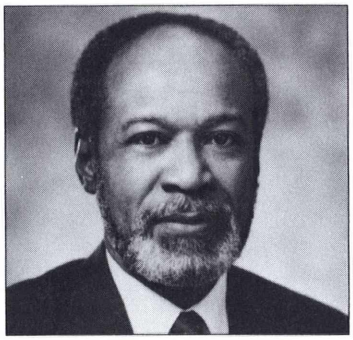
Synergy

Working Together
to Revitalize Science
and Mathematics Education

Directorate for Education and Human Resources, National Science Foundation

Fall 1992



On The Need for Scientific Literacy

Through the Directorate for Education and Human Resources (EHR), the National Science Foundation exercises the unique federal role of advancing mathematics, scientific, engineering, and technological education.

Our mission in EHR, ultimately, is to enhance the quality of life for all Americans. To do so, we must ensure the increased and continuing quality of scientific and technical education. We must direct our attention not only to the education of future scientists and engineers, but also to science education of all citizens in our increasingly technical world.

President Bush and the nation's governors acknowledged this need with the 1989 publication of the National Education Goals. Of these, three are central to EHR—that, by the year 2000, our students will demonstrate sound math and science skills, that our students will be first in the world in math and science achievement, and that every American will be scientifically literate and able to compete in a global economy. These goals have shaped our actions over the last three years and will continue to provide a focus for our efforts.

EHR has recently undergone a major reorganization to help strengthen the Directorate's operation and thereby better accommodate efforts to meet these goals. Divisions have been reorganized to achieve coherence and synergy, to eliminate redundancy, and to ensure accountability. We have evolved into an flexible organization capable of responding quickly and capably to change.

Two similar changes have occurred within our programs. The first draws on the realization that our programs are of little value if the progress they occasion is lost once funding ends. Therefore, we've developed programs to encourage sustainable change and specific outcomes. Second, we've emphasized the explicit importance of partnerships in guiding our educational system into the twenty–first century. We are effective only to the extent to which we forge partnerships among the many players in science and math education.

I have come to believe that an acquaintance with math and science is no longer a luxury; it is a necessity. As society grows increasingly complex, it will become more difficult to function as a citizen without this knowledge. By working together to make math and science an integral part of everyone's education, we can enhance the quality of life for all Americans. Working together will achieve our goals.

–Luther Williams
Assistant Director for Education and Human Resources

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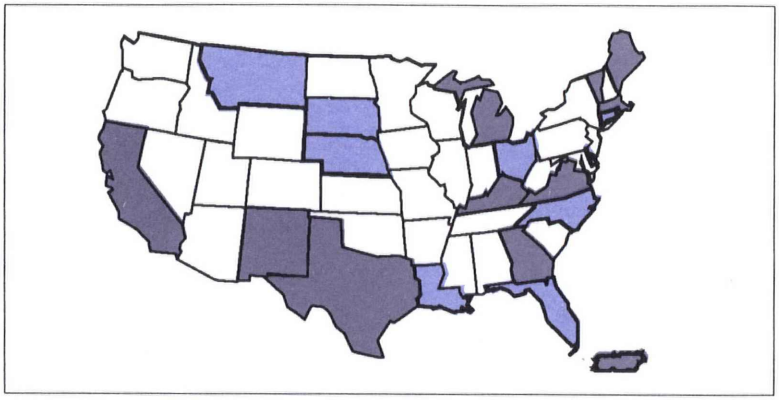

KEY:

1991 SSI States

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Revitalizing State Math and Science Education

Through EHR's Statewide Systemic Initiatives (SSI) program, twenty–one states have now formed creative alliances designed to bring about sweeping change in science and math education.

Ten new states and Puerto Rico have joined an original ten states in this innovative program. In SSI, parents and leaders in education, politics, science, math, and business form a series of unique partnerships. Together, these leaders envision where vital change must occur to bring their state's mathematics and scientific education into the twenty–first century.

"The new idea here is to treat the system as a whole, to look at it from the approach of how the pieces fit together," says program director Janice Earle. "We're trying to change the rules of the game."

Changing the rules involves not only trying to increase student achievement but also changing the very types of math and science that students are taught. SSI encourages hands–on learning in the classroom. Especially with younger students, a focus on activity, discovery, and problem solving is expected to encourage students to keep their native enthusiasm for these subjects.

Because each state faces unique challenges, award money is flexible. Most states, however, are discovering similar needs.

In most cases, program participants are attempting to create more interesting and effective curricula, materials, and testing methods. They are developing strategies to increase student achievement, to use the latest technologies in the classroom, and to improve scientific literacy.

The greatest strength of the SSI program lies in the alliances it fosters. However, these linkages are not easily formed or maintained because legislators, business people, scientists, teachers, and parents all view science and math education differently. The responsibility of alliance members is to come to a consensus on what students need to know and to determine how they can work together to achieve this. The potential payoffs are tremendous.

"I really do believe we're on to something significant," Earle says. "It's very clear that partnerships are being created, that people are working together in totally new ways. . . [Alliances are] coming up with wonderful ideas that everyone can live with. This never would have happened so quickly without the incentive of this program." ❖

Enhancing Academic Research Capabilities

In South Dakota, a pool of state tax money has been established to fund academic research and development (R&D). Over the past decade, Montana has increased its proposal success rate at NSF from 22% to 35%. A Kentucky university has been recognized as one of only seven Numerically Intensive Computing Centers nationwide.

These are just a few of the outcomes of the Experimental Program to Stimulate Competitive Research (EPSCoR), one of several EHR programs designed to bring about systemic change.

EPSCoR currently works with 19 jurisdictions in order to enhance their universities' ability to support nationally competitive research. These states, while outstanding in some areas, are often at a disadvantage when competing for federal funding against states with more fully developed research infrastructures.

As a result, EPSCoR states often receive a relatively lower portion of federal R&D funding. For example, as shown on the graph at right, ten states currently receive 60% of NSF funding while the 19 EPSCoR states share only 5% among themselves. This pattern is repeated in almost all federal R&D agencies. For this reason, NSF's EPSCoR program was recently expanded by Congressional mandate to other federal agencies, which are working with NSF to implement similar programs of their own.

EPSCoR awards states modest grants to form partnerships among the academic science and engineering community, state government, and the private sector. Partnerships work to develop a plan for making sustainable, systemic improvements in their state's academic research capacity. These states then compete for merit–based EPSCoR grants which help put their plans into action. After several years, it is expected that participants will be better able to compete for national research funding on their own.

"Talent knows no geographic boundaries," says program director Dr. Richard Anderson, explaining the philosophy behind the EPSCoR program. EPSCoR states often have significant untapped academic potential despite receiving little R&D funding.

EPSCoR uses what is often called seed money to stimulate improvements in the state's academic R&D enterprise. Although grants are somewhat small, the funds help each state determine in what areas they are most likely to become nationally competitive and to fully develop these "niches of excellence".

The system, so far, seems to be working. Participants have been making the necessary commitments—setting aside tax money, hiring and retaining faculty, and adding laboratory equipment—to ensure that the improvements

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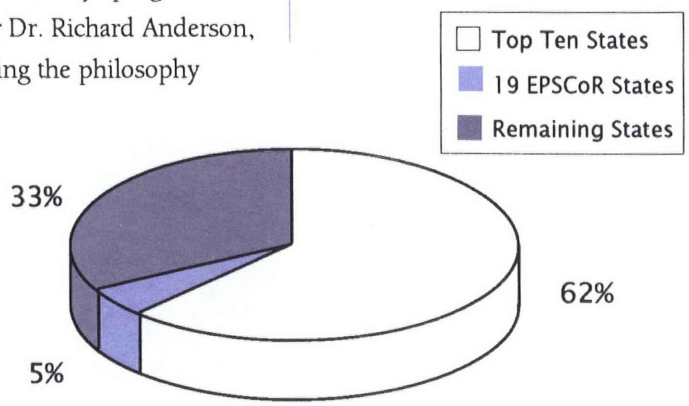


Total NSF R&D Funding by State, FY 1990

Ventures Program Launched in D.C. Schools

Average Dropout Rate in D.C. Public Schools

Total students in D.C. Schools

% of students who drop out

% of graduates who go on to college

% of graduates who take the SAT

Even the most underprivileged, unprepared student can master a rigorous, academically challenging program of study, say the founders of the Ventures program, an ambitious project which will go into effect in eight Washington D.C. high schools and two junior high schools this September.

The Ventures program, partially funded through EHR, pushes students to their academic limits. All participants complete four years of math, science, English, and social studies by the time they graduate, as well as three years of foreign language. Faced with a continuous emphasis on reading, writing and speaking skills, students must maintain a B average by their junior year. In addition, Ventures students go to school longer than their counterparts—school is extended by one period each day, and academic summer programs are strongly encouraged.

Teachers don't face an easy ride in Ventures either. Ventures teachers plan curricula, design and implement new courses, require homework every night in all subjects, and participate in a variety of workshops. Their biggest duty, however, is to provide support from day one of high school. From the start, teachers constantly encourage Ventures participants, telling students they can and will succeed—and, remarkably, they do.

Washington D.C. public schools desperately need the help. According to recent reports, the drop–out rate inside city schools is nearly 50%. Less than half of current graduates go on to college, and only a third take the SAT. Even among these students, verbal and math SAT scores average about 100 points below the national average. Can the Venture program make significant improvements in a school system which produces these distressing statistics?

The answer would appear to be yes. In similar school districts around the nation, Ventures has produced amazing results. In 1991, almost 95% of the 1,306 graduating participants went on to enroll in four-year colleges, compared to the national enrollment rate of 60%. After a year in college, these same students were maintaining a grade point average of 3.00 or better, and nearly half were majoring in sciences, engineering, or health care fields. Program officers in EHR are hopeful that local schools will enjoy similar success.

"We're quite proud," says Human Resources Development Deputy Division Director Roosevelt Calbert. "We don't know of another concerted effort with these specific goals within the Washington public school system." ❖

Innovative Alliances To Assist Students

EHR has funded six Alliance for Minority Participation (AMP) projects as part of an initiative to increase the number of minority students receiving undergraduate degrees in science, math, and engineering.

AMP projects, located at major universities in Alabama, Arizona, California, Mississippi, Puerto Rico, and Texas, sponsor programs supporting undergraduate students who choose science, mathematics, and engineering majors. Each alliance offers a variety of enrichment activities designed to best meet the needs of students in that area.

The AMP program, director Dr. Ana Guzman explains, is interested in students who have historically dropped out of math, science, and engineering programs or who could have successfully entered these fields but have chosen not to. These students face challenges in college which have nothing to do with their academic potential. Instead, they often lack the support systems needed to succeed and the industry contacts which mentor students and assist them in locating a position after graduation. The program assists students in each of these areas of need.

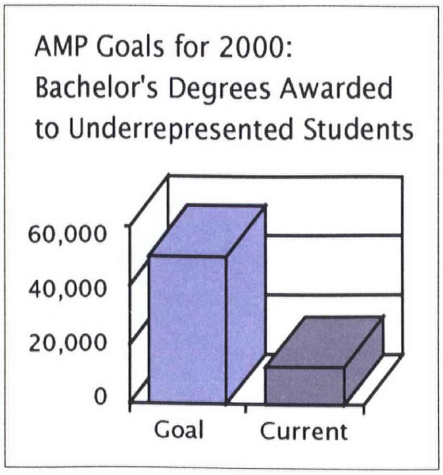
Most student participants receive financial assistance in the form of research stipends which offer students a chance to gain invaluable laboratory experience. In addition, AMP provides study groups designed to help students through what are often called the "gatekeeper courses"—early science and math courses which dampen many students' interest in pursuing a scientific career. Research shows that these efforts make a significant difference in a student's academic career.

AMP also forges links between industry and students. By involving businesses and industries as integral alliance members, the program creates contacts which may aid underrepresented students upon graduation by facilitating entrance into the job market.

"Our vision is to give universities an opportunity to access math, science, and engineering to a greater number of students," Guzman explains. "We attempt to look at all the variables and create programs which will enable these students to succeed." ❖

In the field:

In the Arizona State University AMP project, 35 colleges and universities, eight professional organizations, two government laboratories, nine educational organizations, and 26 corporations throughout Arizona, New Mexico, Colorado, Utah and Texas are working together in a plan expected to double the number of baccalaureates awarded to the region's underrepresented minority students by 1996.



FOCUS

Report Stresses Need to Reward Teachers for Teaching

At a recent NSF–sponsored colloquium, 53 Presidential Young Investigators—some of the nation's brightest young faculty—convened in Washington D.C. to discuss the future of American higher education. Their charge, to report their vision of the future, of key courses of action, and their recommendations to higher education and the National Science Foundation. The following is an excerpt, reprinted with permission, from the executive summary of the PYI Colloquium report entitled "America's Academic Future," published in January, 1992. Copies of the report can be obtained upon request from the Division of Undergraduate Education, 202–357–9644.

To assure high quality precollege and undergraduate instruction in engineering, mathematics, and the sciences for all students and citizens in the year 2010 and beyond, U.S. higher education in general, and the National Science Foundation in particular, must:

1. Encourage and reward teaching excellence, instructional scholarship, and public service as well as research. The lack of support, indeed, occasional outright discouragement, of faculty achievements in teaching, instructional scholarship, and public service is among the most pressing problems in higher education. At the heart of it is . . . tenure and promotion criteria that does not encourage faculty to aspire to broad scholarly achievements, especially in instructional innovation . . . Tenure and promotion criteria and related rewards need to be applied with greater recognition of individual faculty ability and potential.

2. Increase substantially resources for instructional innovation and curriculum renewal, especially for undergraduate education. . . . Funds for instructional innovation are nearly nonexistent. Lack of adequate resources assures inadequate attention to long–term curriculum renewal and sustains an unfortunate and inaccurate impression in the minds of many that teaching well is unimportant and without merit . . . All parties—education, industry, State and Federal agencies, and the public—must recognize that regularly budgeted, long–term programs for curriculum renewal to maintain the faculty's instructional excellence are as essential as funds for disciplinary renewal to maintain their technical currency.

3. Assume primary responsibility for public understanding of science and technology, principally through high quality precollege teacher preparation and lower division undergraduate instruction. Whatever the level of scientific and technological literacy we hope to attain in this country . . . it will be learned primarily in K–12 classrooms, and for those who go on to college, in the Freshman and Sophomore years . . . Especially critical, therefore, is the preparation of those students aspiring to precollege teaching careers in mathematics and the sciences, and the instructional preparation of those graduate students aspiring to academic careers.

4. Assure adequate career preparation in engineering, mathematics, and the sciences by all segments of society, particularly careers as precollege or college faculty. Science, mathematics, and engineering careers are viewed by many as rather unexciting, unrewarding . . . Career choice is primarily a

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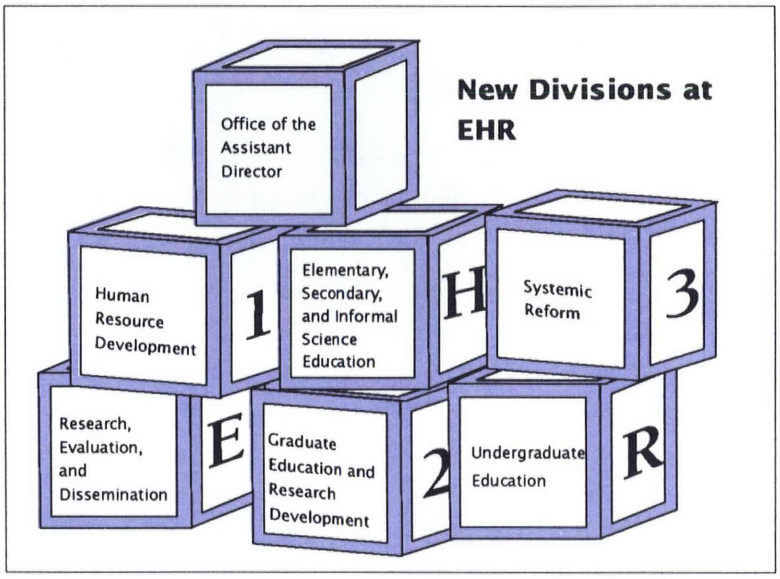
product of experiences. . .We have considerable control over the educational environment and the quality of instruction. Students are not encouraged to pursue careers in fields in which they perceive instruction to be tedious and uninspired, coursework to be irrelevant or excessively demanding, and success to result from special talent or demographic similarity. We must be more inclusive.

5. Encourage the development of discovery–oriented learning environments and technology–based instruction at all educational levels. Our lecture–dominated system of education encourages a passive learning environment, invites the development of highly compartmentalized (lecture–sized) curriculum, and instills neither the motivation nor the skills for life–long learning. . . Emphasis [must be] given instead to discovery–oriented learning in which disciplinary and geographic boundaries become less distinct . . . Students must be active and faculty must be as creative in their teaching as they are in their research. ❖



Building a More Cohesive Organization

The Directorate is now completing a major reorganization designed to create a more dynamic, focused EHR.

Former divisions have been rearranged and their programs divided among six new categories. These changes, for the first time, group programs which deal with specific educational levels together, providing a clearer focus for EHR support at each stage of the educational pipeline. For example, the undergraduate education of future teachers will be located in the Division of Undergraduate Education, enabling teacher preparation to become an integral focus of EHR's collegiate efforts. Other new divisions include Elementary and Secondary and Informal Science Education, and Graduate Education and Research Development.

At the same time, the reorganization also separates out those programs with a comprehensive focus. These programs are now part of three units—the Office of Systemic Reform, the Division of Human Resource Development, and the Division of Research, Evaluation, and Dissemination. Work done in the latter two of these divisions affects all educational levels.

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Reorganization
(continued from page 7)

These groupings, according to NSF Assistant Director for EHR Dr. Luther Williams, represent a more appropriate organizational scheme, one which will increase EHR's efficiency in meeting the Foundation's and the nation's goals.

Another vital component in the reorganization is the increased emphasis given to comprehensive planning, in which new programs are planned collectively instead of within one isolated division. The planning function, Dr. Williams says, is integral to our being strategic, to our being a dynamic organization that can explore windows of opportunity and deal effectively with challenges.

"We've created a situation, through this reorganization," explains Dr. Williams, "where one plus one plus one will equal greater than three in terms of impact and outcome." ❖

R&D Funding
(continued from page 3)

made in EPSCoR will be permanent. And results have been promising. Most states have seen a significant increase in the success of their grant proposals at NSF and other federal R&D agencies.

"Institutions in these states can play a greater role in the research enterprise," Anderson says. "We work with them because it's in the national interest to fully develop all of our science and engineering capability." ❖

Directorate for Education and Human
Resources (EHR)
National Science Foundation
1800 G Street
Washington, D.C. 20550

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