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ABSTRACT

In 1994 with the initiation of Congress, the Office of Educational Research and Improvement (OERI) created a panel for the evaluation of educational programs in the content areas of mathematics, science, gender equity, educational technology, and safe, disciplined drug-free schools. In 1998, the Expert Panel on Mathematics and Science Education examined mathematics education programs and surveyed science curriculum frameworks. This document identifies two exemplary and seven promising science education programs based on the quality of the program, its usefulness to others, educational significance, evidence of effectiveness, and success. Contact information for each program is provided. Contents include: (1) Introduction; (2) The Review Process; (3) How To Use These Recommendations; (4) Evaluation Criteria; (5) Exemplary Programs; and (6) Promising Programs. (YDS)

U.S. DEPARTMENT OF EDUCATION

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Exemplary & Promising SCIENCE PROGRAMS 2000

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Exemplary & Promising Science Education Programs

2001

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INTRODUCTION

In 1994, Congress directed the Office of Educational Research and Improvement (OERI) to establish "panels of appropriate qualified experts and practitioners" to help identify educational programs and materials that work. In response, OERI created a system of expert panels to evaluate educational programs in the content areas of mathematics and science education, gender equity, educational technology, and safe, disciplined and drug-free schools; and to recommend to the Secretary of Education those programs that should be designated as exemplary or promising. OERI established the Mathematics and Science Education Expert Panel in 1996, guided by the advice of educators, scientists, mathematicians, and policymakers with extensive experience in mathematics and science education. The intent of the Panel was to provide an informed examination of available mathematics and science education materials that could be used as a tool to assist school personnel in the selection of curricular materials. The Panel developed and monitored a valid and reliable process for reviewing program submissions and materials that included creating criteria under which programs would be examined, developing review protocols, examining the evaluation instrument ratings and comments of field-based reviewers, and making decisions about which programs to recommend to the Secretary as exemplary and promising. The criteria were developed pursuant to OERI regulations that implemented the statutory directive.

THE REVIEW PROCESS

In 1998, the first year of operation, the Expert Panel on Mathematics and Science Education examined mathematics education programs. In 1999, the Panel turned its attention to science education programs. As they had done during the mathematics review cycle, the Expert Panel surveyed the field of science education to learn about the curricular frameworks in use across the country. By the end of 1996, 46 states plus 2 other jurisdictions (DC, VI) had completed a state content standards or curriculum framework document for K–12 science education closely aligned with the *National Science Education Standards* established by the National Research Council (NRC) and *Project 2061: Benchmarks for Science Literacy* from the American Association for the Advancement of Science (AAAS). As the Panel set up the process for making determinations, the criteria they established for reviewing science education programs were, therefore, heavily aligned with those standards.

The Expert Panel instituted an open and widely publicized submission process that requested voluntary applications from the field. As part of the submission process to the Panel, science education programs were asked to identify which of three specialty areas—earth science, life science, and physical science—their programs covered. A total of 27 science education submissions were received and reviewed during the 1999 cycle.

Teachers, researchers, and practitioners with expertise in science education were nominated by diverse science education sources to serve as field-based reviewers to examine the quality of the programs submitted to the Panel. Factors such as specialty science area expertise and grade level experience were weighed in determining which candidates were selected as reviewers. Reviewers selected by the Department were diverse in terms of gender, ethnicity, and geographic location. They represented a broad range of areas of expertise and often indicated expertise in multiple professional areas, grade levels, and science content areas. A total of 37 field-based quality reviewers were selected and trained for 3 days in the review process. Reviewers were assigned to review submissions matched with their areas of science expertise and grade level experience.

Each of the 27 science submissions was reviewed by at least 2 field-based quality reviewers. They reviewed the quality of the program, its usefulness to others, and its educational significance based on materials submitted by the developers. Programs that received high ratings from this quality review procedure were then reviewed by program evaluation experts who assessed the rigor of the evaluation data and the claims of effectiveness made by the submitters. The full Expert Panel then examined all of the program submissions and materials along with the ratings and comments provided by the program quality and program evaluation reviewers to determine which science education programs to recommend to the Secretary of Education as exemplary or promising.

Exemplary programs were highly rated on quality, usefulness to others, and educational significance and provided *convincing* evidence of effectiveness in *multiple* sites with *multiple* populations. Promising programs were rated high in terms of quality, usefulness to others, and educational significance and provided *preliminary* evidence of effectiveness in *one or more* sites.

How to Use These Recommendations

This publication provides descriptions of the two exemplary and seven promising science education programs designated by the Department. Contact information for each program is also provided. In the program summaries that follow, the sections "Program Description" and "Professional Development Resources and Program Costs" were prepared based on information provided by the developers. Where needed, developers provided updated information on costs for this publication. The remaining sections—"Program Quality," "Usefulness to Others," "Educational Significance," and "Program Effectiveness and Success"—are based on the assessments of the quality and evaluation reviewers and Expert Panel members.

These recommendations may be used in many ways. They probably will be most helpful to those who are engaged in decisionmaking about science curriculum materials and can match the goals of the program with their own system's goals. The Expert Panel selection criteria and review process can be used as a basis for analyzing materials and programs under consideration for selection. In another vein, school districts can use the selection criteria and review process as a point of comparison for updating their own curriculum selection process. Or, local school or school district selection committees for science programs and materials may use these recommendations to decide which materials they will review in greater depth. The designated programs and the process for selection are additional tools provided to help schools and districts make the important decisions on appropriate materials and programs for their science courses.

Evaluation Criteria

The following criteria and indicators were used to evaluate the science programs submitted to the Expert Panel.

A. Quality of Program

Criterion 1. ***The program's learning goals are challenging, clear, and appropriate for the intended student population.***

Indicator a. The program's learning goals are explicit and clearly stated.

Indicator b. The program's learning goals are consistent with research on teaching and learning or with identified successful practices.

Indicator c. The program's learning goals foster the development of skills, knowledge, and understandings.

Indicator d. The program's learning goals include important concepts within the subject area.

Indicator e. The program's learning goals are achievable with appropriate hard work and persistence.

Criterion 2. ***The program's content is aligned with its learning goals, and is accurate and appropriate for the intended student population.***

Indicator a. The program's content is aligned with its learning goals.

Indicator b. The program's content emphasizes a few topics in great depth.

Indicator c. The program's content reflects important scientific ideas and the processes and nature of scientific inquiry.

Indicator d. The program's content makes connections within a particular science, across the sciences, and to other disciplines.

Indicator e. The program's content is culturally and ethnically sensitive, free of bias, and reflects diverse participation and diverse student interests.

Criterion 3. ***The program's instructional design is appropriate, engaging, and motivating for the intended student population.***

Indicator a. The program's instructional design provides students with a rationale for learning this material.

Indicator b. The program's instructional design attends to students' prior knowledge and commonly held conceptions.

Indicator c. The program's instructional design fosters the use and application of skills, knowledge, and understandings.

Indicator d. The program's instructional design is engaging and promotes learning.

Indicator e. The program's instructional design promotes student discussions, appropriate collaborative work, and reflection on experiences.

Indicator f. The program's instructional design promotes multiple and effective approaches to learning.

Criterion 4. ***The program's system of assessment is appropriate and designed to provide accurate information about student learning and to guide teachers' instructional decisions.***

Indicator a. The program's system of assessment is an integral part of instruction.

Indicator b. The program's system of assessment is consistent with the content, goals, and instructional design of the program.

Indicator c. The program's system of assessment encourages multiple approaches and methods.

Indicator d. The program's system of assessment probes students' abilities to demonstrate depth of understanding and to apply their learning.

Indicator e. The program's system of assessment helps teachers select or modify activities to meet learning needs.

B. Usefulness to Others

Criterion 5. ***The program can be successfully implemented, adopted, or adapted in multiple educational settings.***

Indicator a. The program provides clear instructions and sufficient training materials to ensure use by those not in the original program.

Indicator b. The program is likely to be successfully transferred to other settings.

Indicator c. The program specifies the conditions and resources needed for implementation.

Indicator d. The program's costs (time and money) can be justified by the benefits.

C. Educational Significance

Criterion 6. ***The program's learning goals reflect the vision promoted in national standards in science education.***

Indicator a. The program's learning goals and subject matter content are aligned with national standards.

Indicator b. The program's pedagogy and assessment are aligned with national standards.

Indicator c. The program promotes equity and equal access to knowledge as reflected in national standards.

Criterion 7. ***The program addresses important individual and societal needs.***

Indicator a. The program is of sufficient scope and importance to make a positive difference in student learning.

Indicator b. The program contributes to increases in teachers' knowledge of effective teaching and learning.

Indicator c. The program:

- is designed to improve learning for a wide spectrum of students; OR
- serves to meet the special learning needs of underserved students; OR
- serves to meet the special learning needs of high-performing students whose interests and talents go beyond core science education.

D. Evidence of Effectiveness and Success

Criterion 8. ***The program makes a measurable difference in student learning.***

Promising Programs, in addition to satisfying Criteria 1–7, must provide *preliminary* evidence of effectiveness in *one or more sites* for *at least one* of the indicators below:

Indicator a. The program has evidence of gains in student understanding of science.

Indicator b. The program has evidence of gains in inquiry, reasoning, and problem solving skills.

Indicator c. The program has evidence of improvements in course enrollments, graduation rates, and postsecondary school attendance.

Indicator d. The program has evidence of narrowing the gap in achievement or accomplishment between disaggregated groups.

Indicator e. The program has other evidence of effectiveness or success.

Exemplary Programs, in addition to satisfying Criteria 1–7, must provide *convincing* evidence of effectiveness in *multiple sites with multiple populations* regarding *two or more* of the indicators below. The items must include either both indicators from Part I or one indicator from Part I and one indicator from Part II. Providing evidence of two indicators from Part II is not sufficient.

Part I

Indicator a. The program has evidence of *significant* gains in student understanding of science.

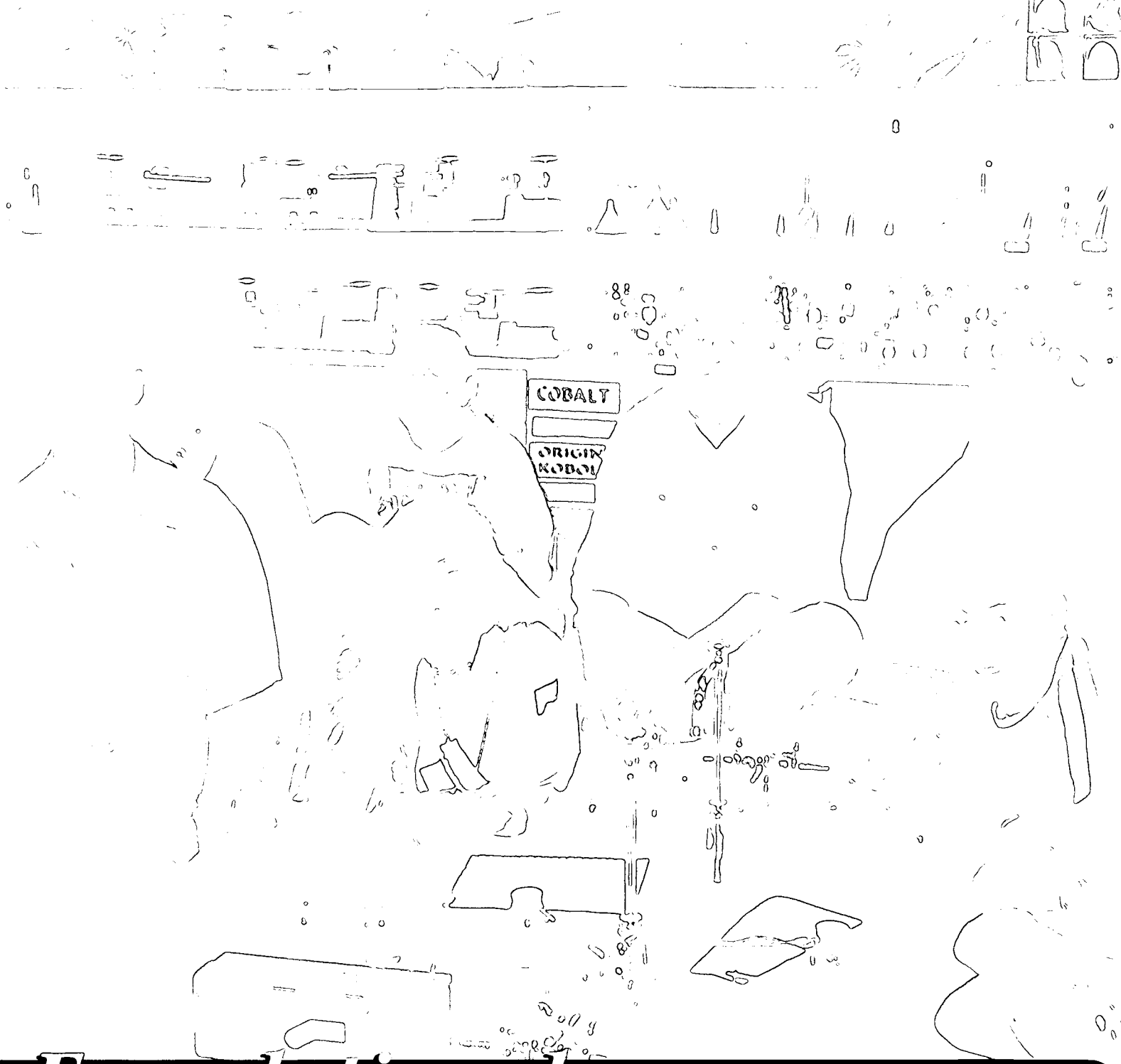
Indicator b. The program has evidence of *significant* gains in inquiry, reasoning, and problem solving skills.

Part II

Indicator c. The program has evidence of improvements in course enrollments, graduation rates, and postsecondary school attendance.

Indicator d. The program has evidence of narrowing the gap in achievement or accomplishment between disaggregated groups.

Indicator e. The program has other evidence of effectiveness or success.



Foundational Approaches in SCIENCE Teaching (FAST)

EXEMPLARY PROGRAM

Foundational Approaches in Science Teaching (FAST)

Foundational Approaches in Science Teaching is designated as an **Exemplary** science program.

Program Description

Foundational Approaches in Science Teaching (FAST) is a sequence of three inquiry science courses designed specifically to address the developmental needs of students ages 12 to 15. The three courses are: *FAST* 1, The Local Environment; *FAST* 2, Matter and Energy in the Biosphere; and *FAST* 3, Change Over Time. In each course, content is organized into three strands called physical science, ecology, and relational study. Relational study focuses on the interrelationships of the science disciplines and the interactions of science and society. The goal of this comprehensive program is the development of a scientifically literate student who has the background necessary for understanding environmental concerns arising in our technological society, and the foundational tools for further study in the sciences. The principal objectives of *FAST* are to develop knowledge of concepts that are foundational to modern science and to develop laboratory and thinking skills, such as using symbolic tools employed in science, engaging in scientific inquiry, and using scientific knowledge for making decisions. Special emphasis is placed on students communicating what they have learned through oral and written reports, graphing, etc.

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Professional Development Resources and Program Costs

FAST is used by over 5,000 teachers in 36 states, and 10 foreign countries. It has a support network of 14 universities and a cadre of 75 certified instructors. The program recommends that the local educational agency designate a local coordinator at the district/school level.

Teachers participate in a 10-day, 70-hour, on-site institute before teaching *FAST*. There are separate institutes for each of the three *FAST* courses. Each participant receives a full set of materials, including all teacher and student instructional guides. *FAST* provides preliminary outreach with school personnel and a commitment-building process that includes site visits and detailed implementation suggestions, supporting professional development and networking opportunities, follow-up coaching, and an implementation review process. First-year start-up costs are approximately $29 per pupil for instructional materials, supplies, and professional development (assuming the sharing of a classroom materials set by multiple classes with 75 students per teacher).

Program Quality

Reviewers found that the program's goals and objectives are clear and provide middle school students with a solid foundation for sound decisionmaking as adult citizens and in preparation for productive science-based careers. The goals are consistent with the constructivist approach to learning. Content is aligned with the program's learning goals and emphasizes several topics, which are covered in depth over the 3-year length of the program. Each area of science is studied extensively and then brought together through study of the ecology of the local environment. The content reflects important scientific ideas, processes, and the nature of scientific inquiry.

The instructional approach enables students to incrementally build on their prior learning and experiences, by repeatedly using skills introduced early in the program in new contexts. Active engagement in laboratory exercises or field experiences consumes approximately 75 percent of class time. Remaining class time is spent on data collection, discussion, literature research, and report writing. *FAST* provides a variety of assessment instruments and methods and a detailed *Evaluation Guide* for each level of the program. Assessment is embedded in day-to-day instruction so that instruction can be calibrated frequently, and self-assessment by students is an integral part of the program.

Program Effectiveness and Success

Reviewers found convincing evidence, stretching over nearly 25 years of the program and across numerous implementation sites, to conclude that *FAST* has a positive impact on student learning. Numerous well-designed evaluation studies revealed statistically significant improvement in student learning reported as post-test differences between *FAST* and non-*FAST* student scores, and pre-post test student gain scores, more than would be expected over an academic year, for *FAST* students on standardized tests addressing understanding of science.

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Usefulness to Others

Reviewers concluded that the program provides ample training materials and support to ensure successful implementation. Intensive preimplementation training and follow-up support are readily available at a reasonable cost.

Educational Significance

The program's learning goals reflect the vision promoted in the national standards, and an independent assessment determined that *FAST* was well aligned with these standards. Reviewers noted that the goals are serious, significant, and well developed. The program is of sufficient scope, duration, and importance to make a positive difference in student learning.

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Post-test only, quasi-experimental control group studies using random selection of 7th-grade *FAST* and non-*FAST* students showed that *FAST* students scored statistically significantly higher, at the $p<.01$ level, than non-*FAST* students on the California Test of Basic Skills (CTBS) test of general science knowledge. A pre-post test, actual vs. expected performance study of students, found Grades 6 and 7 *FAST* students scoring statistically significantly higher, at the $p<.05$ level, than expected on the statewide CTBS post-test. In other post-test only studies using various measures of student performance, *FAST* students scored statistically significantly higher than expected while control students did not.

In several studies using performance assessments (e.g., a project-developed 24-item applied assessment of laboratory and desk problems and graph construction and interpretation), *FAST* students in Grades 6 and 7 scored statistically significantly higher than non-*FAST* students in the same grades on science laboratory skills, process skills, and science achievement. A variety of evidence, including self-report and videotape data, attested to *FAST*'s impact on knowledge, practices, and attitudes. In addition, shifts in teacher profiles toward the approaches called for by the National Science Education Standards (NSES) were documented. On the Self-Report About Teaching instrument, *FAST* teachers showed a statistically significant shift, at the $p<.05$ level, in their self-reports on teaching toward inquiry.

Modeling Instruction in High School PHYSICS

EXEMPLARY PROGRAM

Modeling Instruction in High School Physics

Modeling Instruction in High School Physics is designated as an **Exemplary** science program.

Program Description

Modeling Instruction in High School Physics is grounded on the thesis that scientific activity is centered on modeling: the construction, validation, and application of conceptual models to understand and organize the physical world. The program uses computer models and modeling to develop the content and pedagogical knowledge of high school physics teachers and train them to be leaders in science teaching reform and technology infusion in their schools and districts. The program relies heavily on professional development workshops to equip teachers with a teaching methodology. Teachers are trained to develop student abilities to make sense of physical experience, understand scientific claims, articulate coherent opinions of their own, and evaluate evidence in support of justified belief. For example, students analyze systems using graphical models, mathematical models, and pictorial diagrams called system schema.

Teachers use their knowledge of the modeling method to construct and evaluate instructional units of their own design and from standard curriculum materials. More specifically, teachers learn to organize course content around scientific models; engage students collaboratively in making and using models to describe, explain, predict, design, and control physical phenomena; involve students in using computers as scientific tools; and continuously improve and update instruction with new software, curriculum materials, and insights from educational research. Instructional materials developed and disseminated in the project are ancillary to disseminating a flexible teaching methodology adaptable to new materials.

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Professional Development Resources and Program Costs

High school physics teachers attend a series of intensive workshops over 2 years. Most participants proceed to share their new pedagogical insights and techniques with colleagues, and many commit to conducting modeling workshops. The project plans to sustain and extend science teaching reforms instigated by the workshops through the development of local infrastructures to support the continued professional development of teachers. Regional Science and Technology Education Partnerships (STEPs) are planned between university physics departments and local physics teacher alliances. Foundations for statewide partnerships already have been established in Arizona and Wisconsin.

The cost for an individual teacher to implement the mechanics modeling program includes tuition for a 4-week summer workshop, $120 for instructional materials, and travel/room/meal expenses. For a group of school districts to implement the mechanics modeling program for 24 physics teachers, minimal workshop costs include fees of $5,000 x 2 master teacher-leaders and $120 x 24 teachers for instructional materials. Implementation of mechanics in the classroom is best accomplished with computers that have universal laboratory interface (ULI) and three microcomputer-based laboratory (MBL) probes: motion detector, pair of photogates, and force probe. Typical cost of one workstation is $2,000. One computer for every three students is recommended.

Program Quality

Reviewers stated that the program's goals are explicit and reflect current research on learning theory. As a supplement to any physics course, the program's learning goals include reinforcement of the most important concepts with the study of mechanics. The physics content embedded in the units is fundamental to mechanics, physics, and all science. The program's content is aligned with its stated goals, and the instructional approach emphasizes important mechanics problems in depth. *Modeling Instruction in High School Physics* utilizes experimental design, control of variables, and calls for reasoning and application of skills in solving various kinematics and dynamics problems. There is strong use of student discourse, as evidenced by the need for students to present and justify conclusions derived in the laboratory. Multiple strategies for problem-solving are encouraged, reflecting sensitivity to individual student differences and abilities. The program contains a rich, integral system of assessment that is one of its strongest features, and the multiple modalities it employs provide teachers with ample entry points into the students' learning processes.

Program Effectiveness and Success

Reviewers found that the program provided extensive and persuasive evidence of gains in student understanding of science and in inquiry, reasoning, and problem-solving skills. Data also confirmed that an important factor in student learning is the degree of implementation by teachers of modeling methods learned in the workshops. There were repeated findings that greater degrees of program implementation of the modeling methods were associated with larger student gains. Reviewers commented that these repeated findings negated the possibility that student improvements might be attributable to more motivated teachers.

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Usefulness to Others

Reviewers noted that many aspects of the teaching methodology can be successfully transferred to other settings. The program offers a wide range of teacher support, including information on laboratory, extension, application, and deployment activities. The program recommends teacher training of 8 weeks over 2 summers to accomplish pedagogical transformation and a large infusion of equipment and technology in the classroom. Some school districts may need to seek external aid to meet the costs of the program.

Educational Significance

The goals of the program strongly mirror the vision promoted in the national science standards. Reviewers emphasized that the program is impressive in its awareness of and attention to the national content, teaching, and assessment standards. The program is exceptional in its modeling and emphasis on the skills, attitudes, and values of scientific inquiry. It addresses important individual and societal needs by providing constructivist pedagogy for the fundamental mechanics that are crucial to understanding the physical world.

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The program presented numerous evaluations that utilized a pre-post measure, Force Concept Inventory (FCI), on large numbers of both treatment and matched comparison groups; were carried out in multiple sites during several years; and made empirical connections between implementation of the approach and results. Sample sizes varied from year to year, with most final merged datasets ranging in size from about 1,300 students and 50 teachers, for Phase I 1995–97 data collection, to over 3,000 students and 70–80 teachers for the larger number of participants in Phase IIa 1997–98 and Phase IIb 1998–99 data collection. Student data came from three major high school course types: regular and introductory physics, honors level physics, and advanced placement physics.

The FCI instrument has high reliability and was developed to assess the effectiveness of introductory physics instruction, specifically the effectiveness of mechanics courses to teach students to reliably discriminate between the applicability of scientific concepts and naive alternatives in common physical situations. FCI data on 24,000 students in courses of hundreds of high school, college, and university teachers indicated that students' naive beliefs about motion and force are little changed when using traditional instructional methods, while greater changes can be achieved with instructional methods derived from modeling.

Repeated findings demonstrated greater gains for program students in physics content knowledge when compared to physics students of the same teachers in the year before the teachers implemented the program and students in traditional physics classes and alternative reform programs. The *Modeling Instruction in High School Physics* students exceeded the performance of the comparison groups by margins that in some cases exceeded two standard deviations.

PROMISING PROGRAM

Developmental Approaches in Science, Health, and Technology (DASH)

Developmental Approaches in Science, Health, and Technology (DASH)

Developmental Approaches in Science, Health, and Technology is designated as a **Promising** science program.

Program Description

Developmental Approaches in Science, Health, and Technology (DASH) is a comprehensive K–6 program. It reaches the spectrum of learners found in typical classrooms through over 650 interconnected, developmentally appropriate, hands-on activities that are aligned with national standards. The goal of *DASH* is to engage students in the excitement of questioning and making sense of things unknown, inventing and building to solve problems, and caring for themselves through their experiences in science, health, and technology learning.

DASH activities at each grade level are organized into 10 content clusters: learning; time, weather, and sky; animals; plants; food and nutrition; health and safety; wayfinding and transportation; energy and communication; conservation, recycling, and decomposition; and matter, space, and construction. Program content is sequential and spiraled to promote reinforcing, multiyear development of concepts and skills. Students work inside and out of the classroom as a research community, modeling the real world roles of scientists and technologists, with the teacher as the research team leader. Assessment is integrated into instruction. Each activity has a portfolio-building product, and each grade level has a concept and skill inventory for student self-assessment.

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Professional Development Resources and Program Costs

DASH is used by over 11,000 teachers in 26 states. There is a support network of 14 universities and a cadre of 175 certified instructors. The local educational agency designates a local coordinator. Professional development is preceded by outreach with school personnel and a commitment-building process that includes site visits, presentations on standards- and research-based curriculum and methodology, data gathering, and detailed suggestions for implementing *DASH* at the site.

Teachers participate in a 10-day, 60-hour, on-site institute prior to implementation of the program. Each participant receives a teacher set of materials, including a *Teacher Guide* for the grade level, blackline masters for students, and an *Instructional Guide*. Administrators are assisted through special workshops, consultations, and a *Handbook for Administrators*. *DASH* provides supporting professional development and networking opportunities, follow-up activities, and an implementation review process. The implementation cost estimate is $1,075–$1,270 per classroom and includes teacher participation in the professional development institute, all instructional materials, handouts, a teacher set of materials, a newsletter subscription, and start-up supplies. No special equipment is required.

Program Quality

Reviewers found the program's goals to be clear, easy to follow, developmentally appropriate, and based on research in science and mathematics. Program content is challenging and aligned with learning goals. The program provides excellent opportunities for students to grow in science inquiry and develops in-depth content knowledge. The cluster format and spiral approach to learning are significant because they give students important scientific concepts for a knowledge foundation and a formidable beginning for future learning. Students are guided through exploration, application, generalizations, and explanations as they work through year-long and multiyear activities.

Reviewers noted that *DASH* is focused on instructional design that encourages all students and promotes an environment that is appropriate, engaging, and motivating. The student's role as scientist is defined in each lesson, and the connection made to every day occupations provides students with a rationale for learning the material. *DASH's* attention to pedagogy, sequencing activities, building on prior experiences, valuing students' prior work and products, and clear guides to facilitating discussions and building questioning skills are outstanding. The program's assessment system is based on the premise that there are a variety of learning styles and different ways to assess those styles. The assessment system promotes strong teacher-student dialogue and trust for the instructional program.

Program Effectiveness and Success

Reviewers found that *DASH* provided evidence from 14 case studies conducted in 5 states that students in Grades K–5 demonstrated an understanding of fundamental science concepts and the use of essential skills, such as inquiry and data gathering techniques as well as integration and application of science concepts. The program provided evidence of improved student achievement in the form of comparisons of standardized test score data

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Usefulness to Others

Reviewers concluded that the program's low cost and clear instructional plan, combined with support materials for each cluster, make it accessible to most K–6 classes. Training is located throughout the country and can be conducted in local school districts. No special facilities or materials are required, and lessons are clear and easy to implement.

Educational Significance

Reviewers noted that the program's pedagogy and assessment are aligned with national standards. *DASH* manuals provide a clear correlation of the national standards with specific program activities. The program addresses important individual and societal needs through its broad base of gender- and ethnic-free activities; long-term, multiyear approach to building depth and breadth of learning; focus on both in- and out-of-school issues; attention to societal issues such as health protection and environmental needs; and accommodation for diverse learning styles.

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Web Site: http://www.hawaii.edu/crdg

for *DASH* students with national, state, and district data, and pre- and post-test *DASH* test scores in one district. The multiple-case study results also demonstrated a positive change in teachers' attitudes about science and approaches to teaching science, and increased teacher knowledge and use of standards-based instructional strategies in elementary science.

A well-designed and conceptualized case study evaluation was implemented, in which multiple cases were considered multiple experiments and results were based on analytic rather than statistical generalization. The design required common training of senior researchers; multiple, independent observers at each site; and an independent external evaluator to conduct pattern matching and cross-case analyses. Data collection included multiday observations; video and audio taping; interviews with teachers, administrators, and students; student-created products and artifacts; engaged learning time; test data; and teacher lesson plans. Analysis followed cross-experiment rather than within-experiment logic and design. If two or more cases supported the same assertion, replication was claimed. Triangulation of multiple data sources at each site and cross-case analyses were used to derive findings consistent across the 14 diverse sites.

Event-Based SCIENCE *(EBS)*

PROMISING PROGRAM

EVENT-BASED SCIENCE (EBS)

Event-Based Science is designated as a **Promising** science program.

PROGRAM DESCRIPTION

Event-Based Science (EBS) is a supplemental program for students in Grades 6–8. It offers an innovative, modular approach to middle school science education, using videotaped television news coverage of real events (e.g., oil spill, hurricane, outbreak, first flight) to establish relevance and context. From the event flows a problem, the solution to which requires students to learn relevant science concepts. Engaging interviews, lively narrative, and team involvement lead students to want to know more. Juxtaposition of hands-on science activities with newspaper articles, interviews, and science exposition creates a rich student resource package. Although *EBS* can be used to fashion a comprehensive science program, most school districts use two or three units per year. World Wide Web support for *EBS* modules includes links to sites with specialized information and data, as well as to internal pages designed to provide teachers with ongoing help in implementing the program.

PROGRAM QUALITY

Reviewers found the program's learning goals to be challenging, appropriate, and clearly stated in the teacher and student editions. *EBS* modules contain appropriate content and provide students with other types of skills that contribute to life-long learning, such as responsibility, organization, cooperation, and communication skills. The modules are designed to promote student understanding of and development of scientific inquiry. For example, students create their own questions and experiments; collect, analyze and interpret data; draw conclusions and present information to an audience; and reflect and correct areas in need of more development. The real-world content and instructional

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Professional Development Resources and Program Costs

There is a network of certified *EBS* trainers, whose work is supported by Dale Seymour Publications through a cooperative agreement with the Event-Based Science Institute, Inc. The Institute provides free workshops to schools and school districts that purchase as few as 35 class sets of *EBS*, with the actual minimum purchase required depending on travel costs.

The costs of *EBS* books are $9.95 for the student edition, $24.50 for the teacher's guide with video, and $145 for a set of 15 student editions, a teacher's guide, and a video (plus 10 percent shipping and handling). The program keeps additional costs at a minimum by using materials and equipment that are readily available in a typical middle school.

design as presented through multiple opportunities, consistent with national science standards, enhances and promotes learning of the identified concepts in an active and engaging environment. The modules grab students' interest, elicit their ideas, and provide the context for learning opportunities that are ultimately demonstrated through a highly engaging performance task. The social constructivist pedagogy used for the group work and the authentic performance assessments are strengths of the program.

Program Effectiveness and Success

Reviewers found that the program presented evidence of statistically significant gains in student understanding of earth science concepts for *EBS* students in Grades 6–8. Evaluation studies were conducted during the cohort years 1992–93, 1993–94, and 1994–95. The 6 test sites were diverse, and the 20 treatment and 20 control classrooms (with approximately 400 students in each group) covered the same earth science content. Treatment students received three *EBS* units, and control students received their traditional earth science curriculum. Statistical comparisons between treatment and control students were conducted using preprogram measures, including an 8-item multiple choice general science test, a 38-item science attitude survey, and science grades to assess the comparability of the groups.

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Usefulness to Others

EBS is easily adapted to all educational settings, and the modular design fits easily into existing curricular structures. Reviewers noted that the teacher's guide and Web site provide support to teachers to help them develop the program, assess student learning, and modify lessons for all learners. Implementing sites require a Web browser with access to the Internet. The program is culturally diverse, and it allows all students to see the variety of people who study science and understand how science affects their lives.

Educational Significance

Reviewers concluded that *EBS* provides a combination of strong and relevant content, good pedagogy, and appropriate assessment that clearly matches the vision promoted in the national standards. By engaging students in inquiry and real-life tasks, students view science as important and fulfilling. The program is designed to improve learning for a wide spectrum of students and to help teachers motivate students by presenting them with various ways of accomplishing the same goals. All students have the opportunity to learn and feel successful with this program.

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Statistical analyses of treatment and control students' performance on a 35-item multiple-choice, earth science post-test covering content from 2 of the 3 *EBS* earth science units that were taught yielded statistically significant treatment effects for *EBS* students. Post-test item selection and development were based on standardized tests, textbooks used by control classes, and information from *EBS* unit developers.

Statistically significant treatment effects were demonstrated using chi-square analyses of the data collected from a 45-item, post-test science attitude survey administered to 420 treatment and 390 control students in earth science classes at the end of the school year. The program also claimed statistically significant treatment effects using a multivariate analysis of covariance on data from three scientific skill application tasks (i.e., group procedure, data table, and write-up) of a performance assessment measure administered to more than 100 treatment and 100 control students at 2 sites.

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PROMISING PROGRAM

Great Explorations in MATH AND SCIENCE *(GEMS)*

Great Explorations in Math and Science (GEMS)

Great Explorations in Math and Science is designated as a **Promising** science program.

Program Description

Great Explorations in Math and Science (GEMS) is a supplemental enrichment program for students from preschool through 8th grade. *GEMS* provides teachers with more than 70 teacher's guides, support documents, and pedagogical handbooks; professional development opportunities; an active Web site; and a national support network of *GEMS* Leaders and Associates and over 45 regional sites. More than 600,000 teachers and 8 million students have experienced *GEMS* activities over the past 15 years. *GEMS* uses readily accessible materials. The program's units, presented as flexible enhancements or in curriculum sequence, are designed to help all teachers reach all students and feature clear step-by-step teacher instructions.

Many *GEMS* units focus on science and exemplify the integration of science and mathematics. Science content reflects life science, physical science, earth science, and science as inquiry. In addition to the specific subject matter learning goals taken from the National Science Education Standards (NSES) and standards-based content conveyed, there is a strong emphasis on cooperative learning and problem-solving, literature/language arts connections, and real world relevance. *GEMS* units feature an inquiry-based, guided-discovery, student-centered approach to learning. An assessment component is in place for the entire series.

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Professional Development Resources and Program Costs

GEMS offers a wide spectrum of professional development opportunities, including awareness, leader's, associate's, and assessment workshops, as well as other customized or specialized presentations, workshops, and institutes. Professional development sessions are presented at national and regional conferences through the national network of over 45 *GEMS* sites and by *GEMS* Associates and Leaders. All workshops and institutes are inquiry-based in both practice and theory and include strong emphasis on both scientific content and effective pedagogical approaches.

GEMS guides range in price from under $10 to several that are in the $30 or $40 range, with an average retail price of approximately $15. Optional *GEMS* Kits range in cost from under $50 to $450, depending on complexity. Costs for professional development workshops and institutes vary, depending on length of training and other factors. The cost estimate for a 3-day *GEMS* Leader's or Associate's workshop is under $400 per person, and both include a large number of *GEMS* guides and handbooks as part of the fee.

Program Quality

The *GEMS* activities and investigations are based on research and best practices, including programs based on the constructivist theory of learning. The content is aligned with learning goals representing scientific ideas, processes, and the nature of scientific inquiry. *GEMS* activities take an in-depth approach by showing connections within and across disciplines. The units provide ample activities for the development of both skills and knowledge, and the overarching themes allow students to make connections between science disciplines and within specific areas of science.

Reviewers noted that the instructional design is appropriate, engaging, and motivating. The design promotes multiple and effective approaches to learning by suggesting many and varied ways to achieve understanding. Students are involved in discussions, report their observations, engage in collaborative work, and reflect on their experiences throughout the activities. They apply new knowledge in the design and completion of experiments and investigations. Assessment is an integral and frequent part of instruction.

Program Effectiveness and Success

Reviewers reported that statistically significant results from multiple evaluation studies provided evidence of the effectiveness of several *GEMS* units or groups of units. Evidence was based on evaluations that were well designed and generally utilized control groups, pre-post assessments, appropriate sample sizes, and tests of significance to validate differences in outcomes for student learning. Results of the evaluation studies yielded evidence of gains in understanding of science in favor of *GEMS* students for four units based on pre-post test, questionnaire, interview, and performance assessment data, and gains in inquiry, reasoning, and problem-solving skills in favor of *GEMS* students for two units based on pre-post performance assessment data.

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Usefulness to Others

Reviewers found that the program covers a variety of topics and provides easy to follow, step-by-step instructions in each manual. Strong support for implementing and adapting the program comes from the training available and the handbook, *The Architecture of Reform: GEMS and National Standards*, which reviews the process of identifying curriculum goals and integrating *GEMS* modules into either new or existing curriculum. The extensive national network of sites and trainers provides continuous support to teachers and others implementing the program.

Educational Significance

Reviewers indicated that the program is aligned with the national standards for content and classroom assessment. By aligning the materials with the national standards, *GEMS* ensures that the content and skills presented are important for all students to know and be able to do. *GEMS* encourages and supports the introduction of activity-based science into the classroom. The program demonstrates the belief that science is for all students and displays a strong commitment to equity and diversity.

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The program also provided evidence of success in the form of teachers' self-reports of improvements in their science knowledge and teaching practices. Three evaluations, using teacher and sometimes student data based on follow-up surveys and interviews of the effectiveness of some of the *GEMS* units, showed that teachers perceived the particular unit being evaluated to be effective in helping students learn, influencing teaching behaviors, and influencing teacher and student attitudes. Effects of the units were shown to have lasted over time.

PROMISING PROGRAM

Habitat Ecology Learning Program (HELP)

Habitat Ecology Learning Program (HELP)

Habitat Ecology Learning Program is designated as a **Promising** science program.

Program Description

The Habitat Ecology Learning Program (HELP) is a comprehensive life science program for upper elementary school students related to endangered species and their habitats. The program is designed for students of all ability levels in Grades 4–6. The goal of *HELP* is to increase student knowledge of the science of ecology by sustaining teacher use of inquiry-based instructional strategies, and integrating the educational richness of community zoos and other life science centers with classroom instruction.

The *HELP* curriculum includes five modules spotlighting the major habitats of the world: rain forests, temperate forests, deserts, grasslands, and wetlands. A sixth module, "How Nature Works," provides an overview of key ecological concepts that enables students to understand the habitat modules. Each module is accompanied by a comprehensive teacher's manual that includes student activities, case studies, experiments, authentic assessments, and extensive visual enrichments.

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Professional Development Resources and Program Costs

Through its National Programs Division, the Bronx Zoo maintains a staff of three full-time staff developers whose sole responsibility is the delivery of teacher training workshops at host zoos and school districts across the country. Workshops run from 2 days to 2 weeks, depending on classroom needs and the scheduling requirements of teachers and school districts. Teachers are provided with a follow-up Technical Assistance Program featuring a toll free teacher consultation hotline, teacher newsletters, and videoconferences. A complete set of *HELP* materials costs $299, although the modules can be purchased individually. The cost estimate for a sample 2-day, off-site training for 20 participants is $4,325.

Program Quality

Reviewers found that the program's content focuses on important ideas and incorporates ideas and skills across the sciences and from other disciplines. As the physical science concepts of temperature and precipitation are developed in the program, constant connections are made to earth sciences and climates. Concepts from both of these sciences are then connected to the impact on life sciences. Curriculum activities encourage students to examine, observe, speculate, and test hypotheses carefully.

The instructional design promotes multiple and effective approaches to learning as a way to engage students as individuals, in small groups, and as a whole class. Understandings are developed through scientific investigation, and field trips are focused and clearly connected to classroom work. Assessment includes embedded and formal evaluations using a variety of methods, such as role-playing, debating, and researching.

Program Effectiveness and Success

HELP has evidence of effectiveness in multiple school settings. The program provided evidence of its effects on the learning of students and impacts on elementary teachers. Evaluations were well designed and controlled for alternative explanations for the results. Multiple measures of student mastery of science concepts and content were used, and these measures consistently revealed greater gains in favor of *HELP* students over non-*HELP* students. Evaluation data substantiates gains in student learning through the enhancement of teachers' knowledge of content and concepts, use of authentic assessments, and use of real life situations to teach students. The research design provided evidence that teacher enhancement made the difference in treatment vs. comparison group gains.

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Usefulness to Others

Reviewers noted that the training could be conducted at the local school district, adding that cost is low and materials are easily accessible. Instructional and support materials are included in the clearly written and inexpensive manuals. Reviewers acknowledged that field trips could be problematic for some schools. However, the project states that field trips are recommended but not essential parts of the program.

Educational Significance

Program content is aligned with national science standards. Students are engaged in personal observation and investigation without a great deal of cost or special preparation. The thorough but simple language used in the module manuals provides teachers with background information allowing them to teach an investigative program successfully. The program is of sufficient scope and duration to make a positive difference in learning, and students address the important and significant environmental issues of habitat and species endangerment and extinction. Multiple intelligence formatting of lessons allows all students to become engaged in learning.

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Reviewers found the pre-test/post-test comparisons of student achievement for the *HELP* (315 students in 17 classes in 16 schools in 8 states) and non-*HELP* (260 students in 17 classes in the same schools) groups to be well done. A 1993–94 independent evaluation presented a well-designed study in which the *HELP* students achieved higher scores, to a statistically significant degree of $p<.001$, than comparable non-*HELP* students on a criterion-referenced test of habitat ecology concepts, designed by the Bronx Zoo but not specifically for this program. Other assessments of student learning gains also supported the positive impact of the program on student understanding of important science concepts and related knowledge and skills. Teacher and parent surveys and teacher authentic assessments, such as portfolios, journals, observations, student projects and presentations, were conducted to substantiate that student learning was occurring.

The positive impacts on attitudes and integration of community resources into more realistic educational settings are a plus for the program. Evidence demonstrated that the program had meaningful effects on teachers' knowledge of science and scientific concepts and that they changed some of their teaching methods in a positive way. Analysis of teachers' lesson plans indicated that teacher quality of instruction in science improved. External evaluators also reported that classroom visits to zoos increased and that the visits were focused with structured work assignments rather than simply touring the zoo.

National

PROMISING PROGRAM

SCIENCE CURRICULUM

for High Ability Learners Project

National Science Curriculum for High Ability Learners Project

National Science Curriculum for High Ability Learners Project is designated as a **Promising** science program.

Program Description

The National Science Curriculum for High Ability Learners Project is a supplemental program that has been implemented across Grades 2–8 and, in several school districts, with a broad group of students within the average to gifted range of ability. The curriculum units employ problem-based learning as the catalyst and integrative agent for engaging students in the study of the concept of systems, specific science content, and the scientific research process. These three foci constitute the overarching goals. Students learn the elements, boundaries, inputs, and outputs as well as interactions of selected systems, and how science systems interact with real world social, political, and economic systems. Students engage in a scientific research process that leads them to create their own experiments and design their own solutions to each unit's central problem. The units encourage in-depth study, and content areas cover a breadth of scientific subject matter drawn from the physical, life, and earth sciences. Each unit constitutes approximately 30 hours of instruction, with students typically receiving two units within an academic year. Major components of the program include a curriculum framework that contains goals and learning outcomes linked to individual lesson plans; embedded and post assessments that focus on science content, concept, and process learning; 25 lesson plans that address these goals and outcomes with relatively equal emphasis on each of the goals; and a real world problem that serves as the catalyst for subsequent learning in the unit.

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Professional Development Resources and Program Costs

The program offers a full menu of training workshops and institutes of varying duration and maintains a national network of school districts actively using the science materials at multiple grade levels. The training model is integrative, problem-based, and hands-on. Each training module provides three segments: introduction of the strategy to be employed with appropriate theoretical framing; participant practice in the strategy in dyads or small groups; and whole group debriefing of the strategy and its use in the units. A teacher's guide provides readings and illustrations of curriculum and instructional approaches central to implementing the units. Each unit contains teacher material, such as lesson plans with notes to the teacher and a special section devoted to instructional issues.

Implementation cost is approximately $3,000. The cost estimate for a 2-day, on-site training for 5 teachers (N=35) from Grades 2–8 is $8,885, which covers the training consultant, teacher release time, materials, and supplies. The cost estimate for a classroom of 20 students is $254 per teacher or $12.70 per student.

Program Quality

Reviewers found that the program is challenging and does an excellent job of presenting inquiry as a process used by scientists and modeled by students to learn new information rather than to verify something already known. The effort the program makes to provide students with a genuine connectedness to their learning and opportunities to reflect on their learning is commendable. The problem-solving format and metacognitive strategies contribute to student success. The program promotes thinking through frequent discussions, allowing students the opportunity to revise and restructure their ideas. It centers on the interests of students, places the teacher in a supporting role, and uses authentic assessment.

The instructional design integrates both process and content in a format that is appropriate, engaging, and motivating. Reviewers noted that the program has particular strength in unifying concepts and rigorous inquiry. The unit assessments are consistently designed to measure student achievement in both process and content and relate directly to real world problems. Students have multiple opportunities and ways to demonstrate proficiency and understanding.

Program Effectiveness and Success

Reviewers reported that the *National Science Curriculum Project* has evidence showing that students gain an understanding of how to design experiments. Students demonstrated statistically significant gains in science learning in four curriculum units. Reviewers found that the evaluation design was well conceived, data analysis was appropriate, and the sample sizes were adequate. They noted that the instrument, Fowler Diet Cola Test, had high reliability and content validity and was appropriate for measuring student ability to apply the scientific method and demonstrate scientific reasoning skills through the open-ended opportunity to design an experiment.

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Usefulness to Others

Reviewers concluded that the program's organizational structure and comprehensive training program lead to successful implementation in multiple educational settings. Implementation cost is reasonable, and the program does not require special room settings or equipment. The teacher's guide and other support materials are comprehensive.

Educational Significance

Reviewers indicated that the program has the potential to affect the way science is delivered in both self-contained or pull-out gifted programs and regular classrooms because of its alignment with national science education standards. This program serves as an excellent model of an instructional program that has gone beyond alignment and demonstrates the successful integration of teaching, assessment, and content standards. The program's focus on unifying concepts and processes, important science content, and scientific inquiry serves as an exceptional model for program developers as they make the transition to reform-driven curricula and for teachers as they look for guidance in meeting rigorous state and national science standards.

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Two curriculum units were evaluated using a quasi-experimental design with pre- and post-tests administered to students in both experimental and comparison classrooms in a large number of settings. One of the unit evaluations compared 45 experimental classrooms from 15 school districts in 7 states with 17 comparison classrooms from the same school districts; and the other unit evaluation compared 27 experimental classrooms from districts in 5 states with 3 comparison classrooms in 2 states. Data were analyzed using analysis of covariance and results yielded gains in favor of the students in the experimental classrooms that were statistically significant, at the $p<.001$ level. Two additional units were tested using pre- and post-tests administered only to project implementation classrooms, 16 classrooms from 3 states for one unit and 12 classrooms from 3 states for the other unit. Data were analyzed using t-test analysis of classroom means and results yielded statistically significant student gains at the $p<.001$ level.

Results of a teacher survey of program implementation demonstrated high effectiveness ratings for the three units tested and consistently positive teacher responses. The teacher evaluation forms were balanced with positively and negatively worded items to control for response bias.

PROMISING PROGRAM

SCIENCE 2000®

SCIENCE 2000®

Science 2000® is designated as a **Promising** science program.

PROGRAM DESCRIPTION

Science 2000® is a comprehensive program for students in Grades 6–8 with four units at each grade level; although not a comprehensive program there is one Grade 5 unit available. The goal of the program is to deliver science content in pedagogically appropriate treatments so students can recognize their preconceptions; implement and design experiments and read and do research; discuss and present their findings; confirm or correct their preconceptions; and demonstrate their understandings by using them in new contexts and performing well on assessments.

Each grade level of *Science 2000®* consists of a year-long set of activity-based curriculum materials including lesson plans, student lab experiments and activities, assessments, databases of text and graphic content information, simulations, 2 hours of video, and about 800 slides. This material supports four thematically connected units that are organized to solve a problem. *Science 2000®* weaves together scientific disciplines such as physical, earth, and life sciences and other disciplines such as mathematics, English/language arts, history/social science, art, and music. The curriculum helps students make connections among the sciences and with other subjects. The program is delivered in MAC or PC software and videodisc or a *Science 2000+®* WIN CD upgrade with an Internet-ready environment and preselected Web links. *Science 2000+®* serves as a bridge from the traditional text-based classroom materials or textbooks supplemented by single purpose kits to the future of Internet-based inquiry. The video track is available in Spanish or English. Printed lesson plans, blackline masters, and an implementation guide accompany the software. *Science 2000®* bridges the gap between traditional instructional materials and technology and is a blueprint for integrating technology in the curriculum.

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Professional Development Resources and Program Costs

Science 2000® addresses staff development in two modes. When a site license is purchased, the publisher, Decision Development Corporation (DDC), provides at no fee a 3-hour training/overview at the site to introduce teachers to the program's materials and resources. In addition, DDC offers at a cost 1- or 2-day seminars that cover general training for integrating technology in the curriculum and in-depth training in the use of the program. The basic multimedia system provides a rich interactive environment for teachers as well as students, and is a method of teacher development. DDC's technical support and Web site mailbox are two avenues of ongoing support.

The full-year program for a grade level costs $2,500 per teacher for all components. Materials and supplies a district ought to provide to implement the program include at least one computer workstation with a CD-ROM drive at a cost of $1,200 to $2,500 and a printer. It is optional for a district to provide training and staff development beyond the one half-day training DDC offers with the license purchase. Additional training costs $960 per day, or $35,000 for a 1-year contract including on-site support 1 day per week during the school year (at a maximum of 36 visits). Personnel needs include a district/site technical support person who can install software, troubleshoot, and maintain the computer systems.

Program Quality

Reviewers noted that the program's learning goals are rigorous, clear, and appropriate. Content is aligned exceptionally well with the learning goals and embedded in the problem-solving activities. Lessons are structured to call attention to research about concept acquisition, and connections are made across science disciplines. Environmental science and technology are integrated into the units.

The instructional design is a strength of the program and fosters student use and application of skills, knowledge, and understandings. Printed lessons, transparencies, simulations, experiments, problem-solving investigations, and computer and multimedia technology bring in real world contexts that allow the program to be self-motivating and engaging for students. Lesson plans and procedures provide opportunities for students to engage in rational inquiry, discussions, reviews, and question and answer sessions. The program promotes multiple and effective approaches to learning. Assessment is appropriate and designed to provide accurate information about student learning and to guide teachers' instructional decisions. At the end of each lesson, students are required to respond to a series of questions that assess content knowledge and understanding. The investigations and simulations are more closely related to authentic assessment. The teacher's guide helps teachers to develop and modify the lessons and clusters to better help all learners and identify areas that could be used as alternative assessment pieces.

Program Effectiveness and Success

Reviewers found evaluation evidence that *Science 2000®* produced statistically significant gains in students' science knowledge. The program also demonstrated evidence of student and teacher satisfaction based on Grades 6, 7, and 8 teacher surveys, student surveys, and classroom observations.

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Usefulness to Others

Science 2000® can be successfully implemented, adopted, or adapted in multiple educational settings, provided that the implementation site can meet the costs of the technology and training needs of its school staff. Reviewers noted that the program provides teachers with comprehensive information and instructions for program implementation and use.

Educational Significance

The learning goals reflect the vision promoted in national standards. Reviewers noted that the program promotes equity, is easily adapted to all types of learners, and allows students to take ownership of their work and helps teachers facilitate that development. The thematic nature of the units enables teachers to tie disciplines together and students to construct linkages between the sciences rather than viewing them as separate subject areas.

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An evaluation conducted by California State University, Fresno used a pre-post test design to assess students' concept acquisition. Subjects were 166 *Science 2000®* students in Grade 7 at five sites/five classrooms and 196 *Science 2000®* students in Grade 5 at five sites/six classrooms who were of varying ethnicity, language proficiency, and achievement. The evaluators and program developers constructed test instruments to measure content knowledge using both open-ended questions and performance-based tasks, and the post-test was an alternate version of the pre-test. Field test data were used to establish the reliability and validity of the instruments and develop scoring rubrics. A unit of *Science 2000®* was taught between the tests. Student scores on the pre- and post-tests were statistically analyzed using a series of dependent t-tests for all items and the composite in each grade and a series of analyses of covariance for individual changes and group differences among subsets of students. Results indicated that all students showed statistically significant pre-post test score improvement at the $p<.0001$ level.

Another evaluation conducted by the University of California, Irvine used a post-test-only design to assess students' problem-solving skills. Subjects were 220 *Science 2000®* students in Grade 7 and a matched comparison group of 105 students from the same schools as the treatment group. Results demonstrated that *Science 2000®* students performed statistically significantly better than comparison students, at the $p<.04$ level, on a performance assessment.

A third study compared the overall Texas Assessment of Academic Skills (TAAS) science test scores for two schools using Grades 7 and 8 *Science 2000®* curriculum modules to the state overall TAAS science test score, which was an 84.6 percent passing rate. Results demonstrated higher overall passing rate percentages of 91 percent and 89 percent for the two *Science 2000®* schools.

Sunflower

PROMISING PROGRAM

SCIENCE

Discovery Curriculum for Children

Sunflower Science Discovery Curriculum for Children/Girasol Revista de Descubrimiento Cientifico para Niños

Sunflower/Girasol Science Discovery Curriculum for Children is designated as a **Promising** science program.

Program Description

The Sunflower/Girasol Science Discovery Curriculum for Children introduces teachers and students to the world of scientific exploration and problem solving. Geared toward students in Grades 2–6, the science units on plants, air, water, and the human body, present information and experiments in stimulating graphic formats and pose interesting and relevant questions for children based on current scientific developments. This supplemental curriculum places science learning in context and promotes environmental responsibility. In each *Sunflower/Girasol* unit, children are asked to carry out investigations in their schools, homes, and neighborhoods. Whether they are calculating water waste, making a field guide of plant life on the playground, interviewing a parent, or testing the pH of rain water, students are asked to use the data they collect locally to make inferences about the large scale implications of the phenomena. Thus, the curriculum treats science exploration as a vital part of everyday life at the same time it emphasizes academic rigor and deep conceptual understanding.

The materials, available in either English or Spanish, are a rich resource for mainstream, Limited-English Proficiency (LEP), English as a Second Language (ESL), and bilingual classrooms. Each unit of the *Sunflower/Girasol* curriculum is presented in a full color activity book for children. Activities are introduced by a multicultural cast of characters, most of whom are immigrants or the children of immigrants from Latin America. The complexions and experiences of the characters in the student activity books reflect those of students in many urban school systems and help children in less diverse classrooms recognize and value difference.

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Professional Development Resources and Program Costs

The Intercultural Center for Research in Education (INCRE) offers 1- to 3-day training workshops during which participants engage in science as inquiry; learn about topics in the plant, water, human body, and air units; and learn to make curricular links to literacy, math, social studies, and geography. Participants also discuss ways to invite parental involvement and boost student achievement. INCRE provides teachers with research articles, resources, and background information on each topic. Training workshops are optional and cost an average of $500/day, depending on location and number of participants. Local INCRE training representatives are available in Boston, Miami, Washington, DC, and Albuquerque. Curriculum units are sold in classroom sets, at $79 per set, and consist of 30 *Student Activity Books* and a *Teacher's Guide*.

Program Quality

Reviewers found the program goals to be challenging and appropriate. *Sunflower/Girasol* facilitates the development of inquiry skills and makes science relevant by having students use their home, community, and school environments to make sense of the science around them. Strengths of the program include its instructional design, alignment between lesson goals and experiences, and varied opportunities for students to learn concepts and engage in inquiry. Assessment is appropriate and designed to provide accurate information about student learning. The design of an appendix with rubrics describing the depth of student learning is a valuable program feature.

Program Effectiveness and Success

Reviewers found the evaluation to be sound in that it used random assignment, a quasi-experimental comparison group design at different sites, and pre-post tests assessing student understanding of science and environmental education concepts and science process skills for two units. Within the context of a program available in both English and Spanish versions and data that are reliable across the sites involved in the study, the program presented statistically significant gain score evidence that *Sunflower/Girasol* students increased their knowledge of plant and water related concepts and science process skills more than comparison students using a commercial curriculum to study the same topic.

Four schools and a total of 268 students participated in the controlled outcome evaluation. In each participating school, one 3rd-grade class used the *Sunflower/Girasol* plant unit and one 4th-grade class used the water unit. The plant unit was evaluated in four schools, and the water unit in three schools. Comparison groups for each grade in the same schools used commercially available curricula to teach the same topics. Treatment classes were randomly assigned, controlling for the possibility that the more experienced or more motivated teachers at each school site had selected the *Sunflower/Girasol* materials.

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Usefulness to Others

Reviewers noted that materials and resources are inexpensive and do not require a large amount of teacher preparation. Directions on how to plan for a lesson are well written, and a table is provided to help teachers understand how this program can fit into the academic year.

Educational Significance

Sunflower/Girasol's learning goals reflect the vision promoted in the national science standards to have all students develop the ability to engage in scientific inquiry. Reviewers noted that this curriculum is excellent in providing relevant experiences for students to learn about concepts while collecting data and manipulating materials. The program's purpose is to respond to the need to improve academic success rates of traditionally underserved Latino students from poor communities. By highlighting contributions and accomplishments of Latino scientists, *Sunflower/Girasol* encourages Latino children to identify with others of the same origin and culture and opens the world of science to Latino and/or bilingual students.

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The test instruments were prepared in English and Spanish and combined multiple choice questions adapted from the California Test of Basic Skills (CTBS) battery and the Third International Mathematics and Science Study (TIMSS) with performance items consistent with the National Science Education Standards (NSES). Test items assessed student understanding of science concepts (e.g., plant germination and growth, sources of food from plants, water use and conservation, sources of water pollution, and the water cycle) and science process skills (e.g., graphical representation and interpretation of data, predicting results of an experiment, and measurement). All test items were validated twice in nonparticipating schools to ensure the reliability and content validity of the instruments. A multiple regression analysis was used, and the model was specified to predict the gainscore by group, controlling for pre-test score and gender. Analysis of variance was utilized to assess if mean gains varied by school. The analyses pooled data for all the treatment and comparison students, with approximately 70 students in each group. For both units evaluated, the effect sizes of the treatment group controlling for pre-test differences were statistically significant at the $p<.001$ level, and analyses of variance demonstrated positive mean gains in favor of the *Sunflower/Girasol* group that were consistent across all participating schools and statistically significant at the $p<.01$ level.

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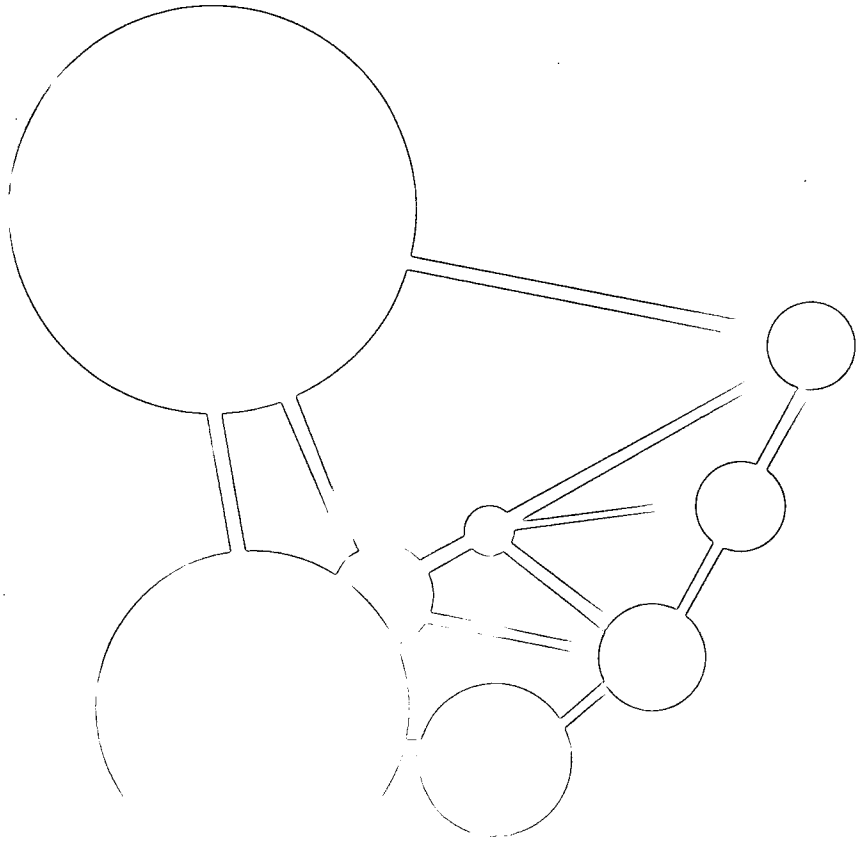

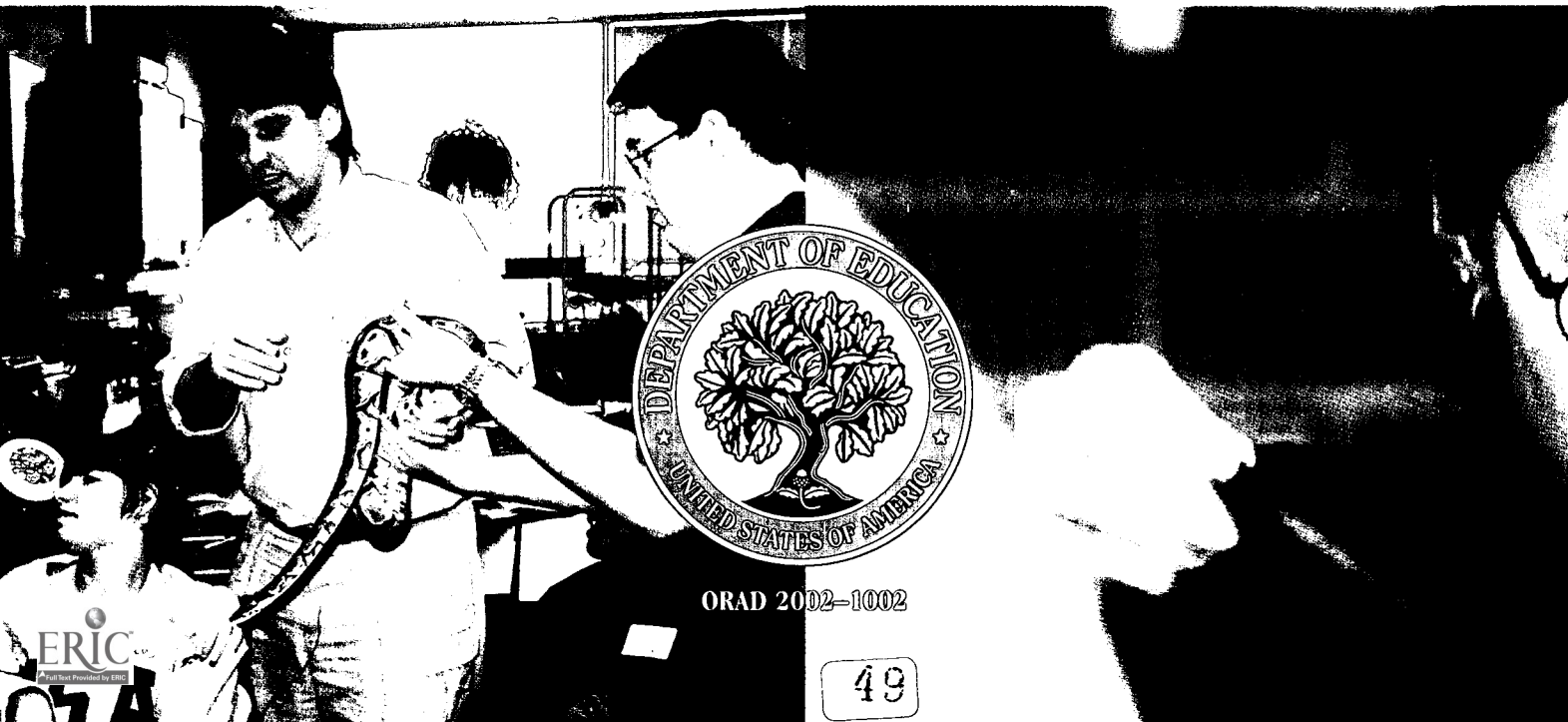

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