each grade from K-6. A total of about 220 teachers enroll. Workshops are held at Caltech, the PUSD District Service Center, and the SEED House, adjacent to the Caltech campus.

- Practicing scientists help train teachers.
- Teachers learn to use hands-on experiments through the use of "science kits."
- The local University partner offers training workshops during the summer and at mid-year.

The Caltech Precollege Science Initiative (CAPSI) is a new organization that builds on the success of Project SEED and branches out into many other areas of professional development. CAPSI provides two resource teachers, clerical support, and kit development for PUSD's K-6 SEED activities.

Through this program, teachers are able to bring scientific methods of inquiry to high schools. In cooperation with the teacher education program at Claremont Graduate School, CAPSI is designing a new college-level science course aimed primarily at elementary education majors, who will use inquiry-based lessons to learn about such topics as blood chemistry, the physics of sound and the biology of plant genetics. With faculty from the Education School at the University of California, Santa Barbara, CAPSI staff are designing and evaluating alternative assessment strategies. Through higher education partnerships and Project SEED extension work, CAPSI also offers classroom teachers ongoing opportunities for professional growth.

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