

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20500

9/5

Bill:

You may not have
seen this. It has a
decidedly negative
tone . . .

Best,
Daryl

The Calculus of School Reform

Despite years of effort and hundreds of millions of dollars, there's scant evidence that the movement to reform U.S. mathematics and science education has significantly improved student learning. Why not?

Seven years ago, elementary school teacher Allyson Glass was a self-described math phobic. A former physical education teacher in her second year of teaching third grade, she relied entirely on a standard math textbook and spent only the prescribed time—about 1 hour a day—teaching the subject. But after a two-summer fellowship studying how to improve math and science teaching, she says she was “totally transformed.” Even during history lessons, her students at Benjamin Franklin Elementary in Meriden, Connecticut, use math to study the geometric patterns in a quilt from colonial times. “The kids know they can’t get away from a lesson without doing some math,” she says. But they don’t seem to mind—most of her students say it’s their favorite subject.

What’s happening in Glass’s classroom is being repeated this fall in thousands of schools across the United States, as a movement to implement national educational standards in math and science takes hold. The movement dates back at least to 1989, when the National Council of Teachers of Mathematics (NCTM) issued guidelines on what students should know at various grade levels. In 1993, the American Association for the Advancement of Science (AAAS), which publishes *Science*, issued a set of benchmarks for science, math and technology education. Two years later, the National Research Council (NRC) followed suit with similar standards for science. Now, educators are revising teacher training, curricula, and assessment practices in an attempt to meet these or similar guidelines, which call for a new approach to teaching, with more hands-on learning leading to a deeper understanding of the subjects. The National Science Foundation (NSF) has also poured \$25 million a year since 1990 into more than a dozen programs

to develop standards-based curriculum materials in mathematics and science.

The push is coming from the top: President Clinton has made a cornerstone of his second Administration the goal that U.S. students will be first in the world in math and science by 2000. And it’s a rare Clinton speech that omits mention of his proposal for a voluntary national test—of reading in the fourth grade and of mathematics in grade

bedrock conviction that local communities should control what their kids learn. Indeed, in some places, battles between proponents and opponents of math reform have left the movement in disarray (see sidebar on p. 1194). A debate is also heating up at the national level as powerful critics attack the notion of national standards as an unwanted incursion into local control. For example, Representative William Goodling (R-PA), chair of the

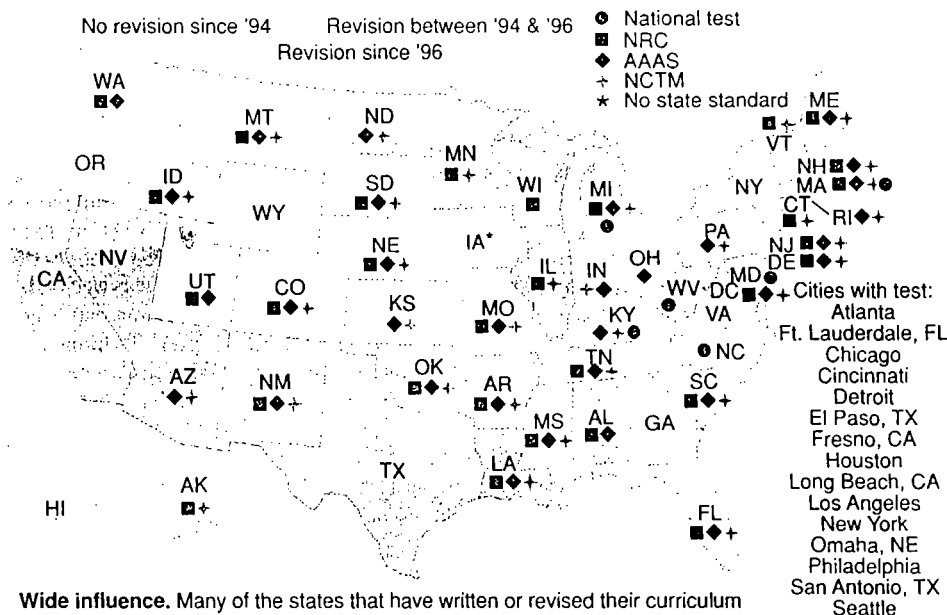
House Committee on Education and the Work Force, has introduced two bills to block the nationwide tests for fourth and eighth graders that Clinton advocates. In a recent *Washington Post* editorial, Goodling wrote that such testing “could lead to a national curriculum ... which Americans don’t want and don’t need.”

As a result, while anecdotal evidence of positive change abounds, no state—or even school district—can yet claim to have reached the

promised land of standards-based learning. Yet many educators take some comfort from the fact that, difficult as it is, change is at least occurring throughout the vast and fragmented U.S. education enterprise. “Considering where American education was [in the late 1980s], there has been remarkable progress,” says education professor David Cohen of the University of Michigan, Ann Arbor. “But, considering where American education was, it would be really good if there had been more progress.”

Whose standards?

The NCTM, AAAS, and NRC guidelines are often billed as national standards, and educators say they have had widespread impact. “The NCTM standards have definitely been used as an important resource document in virtually every state,” says Gordon Ambach, executive director of the Council of Chief State School Officers (CCSSO) in Washing-



eight—that will allow parents and teachers to chart their children’s progress.

Yet, for all this ferment, the effort to implement math and science standards has been a slow and, at times, frustrating experience. The results speak volumes about the difficulties of reforming an educational system run by thousands of independent school districts. Although scores on some tests have improved nationally, significant gains in student achievement remain, for the most part, elusive. One major hindrance is the vast number of teachers who took few math or science courses in college and, unlike Allyson Glass, have had no additional training in the new world of standards-based education. Progress is also slowed by textbook publishers reluctant to make real changes in their products and by the continued emphasis on standardized tests that measure only proficiency with basic facts.

The standards-setting movement has also stirred up political passions that underlie the

SOURCE: ROLF BLANKENHORN & STATE AGENCIES

The Special Needs of Science

While educators making efforts to set standards for science education face many of the same hurdles as those in mathematics, the diversity of the science community makes the job even tougher. Thanks in part to that diversity, there have been two separate efforts in the past 4 years to present a cohesive vision of what students should learn in science classes from kindergarten through grade 12. Combined with the relatively recent appearance of the two documents, these factors have caused science reform to lag behind math in many of the nation's schools.

In 1993, Project 2061, an education reform effort sponsored by the American Association for the Advancement of Science (which publishes *Science*), issued *Benchmarks for Science Literacy*, which recommended what students should learn at various grade levels. (That document followed *Science for All Americans*, which in 1989 described what scientifically literate adults should know.) In 1995, at the request of the National Science Teachers Association and other scientific and educational societies, the National Academy of Sciences issued the *National Science Education Standards*. While the documents are compatible, say most educators, there are enough

differences to confound well-intentioned teachers.

Science reformers also labor under special conditions. Unlike in math, in which there was a consensus in the community on what to cover, the science standards generated pitched battles within fields about content, and between disciplines about their relative importance. In addition, the emphasis of hands-on and lab activities puts increased pressure on an already crowded school day, not to mention tight budgets.

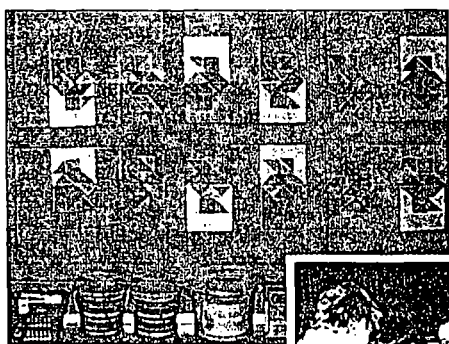
Although the hard-won compromises in the *Benchmarks* and the *Standards* are a welcome step in the right direction, some educators say they both have flaws. "They still are trying to teach everything and therefore not teaching anything in depth," says Senta Raizen of the National Center for Improving Science Education in Washington, D.C. "If we really take inquiry seriously, and it takes a month or two or three, what are we giving up?" she asks. George Nelson of Project 2061 says an upcoming book, *Designs for Science Literacy*, should help teachers decide what to take out of their lesson plans. That's a much harder question, everyone agrees, than deciding what to put in. —G.V.

ton, D.C. But many states have adopted their own variations. For example, the NRC science standards for grades five through eight list six ideas that lead to an understanding of structure and function in living systems. However, the Illinois science framework simply states that by the end of eighth grade, students should be able to "identify similarities and differences among animals that fly, walk, or swim" and "compare structures of plant cells to animal cells."

It's hard enough for even well-trained teachers to keep up with this bewildering diversity of standards. So it may be no surprise that most say they really don't understand what the standards ask them to do. Despite several public relations campaigns—including 500,000 brochures and a video featuring jazz trumpeter Wynton Marsalis and other entertainers—45% of fourth grade teachers nationwide told a 1996 Department of Education survey that they have "little or no knowledge" of the NCTM standards, while only 6% said they were "very knowledgeable" about them. The numbers are somewhat better for eighth-grade teachers—only 16% claim little or no knowledge of the standards, and 17% are very knowledgeable.

Even when teachers are well versed in the standards, they face a tough problem in applying them in the classroom. "You can't just sit down and look at the NCTM standards and say, 'This is what I'm going to do tomorrow, and I'll be implementing the standards,'" says John Wheeler, a mathematics consultant for the Iowa Department of Education. Education professor Marcia Linn of the University of California, Berkeley, agrees. "It's like reading the Bible or the Talmud," she says. "There's 102 million interpretations."

Researchers who have observed "standards-based" classrooms agree that much of what passes for standards-based teaching is a pale imitation of the real thing. Teachers are "making changes around the edges," says Lorraine McDonnell, a political scientist at the University of California, Santa Barbara. There may be more hands-on activities and



Pieces of reform. Students in Allyson Glass's third grade class use quilts to study math.

more small-group learning, she says, but rarely are students required to apply the concepts they learn to real-world problems—one of the central recommendations of the standards.

Such sophisticated teaching is much harder, says McDonnell, and requires more teacher training and more time in the classroom. But training is often lacking. Although "how-to" workshops on implementing the standards are available in many states, the Department of Education survey found that 60% of U.S. students are taught by teachers who have never attended such a workshop, much less a comprehensive pro-

gram like Allyson Glass's fellowship.

Standards-based textbooks could help guide teachers, but publishers have been slow to catch on. "A lot of textbook publishers claim they meet NCTM standards, but it's a little like a Rorschach test," says Senta Raizen of the National Center for Improving Science Education (NCISE) in Washington, D.C. "I don't think there is a textbook series you can buy off the shelf that really speaks to the standards."

Faced with that hurdle, Jo Ellen Roseman, curriculum director for Project 2061, an education reform project sponsored by AAAS, has helped to design a system for analyzing math and science textbooks. It tracks the NCTM and NRC standards as well as 2061's own set of standards, called *Science for All Americans* and *Benchmarks for Science Literacy*. Although she cautions that the project is not finished, preliminary results aren't wildly encouraging. "We've found some units that are outstanding," she says, "but very few." Even NSF-sponsored projects "don't necessarily come through with flying colors."

Most available materials, Roseman says, spend too little time on a given topic, introduce concepts earlier or later than the standards recommend, and rely on memorization rather than allowing students to draw their own conclusions. "Publishers are not yet convinced that the market is driving them to produce these kinds of materials," she adds. "But we're beginning to work with developers" to revise and improve their texts.

One frustration faced by educational reformers is the lack of good information on what students know and how the implementation of standards has influenced that knowledge. The

PHOTOS: ALLYSON GLASS



California Spars Over Math Reform

The world happens first in California, the saying goes. If so, then many of the changes in primary and secondary school mathematics being advocated by professional societies and national education organizations could have a tough time finding a permanent home in U.S. classrooms.

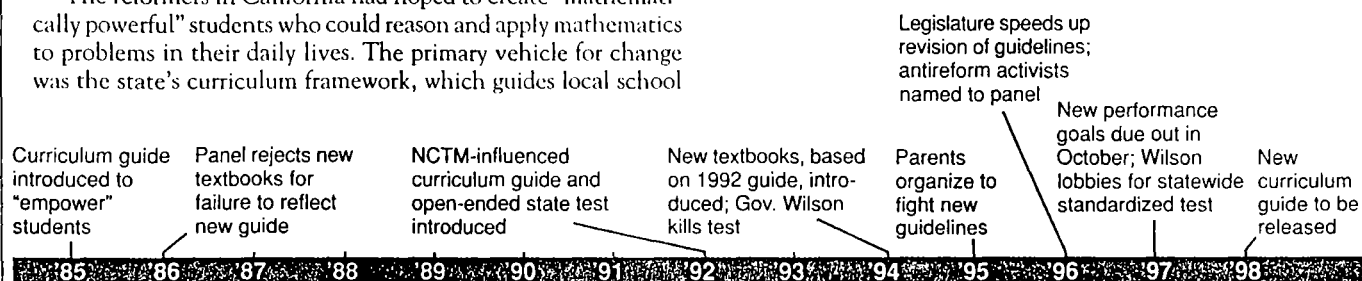
In the late 1980s and early 1990s, California was seen as a shining example of how to implement standards-based reform. And because the state buys 12% of the nation's textbooks, what was happening in California was expected to have widespread impact. But the efforts of reformers—a revised state curriculum framework, new textbooks, and a new statewide test—sparked a vigorous backlash from parents and politicians after their introduction in 1992. As a result, the next version, due out in 1998, promises to be quite different from the standards promoted by the National Council of Teachers of Mathematics (NCTM) in its 1989 document (see main text).

The reformers in California had hoped to create “mathematically powerful” students who could reason and apply mathematics to problems in their daily lives. The primary vehicle for change was the state’s curriculum framework, which guides local school

essay questions, fared even worse: Governor Pete Wilson scrapped it in 1994. The controversy also robbed the reform movement of whatever political clout it once possessed. Antireform activists constitute the majority on the panels that are drafting both the new content and performance standards and the 1998 framework.

Supporters of the 1992 framework fear that the new version will abandon a cornerstone of reform: namely, that all students—not just those pegged as gifted—should be able to understand mathematical reasoning in addition to knowing the basic facts. “The attempts to be bold and visionary have been cast as the only thing we care about,” says Shelley Ferguson, an elementary school teacher in San Diego who has been involved in the reform process. “They’ve been taken to the nth degree in an effort to trivialize what the reform should be about.”

Both sides agree that the latest drafts of the standards, released in



districts and the state’s textbook adoption committee. The 1992 framework, quoting generously from the NCTM standards, called for teachers to question more and explain less, to group higher and lower ability students together, and to assign more projects and fewer workbook drills. By 1994 the radically new textbooks started appearing in classrooms.

The reaction was swift: Parent groups around the state organized to fight what they called “fuzzy math” and “new New Math.” They said the new curriculum used untried teaching methods and replaced basic skill drills, such as multiplication tables and long division, with projects such as writing and illustrating a “Problem of the Week.” “It transformed math problems into English essay writing” and sacrificed mathematical precision, says Bill Evers, a political scientist at Stanford University and a leader of a Palo Alto-based parent group on math reform called Honest Open Logical Debate (HOLD).

In an effort to wipe the slate clean, HOLD and other grassroots organizations persuaded state officials to move up by 1 year, to 1998, the next revision of its frameworks. The state test implemented with the 1992 standards, which included open-ended and

mid-August, are a far cry from NCTM’s document. What is driving the new standards, say Evers and other committee members, is a state requirement to enumerate what students need to know in each grade. In drawing up their plan, the group relied heavily on standards from Virginia and from the Charlotte-Mecklenburg, North Carolina, school district, which follow that format.

Evers says the new draft contains standards as rigorous as those in high-performing Japan, and that it will prepare students to go on to algebra and geometry in eighth grade, 1 year earlier than had been the norm. But Ferguson disagrees. “It’s back to a laundry list of topics to know,” she laments. “Conceptual understanding and problem solving are pretty absent.”

Whatever the outcome, reformers elsewhere say that the California math wars have taught them the importance of educating parents and policy-makers as well as teachers. “We can’t neglect the effort to educate the public about public education,” says Suzanne Wilson of Michigan State University in East Lansing, who has followed the California reforms for more than a decade. If they do, reformers could end up with a report card marked incomplete. —G.V.

meager evidence is decidedly mixed. On the plus side, mathematics scores on the National Assessment of Educational Progress (NAEP)—a national test given by the Department of Education—have risen since 1992. Progress on this test is especially heartening, say reformers, because it includes open-ended questions that measure the kinds of learning they are trying to encourage. And U.S. third and fourth graders scored above the international average in math on the highly publicized Third International Mathematics and Science Study (TIMSS), which compared students from 29 countries. Yet seventh and eighth

graders scored below the international mean (*Science*, 22 November 1996, p. 1296; and 13 June, p. 1642). The TIMSS results were especially curious because the new standards have so far had a limited impact in the lower grades, at least judging by the proportion of teachers who say they are familiar with them.

At the local level, reformers say that traditional tests, which tend to measure how good students are at remembering facts quickly, are not a fair gauge of their efforts. “So much of what is in the standards,” says Iowa’s Wheeler, “is not adequately measured by traditional multiple-choice norm refer-

enced tests like the Iowa Tests of Basic Skills,” which hundreds of thousands of students across the country take each year. “So if you’re not testing that kind of thing, you don’t have any baseline data to go on.” At the same time, the push for accountability has increased the use of such tests. And when scores have dipped, parents have taken to the streets—and school board offices—to protest standards-based reforms.

Accordingly, the standards not only call for a new curriculum and new teaching strategies, but also new tools to measure students’ learning. The NAEP mathematics and sci-

Bipartisan Mood in Congress Opens Door for Pork

ence tests are a step in the right direction, say reformers, with their open-ended problems that require students to explain their reasoning and give credit for correct reasoning as well as correct answers. In addition, the New Standards, a student assessment system that includes open-ended test questions and student portfolios, is gaining popularity.

If Clinton has his way, by 1999 every eighth grader in the country may have the chance to take a standards-based test. Such a test could help shepherd teachers toward a more consistent interpretation of the standards, note former NCTM President John Dossey and current President Gail Burrill, who are chair and vice chair of the committee charged with writing the mathematics exam to be given to eighth graders nationwide.

But some reformers wonder how much impact a voluntary test can have. It is not yet clear what rewards and punishments Clinton's proposed test would carry, but it may be a test without teeth. "I'm skeptical about it," says NCISE's Raizen. "Does it count? No. There are a lot of people who think this kind of test is going to drive reform, but I don't think so."

There's also the question of coverage. So far, only six states and 15 urban school districts have volunteered to join the testing program (see map). Still, the White House remains committed to preparing such a test through the Department of Education, and officials claim that a dozen more states are ready to join in.

Standard iterations

Even as educators around the country are struggling to implement the 1989 standards, NCTM leaders are working on a new and improved version for 2000. The revision provides a "chance to see where we are and what we've done," says Mary Lindquist, education professor at Columbus State University in Georgia, who heads the math council's Commission on the Future of the Standards. The main message will stay the same, but the revised document will "clarify" several areas—including basic skills and proofs—that critics fault in the current version. The new document, called *Standards 2000*, will also update recommendations for using calculators and computers in the classroom. The NCTM has received critiques and suggestions in sessions at its national and regional meetings and through its Web site (www.nctm.org), and it's sorting through thousands of responses before proposing revisions.

But Glass says she doesn't need a national survey to glimpse the future of standards-based reform. "The teachers who have taught by the standards and who have invested in them believe in them," she says. As a result, she adds, her students "become problem solvers. And I don't think that leaves a child."

—Gretchen Vogel

The bipartisan flavor that has become so popular in Congress these days has brought with it the distinct aroma of pork. After fall-



Space pork. Loma Linda University's new space radiation lab is a pet project of Representative Jerry Lewis (inset).



ing into temporary disfavor with congressional budget cutters, legislative earmarks—also known as porkbarrel projects—no longer seem to be a lightning rod for criticism. That's good news for the institutions that stand to gain millions of dollars in R&D funding set aside by lawmakers in 1998 spending bills that Congress hopes to wrap up as it returns to work next week. But others worry that Congress is encouraging bad science by circumventing peer review.

Adding money not requested by the Administration and targeted for specific districts or states is an ancient practice. However, it came under attack in recent years as part of a broader assault on wasteful government spending. But times have changed. The antigovernment ardor has cooled, key opponents of pork have retired, and Republicans and Democrats have set aside their differences in a plan to eliminate the budget deficit by 2002.

NASA and the Environmental Protection Agency (EPA) appear to be the biggest recipients of proposed earmarks among R&D agencies. About \$20 million of the \$614 million that the House appropriated for EPA research in 1998 is for specific pork projects, for example. A typical earmark is the one offered by Representative Jerry Lewis (R-CA), who chairs the House panel with funding oversight of NASA and EPA. He's designated \$2 million in NASA funding for a space radiation

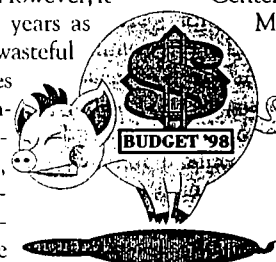
lab at Loma Linda University, a Seventh-Day Adventist school east of Los Angeles, which is in his district. Lewis has also arranged for the University of Redlands in California—also in his district—to get \$1 million from a \$6 million pot for EPA to study the rapidly disappearing Salton Sea.

In the same bill, Representative Alan Mollohan (D-WV) won \$1.9 million for the National Technology Transfer Center in Wheeling, West Virginia, while \$2 million is headed to Houston's Mickey Leland National Urban Air Toxics Research Center, compliments of Texas legislators. Next door, the Louisiana delegation, which includes Appropriations Committee Chair Bob Livingston (R), wangled \$2 million for research at the University of New Orleans into urban waste management and \$1.3 million for oil spill remediation research at McNeese State University in Lake Charles, Louisiana.

The Senate version of the bill has fewer earmarks, but they are individually more impressive. Senator Ted Stevens (R-AK), who chairs the Senate Appropriations Committee, succeeded in winning the largest NASA earmark of all—\$2.5 million for a science learning center in the small town of Kenai, Alaska. And again, Democrats shared the spoils. Senator Daniel Inouye (D-HI), for example, inserted \$2 million for work on a national space education curriculum by the Center for Space Education at the Bishop Museum in Honolulu.

At this point, the projects appear to be mostly add-ons rather than substitutes for the agency's scheduled research. The House version of EPA's overall budget is \$104 million above this year's level and \$41 million above the president's request, while at NASA, the House has included a little less than \$10 million in specific earmarks to a \$5.7 billion appropriation that is \$50 million higher than the White House requested for science, aeronautics, and technology. The bills that include funding for the Energy and Defense departments also have a smattering of specific R&D earmarks, such as the Senate's offer of \$3.9 million in DOE money for biological imaging at the University of California, Los Angeles.

Some appropriators have resisted the



30. Times Educational Supplement

December 12, 1997

New deal for education moves one step closer

Legislation promising changes at every level from nursery to university is about to begin its passage through Parliament. Frances Rafferty reports.

Tony Blair said that education lay at the heart of his Government. Now, as two new pieces of legislation begin their journeys through Parliament, it is time to see what will come of his vision.

The School Standards and Framework Bill establishes a new relationship between central and local government in the raising of standards in schools. It abolishes grant-maintained schools and sets up the new categories of foundation, community and voluntary school. Education authorities are given a duty to promote high standards in schools, to cut class sizes for infants and provide nursery education.

The Secretary of State can suspend the powers of local authorities if he is not satisfied with their performance and he can close failing schools, re-opening them under the Fresh Start scheme.

The Bill establishes education action zones in deprived areas where innovation will be encouraged, the national curriculum can be suspended and teachers will be eligible for more money.

It sets up the mechanism for parental ballots to abolish grammar schools, allows partial selection - where it exists - to remain and allows specialist schools to select up to 10 per cent of

pupils by aptitude.

The Teaching and Higher Education Bill is a slimmer volume. It establishes a general teaching council, a probationary year for new teachers and a compulsory qualification for heads. It gives the Office of Standards in Education the power to inspect teacher-training institutions and gives young people the right to paid time off work to study or train.

More controversially, the Bill introduces tuition fees in higher education and a new student loan scheme and prevents universities charging students top-up fees.

Both Bills are essentially enabling and it will be the regulations set down by David Blunkett, the Education Secretary, that will establish the details. However, they represent a far-reaching reform of the education system.

Stephen Dorrell, Conservative education spokesman and Don Foster, Liberal Democrat spokesman, criticised the increase in centralisation and the extent to which the Secretary of State can intervene.

But Estelle Morris, education minister, said: "Schools doing well

should be left alone, but while a local education authority will need to encourage heads and governors to do even better, it will expect to focus its attentions on schools running into difficulties."

The teacher unions have given the Bills a guarded welcome, fearing the new measures will increase bureaucracy and workload for teachers. They are concerned about the removal of national pay and conditions in education action zones. There is also opposition to the new categories of school.

"The National Association of Schoolmasters Union of Women Teachers holds its head in despair at further structural reforms to the education service," said Nigel de Gruchy, its general secretary.

David Hart, general secretary of the National Association of Head Teachers, sees scope for tension between LEAs and all schools, not just the former GM sector.

The School Standards and Framework Bill receives its second reading in the House of Commons on December 22 and both will be in committee during the new year. ■

31. Times Educational Supplement

December 12, 1997

'Real maths' wins praise

A Government numeracy project has achieved 'staggering' results. Frances Rafferty reports

Nearly 40 per cent of the primary schools taking part in the National Numeracy Project are claiming outstanding results, a report submitted to the Government's Numeracy Task Force shows.

Children from these schools aged 10 and 11 (key stage 2) improved their results by 15 per cent using whole-class teaching and rigorous learning of the times

tables. And in 29 per cent of schools, six and seven-year-olds (key stage 1) also made substantial gains.

The interim report from the National Numeracy Project measures the progress 221 schools in England and Wales have made since the scheme started a year ago.

While on average all schools improved their results in 1997 by 1 per cent at key stage 1 and 8 per cent at key

stage 2, the project schools improved by 4 per cent at key stage 1 and 9 per cent at key stage 2.

With a high proportion of the project schools in disadvantaged areas and with twice the national average of children on free meals, statisticians have called the improvement "staggering".

The results are particularly encouraging for ministers who have

promised that 75 per cent of 11-year-olds will meet the expected standard by 2002. The numeracy project also uses much of the "traditional" approach favoured by both David Blunkett, the Education Secretary, and Chris Woodhead, the chief inspector. It is widely regarded as a major influence on the national numeracy strategy which the Government aims to unveil in the new year.

Anita Straker, director of the project, said: "It is very promising. We have only been going for a year, but results are evidently improving and lots of good practice is happening. The children seemed to enjoy the structure which gave them a sense of security. Some of them called it 'doing real maths'."

In many cases, however, the improvement still left them shy of the national average. In 12 project schools the results were worse than the previous year. This has been attributed to poor teachers, bad management and local problems. There was also some variation in the performances in different local authorities.

The numeracy project avoids the practice of children being taught in unstructured groups. The lesson starts with interactive whole-class teaching, with all children being expected to contribute. The class is then put into ability-based groups and given tasks. The session ends with a whole-class resum.

One of the report's more surprising findings was that girls did not do as well as boys, bucking the trend. Co-ordinators say they need to keep a check that girls play as active a role as boys in lessons.

Compared with white pupils with otherwise similar characteristics, pupils from black African, Asian and Chinese backgrounds did better.

The project also found schools which spent longer doing maths did better. Schools with more children on free school meals had lower scores - despite the improvement shown by some - and average scores tended to be higher in church schools. High pupil-teacher ratios had an adverse effect. But having a higher proportion of staff with maths degrees or pupils who had attended nursery school did not affect scores.

The report has been presented to the National Numeracy Task Force, chaired by Professor David Reynolds. The project's work mirrors that of a number of other schemes, such as one at Barking and Dagenham, which support interactive whole-class teaching.

Professor Reynolds is expected to deliver his task force report to the Government in the new year outlining the national numeracy strategy. Primary schools have been urged to teach maths for at least 45-50 minutes a day. A national year of numeracy is expected to be announced in 1999.

John O'Brien, headteacher of St William's RC primary, Bradford, said he had seen some outstanding results since joining the national numeracy project. He said: "We started with maths as a strength but knew we could do better. Mental skills have improved enormously and all the children achieved more than the standard expectation."

He said one disadvantage was the time needed for planning which skewed organisation of the rest of the curriculum. The children also spent more time learning maths.

He said "If we had to do the same amount of planning for literacy as well, I'm not sure we would have had enough time. We also benefited greatly from the extra money which allowed supply cover when staff were being trained, support from the project co-ordinator and extra, free materials," he said.

A network of 8,000 homework clubs will be established by 2001, David Blunkett, the Education Secretary, announced this week. They will be funded with £200 million from the National Lottery.

The Government is hoping for a mixture of homework clubs and other out-of-hours activities in 2,300 secondary, and 5,800 primary schools. The scheme is part of its attempt to address social exclusion. ■

LOCAL

32. Associated Press

12-15 4:49a

Island public schools to get \$2.1 million for computers

HONOLULU (AP) - The federal government has nearly doubled the amount of money it will give Hawaii's public schools for computer hardware, software and teacher training.

The U.S. Department of Education

said Sunday that island schools will receive \$2.1 million next year from the Technology Literacy Challenge Fund. Hawaii received \$1.1 million from the fund this year.

Diana Oshiro, assistant state schools

superintendent for information and telecommunications, said the increase was much more than expected.

In all, the 50 states will receive \$425 million from the fund this fiscal year, up from \$225 million last year. ■

The President
The White House
Washington, DC 20500

Dear Mr. President:

We are pleased to transmit the report of the interagency working group created in response to your Presidential Directive of March 6, 1997, on improving achievement in mathematics and science. Staff from the Department of Education and the National Science Foundation (NSF) have devoted the intervening time to developing an action strategy that builds on Federal programs -- in partnership with school, professional, business, and community organizations -- to invigorate teaching and learning based on widely-accepted, challenging national standards in mathematics and science.

The report both summarizes what the working group found and outlines a set of policy recommendations to support an action strategy. These basic policy recommendations were prepared within the 90-day timeframe of the Directive. However, we felt it was necessary for the agencies to go beyond a pure statement of policy in order to obtain the specificity important to convincing you and the public that we had developed an action strategy that would significantly strengthen the impact of Federal resources on improving achievement in mathematics and science. Thus, the report also contains a set of new joint activities to which we have committed our agencies that we believe will make a difference. We are already beginning to implement them.

The working group has focused their recommended action strategy on mathematics in grades 5-8 in the near term for reasons that are spelled out in the report. We concur with the need for focus at the early stages of the plan and with where the working group has chosen to place it. We also concur with the working group that it is imperative to broaden to all of mathematics and science at all grade levels over time. We suggest that there be a three-year focused effort on mathematics in grades 5-8, beginning in a preliminary way in FY 1998 with FY 1999 as the first year of full activity. There should be a gradual broadening from that central activity over the following five years.

The plan identifies three key priority areas for action in improving achievement in mathematics in grades 5-8: teachers, instructional materials and technologies, and public information and engagement. Addressing the first two areas requires that teachers, schools and districts make creative use of available resources in order to improve classroom practice in mathematics in grades 5-8. The third requires that we look beyond the classroom to the communities in which our students live.

Federal funds that could be used in addressing the classroom-based priorities largely flow to these schools and districts through three large formula-funded programs in the Department (Title I, Education for the Disadvantaged; Eisenhower Professional Development State Grants; and Goals 2000 -- together about \$8 billion) and through NSF's competitive programs (less than \$400 million total). The Department also provides a range of informational resources and technical assistance. In order to strengthen the impact of Federal funds, the action strategy proposes mechanisms that will provide schools and districts with incentives to pool resources for the purpose of improving achievement in mathematics in grades 5-8. In particular NSF and the Department will develop a program of competitive planning grants designed to jump-start intensive, coherent efforts to upgrade mathematics instruction that use Federal, State, and local funds to sustain long-term improvements and provide models for the future. The two agencies are also ready to embark on joint support for a campaign for public information and engagement.

Cover letter will change —
ED working on a revision

DRAFT
11/5

Comments on
this draft —
compare to
draft in
circulation

In grades 5-8 there are approximately 13.5 million students taught by about 320,000 teachers of mathematics. These students and teachers are found in about 34,000 schools in close to 15,000 districts. The report notes that the extent to which these groups can be served depends on the resources that can be devoted to targeted efforts. The joint program of competitive planning grants can be initiated within existing resources during FY 1998 and expanded somewhat in FY 1999, but its reach will be limited if it must rely on currently available budget resources. The public information and engagement campaign relies on building partnerships with the private sector that will extend the reach beyond what Federal funds will provide.

In order to make this a fully national strategy, we recommend that resources be made available in FY 1999 and beyond to enable the agencies, through the planning grants and other mechanisms, to stimulate activities aimed at improving mathematics instruction and achievement in grades 5-8 in 20-30% of all districts, that is about 3,000 to 4,500 districts. We recommend seeing a significant fraction of those districts through the implementation phase so that there is a set of successful models for other districts to emulate. In the FY 1999 budget process, both the Department and NSF have requested new funding to permit this scope of activity. The additional funds requested amount to about one percent of the \$8.4 billion of funds that could be affected this effort. We anticipate that there will be significant pooling and focusing of Federal resources that will strengthen their impact as felt in the classroom through this joint activity.

Thank you for providing the stimulus for the closer working relationship and exciting undertaking represented by the accompanying action strategy. We stand ready to assist you in your deliberations about implementing the strategy.

(To be signed by Riley and Lane)

AN ACTION STRATEGY FOR IMPROVING ACHIEVEMENT IN MATHEMATICS AND SCIENCE

EXECUTIVE SUMMARY

On March 6, 1997, the President issued a memorandum (Appendix 1) directing the Secretary of Education and the Director of the National Science Foundation to form an interagency working group to develop an action strategy for using Federal resources to assist States and local school systems in preparing students to meet challenging mathematics standards in the eighth grade, and for involving the mathematical, scientific, and technical communities in support of those efforts.

The Presidential directive specified that the action strategy include recommendations for the use of Federal resources to help States, local school districts, and schools improve teaching, upgrade curriculum, integrate technology and high-quality instructional materials into the classroom, and motivate students to help them understand how mathematical concepts are applied in today's global workplace. The directive called for the interagency group to review the status of improvements in mathematics education and identify critical needs, drawing on research and input from educators and professional organizations. In addition, it called for the working group to review how Federal resources and partnerships with other organizations can help improve student achievement in science.

The request was based in part on results of the Third International Science and Mathematics Study (TIMSS), which demonstrated a clear need to focus on improving mathematics achievement in grades 5-8. The President's proposed voluntary national test in mathematics at grade 8 provided an additional stimulus. The action strategy targets mathematics in grades 5-8, building on a strong foundation of activity underway across the country to improve elementary and secondary mathematics and science education.

The action strategy:

- Challenges the Department of Education and the National Science Foundation to work together more closely and to partner with other Federal agencies and with State and local educational agencies to strengthen the impact of Federal investments in mathematics and science education.
- Challenges State and local level school superintendents, mathematics supervisors, school boards, principals and other educators to take a fresh, critical look at curricula, instructional materials, and professional development strategies (and the use of Federal resources in these areas) in light of TIMSS and other recent research results and to be prepared, as needed, to reformulate current approaches to improve effectiveness.
- Challenges the nation's colleges and universities to develop rigorous new programs for teacher preparation, stressing both subject matter expertise and pedagogical mastery. These institutions will also need to take a far more active role in enhancing the skills and knowledge of today's teachers, working closely with States, local school districts, and schools in the process.

- Challenges professional organizations in mathematics, science, engineering and technology to partner with schools, parents, students, community organizations, and business and industry in developing a strong network of local partnerships aimed at raising student achievement.
- Challenges U.S. families to provide strong support and encouragement for their children to reach high standards of achievement in mathematics and science.

Based on the Federal role in improving achievement in K-12 education, the priorities of the action strategy will focus Federal investment on:

- Assisting States, local school districts, and the nation's colleges and universities to provide the skills and knowledge that **equip teachers in grades 5-8 to teach challenging mathematics** content in effective ways, with high expectations for their students;
- Assisting States and local school districts to **select and implement high-quality, standards-based curricula and instructional materials**, including effective use of educational technologies; and
- **Building public understanding** of challenging mathematics in grades 5-8, and **gaining public support** for raising student achievement toward high standards.

The bulk of the Federal resources for improvement in K-12 mathematics and science education flows from the programs of the Department of Education and the National Science Foundation. Developing a coherent approach to strengthening the impact of Federal resources used to improve mathematics achievement in grades 5-8 begins with these programs. Drawing on the resources of other Federal agencies in an effective manner can then follow.

The Department of Education and the National Science Foundation plan a set of joint activities that are the synergy-producing elements of the action strategy. These include:

- Competitive planning grants to accelerate strategic use of resources in improving achievement in mathematics;
- National Convocation on middle school mathematics;
- [The Public Understanding and Engagement Mathematics Initiative,] a mechanism to involve the public more directly in mathematics education;
- Coordinated research and informational activities; and
- Systematic involvement of other agencies.

Other elements of the action strategy draw on the individual strengths of Federal agency programs aimed at improving mathematics education.

The time is ripe for a concerted effort to improve the achievement of U.S. students in mathematics and science. By focusing our immediate attention on improving performance for middle school mathematics, we will be able to give local, State, and Federal educational agencies a target for action that is substantive, timely, and sufficiently ~~constrained~~ that it is reasonable to anticipate progress. As well as addressing an area of current concern, we can develop models for future action across disciplines and grades.

Focused

development of *Make the action strategy is implemented.*
 But the action strategy is only the beginning of the effort. The interagency cooperation must continue and ~~move to the substantive agenda of implementation.~~

assign The Department of Education and the National Science Foundation are committed to meeting the challenge of continuing cooperation so that their programs work in concert. They will ~~enable the~~ *are also committed to* development of appropriate mechanisms to keep other agencies and the professional scientists, mathematicians and engineers with whom they work *to be actively and effectively* ~~actively involved in~~ improving achievement in mathematics and science education. ~~Perhaps most importantly,~~ *they will* keep the goal of raising the achievement of all American students in mathematics and science at the forefront of their attention.

ultimately, all partners in this effort must

AN ACTION STRATEGY FOR IMPROVING ACHIEVEMENT IN MATHEMATICS AND SCIENCE

I. INTRODUCTION

On March 6, 1997, the President issued a memorandum (Appendix 1) directing the Secretary of Education and the Director of the National Science Foundation to form an interagency working group to develop an action strategy for using Federal resources to assist States and local school systems in preparing students to meet challenging mathematics standards in the eighth grade, and for involving the mathematical, scientific, and technical communities in support of those efforts.

The Presidential Directive

The Presidential directive specified that the action strategy include recommendations for the use of Federal resources to help States, local school districts, and schools improve teaching, upgrade curriculum, integrate technology and high-quality instructional materials into the classroom, and motivate students to help them understand how mathematical concepts are applied in today's global workplace. The directive called for the interagency group to review the status of improvements in mathematics education and identify critical needs, drawing on research and input from educators and professional organizations. In addition, it called for the working group to review how Federal resources and partnerships with other organizations can help improve student achievement in science.

The Need for Action

The Third International Mathematics and Science Study

The need for this effort to improve mathematics and science education in eighth grade was made clear by the Third International Mathematics and Science Study (TIMSS).

Results of tests administered in 1995 to students in grades 4 and 8 are now available. The fourth grade results show U.S. students above the international average in both

The Third International Mathematics and Science Study (TIMSS)

TIMSS is the largest and most ambitious of a series of international comparative studies of educational achievement. The Department of Education and the National Science Foundation sponsored the U.S. testing, conducted in 1995 at grades 4, 8, and 12, and the subsequent analysis.

TIMSS involved more than half a million students in 45 countries. 30,000 U.S. students took part. While the relative performance of U.S. students in comparison to students of other countries improved over performance on similar international comparisons of earlier years, there were signs of problems, particularly at grade 8. U.S. students performed above average at grade 4 and below average at grade 8 in mathematics, the only country with such a pattern in either science or mathematics. Grade 12 results will be announced shortly. *not spring.*

While collecting achievement data in each participating country, TIMSS researchers also developed a wealth of information about teachers and teaching, about curricula and instructional materials, about classroom lessons and interactions, and about student attitudes and habits outside the classroom. For example, TIMSS results show that:

- US student performance increases more slowly between elementary and middle school years than in most other countries;
- The U.S. curriculum is not as well focused on topics that would propel students toward more advanced levels of understanding as are curricula in other countries;
- U.S. teachers work longer hours, have less time during the day for preparing classes, and experience more disruption in their classrooms than do their counterparts in other countries.

Thus the TIMSS results have become a source of constructive motivation for mounting an action strategy, taking the issue well beyond the simple comparison of scores in international test taking.

science and mathematics. In science, U.S. students were outperformed only by those in Korea. However, the eighth grade results show lackluster performance by U.S. students, with scores only a bit above the international average in science, and below the international average in mathematics.

TIMSS results for the fourth grade are much more positive than the results of similar international comparisons in the past. They demonstrate that it is possible to make significant progress in international comparisons over time, and that U.S. students can compete favorably with those of other nations in mathematics and science achievement. Our National Education Goals proclaim our dedication to making U.S. students first in the world in mathematics and science achievement by the year 2000. In the early grades, we are making demonstrable progress toward that goal. These results clearly indicate that mathematics and science education in the middle school years should be an important focus for national efforts to help ensure that our students meet world-class standards.

Opportunities for the Future

Eighth grade is a critical point in mathematics education. Achievement at that stage lays the foundation for students to take the advanced high school mathematics and science courses that are keys to college entrance and well-paid jobs. Today, too many students enter high school without this solid grounding in mathematics and, unfortunately, they never gain it, closing doors to opportunities for the future. Often students and their families do not even know that the doors are closing, leading to a mismatch between their expectations for the future and their actions in the present. This is particularly true for students from disadvantaged backgrounds. It is a factor in perpetuating inequities both in participation in advanced education and in lifetime income.

A Voluntary National Test in Mathematics

The President has proposed a voluntary national test in mathematics, to be taken near

the end of eighth grade, as a very visible part of an ambitious, sustained drive for higher, more challenging standards of learning for all students. The test will be based on the framework of the National Assessment of Educational Progress (NAEP). It will be available by the spring of ~~1999~~ ²⁰⁰⁰. Parents and teachers will receive an individual score for each student who takes the test. That score will be linked to national and international benchmarks, in order to provide additional context for parents, teachers and students. For more information, see Appendix 2.

The voluntary national test is only one element of the comprehensive effort needed to accomplish the objective of having all students achieve challenging national standards for performance. This effort will require many individuals -- students, parents, teachers, and community leaders -- working in concert with a common understanding of what they want to see happen. The test, in combination with a national effort to boost achievement, will provide a powerful lever to amplify the effects of existing efforts at local, State, and national levels to improve student achievement in mathematics and science.

Plan of Action: Place Immediate Focus on Mathematics

The TIMSS results show the need for an immediate focus on mathematics education in grades 5-8, where the serious drop from above to below international norms threatens achievement in both mathematics and science at higher grade levels. The President's proposed national voluntary test in mathematics in eighth grade provides a tool to measure progress and also challenges us to provide students with the mathematics in grades 5-8 that will enable them to perform well on it. The National Council of Teachers of Mathematics (NCTM) has developed sets of standards for content, teaching, and assessment that provide a strong footing for standards-based instruction.]

The action strategy targets grades 5-8, building on a strong foundation of activity underway across the country to improve elementary and secondary mathematics and science education. It ^{requires} ~~requires~~ that these

activities continue, at all levels in both mathematics and science, and lays the ~~groundwork~~ ^{foundation} ~~in both substance and process~~ for expanded activities in the future.

Raising Achievement for Disadvantaged Students

Efforts to raise student achievement in mathematics and science must be particularly intensive in high-poverty communities and schools. The National Assessment of Educational Progress (NAEP) in mathematics shows that students from poor families perform significantly less well than other students. In 1996, the average score on the 500 point NAEP scale was 252 for 8th graders who are eligible for free and reduced price lunch as compared to 280 for ineligible students. Students from poor families are also less likely to take algebra, geometry, and more advanced courses in high school.

On July 25, 1997, fifteen urban school districts, including the nation's three largest, pledged to participate in the voluntary national test. They sent a clear signal that students in inner city schools can and should be held to the same challenging standards that are being set for all students throughout the nation. These communities recognize that setting high standards is a prerequisite for improved teaching and learning. Research and experience shows that ^{all} ~~virtually~~ students can meet high standards, and that low expectations lead to low achievement.

Challenges for All Parties

The goal of the action strategy is for all American students to leave eighth grade prepared to pursue the higher-level mathematics and science courses that are the gateway to college, productive employment, lifelong learning, and effective citizenship. Reaching this goal will require action in five areas:

- High expectations, held by teachers, school administrators, parents, and students themselves, for student performance in mathematics and science;

- Challenging standards for content of curriculum, teaching, assessment, and student achievement;
- Instructional materials and technology of high quality that incorporate these challenging standards;
- Teachers with the pedagogical skills and rigorous knowledge of mathematics and science needed to teach these subjects effectively; and
- Activities outside the classroom that reinforce the classroom experience by drawing on the support of parents, the professional communities of mathematicians, scientists, and engineers, business leaders, and the broader public.

Thus, the action strategy:

- Challenges the Department of Education and the National Science Foundation to work together more closely and to partner with other Federal agencies and with State and local educational agencies to strengthen the impact of Federal investments in mathematics and science education.
- Challenges State and local level school superintendents, mathematics supervisors, school boards, principals and other educators to take a fresh, critical look at curricula, instructional materials, and professional development strategies (and the use of Federal resources in these areas) in light of TIMSS and other recent research results and to be prepared, as needed, to reformulate current approaches to improve effectiveness.
- Challenges the nation's colleges and universities to develop rigorous new programs for teacher preparation, stressing both subject matter expertise and pedagogical mastery. These institutions will also need to take a far more active role in enhancing the skills and knowledge of today's teachers, working closely with States, local school districts, and schools in the process.

- Challenges professional organizations in mathematics, science, engineering and technology to partner with schools, parents, students, community organizations, and business and industry in developing a strong network of local partnerships aimed at raising student achievement.
- Challenges U.S. families to provide strong support and encouragement for their children to reach high standards of achievement in mathematics and science.

These challenges are focused on the immediate, urgent need to improve mathematics education in grades 5-8. But be fully effective, this effort must ~~broaden to include~~ both mathematics and science in all grades once the immediate needs have been addressed.

to
ultimately
encourage

II. PRIORITIES FOR ACTION

Consistent with the President's directive, this action strategy identifies steps that Federal agencies, along with their partners, can take to help students reach challenging standards in mathematics in grades 5-8 and to ensure that Federal resources will effectively support State and local reforms. It is based on the efforts of the interagency working group, which reviewed the current state of mathematics education, consulted with other Federal agencies and with outside organizations, and reviewed Federal programs before identifying three priority areas for action. (See Appendices 3-6 for more detailed information.)

The Federal Role

While education is a national priority, it is primarily a State and local responsibility. The Federal role is to provide good information, effective tools, and financial support that will assist States and local communities in ensuring that all of their students have the mathematical skills they need to succeed in the workplace as productive citizens. This includes promoting effective partnerships that mobilize support from the community -- students, parents,

educators, business leaders, volunteers, and concerned citizens from all walks of life -- to that end.

Priorities for Action

Therefore, the priorities of this action strategy will focus Federal investment on:

- Assisting States, local school districts, and the nation's colleges and universities to provide the skills and knowledge that **equip teachers in grades 5-8 to teach challenging mathematics** content in effective ways, with high expectations for their students;
Assisting States and local school districts to **select and implement high-quality, standards-based curricula and instructional materials**, including effective use of educational technologies; and
- **Building public understanding** of challenging mathematics in grades 5-8, and **gaining public support** for raising student achievement toward high standards.

Scope and Scale

In grades 5-8 there are approximately 13.5 million students taught by about 320,000 teachers of mathematics. These students and teachers are distributed among 34,000 schools in close to 15,000 districts. Many of these schools and districts are already actively involved in setting high standards for instruction and student achievement and are implementing plans to achieve them.

The core of this action strategy is assisting all schools and districts to make more effective use of Federal resources in their efforts to address ~~these~~ priorities with respect to mathematics in grades 5-8. The Department of Education and the National Science Foundation ~~will provide~~ opportunities for districts to accelerate their progress toward improved achievement in this area through incentives for enhanced coordination, planning, and implementation. Districts that

the above

plan to

serve large numbers of disadvantaged students will receive particular attention. The number of districts, schools, teachers, and students served will depend largely on the level of resources that can be devoted to the acceleration effort and the readiness of districts to respond.

At the same time, an effort at public information and engagement ^{will} provides a much-needed ~~alternative~~ mechanism to reach a broader base of students and their parents ^{in a more timely fashion than can be accomplished through these core activities.} The participating Federal agencies, with their ties into the science, mathematics, engineering, and technology communities, are well-positioned to encourage these communities to ~~cooperate in~~ ^{help} spurring such an effort.

*somewhat
unhelpful
flow.*

Finally, it is not enough to address only today's teachers and implementation of instructional materials and technologies available now. Approximately 30,000 new teachers of mathematics in grades 5-8 are needed each year. At the same time, development of learning technologies is extremely rapid, and adaptation of curricula to accommodate this pace is a continuing concern. Addressing these issues is also an important part of the action strategy.

Progress in any one of the three priority areas -- teachers, instructional materials and technology, and public information and engagement -- will often depend on and demand improvement in others. For instance, the introduction of high-quality instructional materials will have little impact if teachers are not trained to use those materials effectively. The action plan must work on all fronts in order to make progress toward improved student achievement. The action plan below first provides an orientation to existing resources and specific new joint activities. The final sections are organized around the three priority areas.

III. ACTIONS TO STRENGTHEN THE IMPACT OF FEDERAL RESOURCES

The bulk of the Federal resources for improvement in K-12 mathematics and science education flows from the programs of the Department of Education and the National Science Foundation. (See Appendix 3 for a summary.) Developing a coherent approach to strengthening the impact of Federal resources used to improve mathematics achievement in grades 5-8 begins with these programs. Drawing on the resources of other Federal agencies in an effective manner can then follow.

Current Federal Resources

In FY 1997, the National Science Foundation invested \$377 million in K-12 science and mathematics education, including investments in the undergraduate preparation of teachers. The funds go largely to colleges and universities, State and local educational agencies, and nonprofit organizations. They are awarded through competitive review of proposals for funding of specific projects. Over the past few years, the Foundation has placed a high priority on system-wide reform of mathematics and science education. It asks local and State educational agencies to align resources of all types, including those obtained through other Federal programs, to effect change. The Foundation highlights specific areas of emphasis within broader programming, establishes clear priorities for funding within the criteria for selection of awards, and holds grantees accountable for performance. Over the years, projects aimed specifically at mathematics in grades 5-8 have been comparatively scarce.

The Department of Education allocated approximately \$8 billion in FY 1997 through three major formula-driven programs: Goals 2000; Eisenhower Professional Development State Grants; and Title I: Education for the Disadvantaged, that include improved achievement in mathematics and science among their objectives. Goals 2000 aids States and school districts to develop and implement challenging academic standards and upgrade teaching and learning in order to

reach the National Education Goals, including the goal of becoming first in the world in mathematics and science. The Eisenhower program places an explicit focus on science and mathematics. Of the \$310 million appropriated for FY 1997, \$250 million was required to go to mathematics and science.

The 1994 reauthorization of Title I placed new emphasis on helping disadvantaged students meet the same challenging academic standards expected of all children. States are currently developing standards and standards and assessments in reading and mathematics consistent with that emphasis. The Department of Education works actively with States and school districts on identifying actions that can be taken to achieve significant change, provides information and examples, and makes technical assistance available as needed.

Title I Schoolwide Programs

The 1994 reauthorization of Title I gave the program an entirely new purpose, namely, to teach disadvantaged students to the same high standards to which all other students are held. States are now in the process of establishing assessment mechanisms to measure students' progress against such standards, in at least reading and mathematics. In addition, the reauthorization lowered the eligibility threshold for Title I schoolwide programs. Schools with at least a 50 percent child poverty rate may now use their Title I funds (along with other Federal, State, and local funds) to make comprehensive improvements in the instructional program of the entire school, rather than providing discrete services to individual children. This change gives those schools the flexibility, for instance, to use Title I funds to upgrade the mathematics curriculum for all students.

A dozen other departments and agencies sponsor activities that relate to, and could promote, standards-based education that improves students' mathematics and science learning and overall academic performance. In general, these agencies focus far more on science than mathematics, and commit

modest resources to improving K-12 education. Most offer staff and facilities, often on a volunteer basis, to support local schools and teachers. And all have developed and are sharing supplementary instructional materials on their Web sites.

Mathematics Education and the Department of Defense

Two agencies within the Department of Defense (DoD) offer complementary approaches to introducing rigorous national standards in their educational activities.

The DoD Education Activity (DoDEA) provides education for military and civilian dependents overseas (DoD Dependents Schools or DoDDS) and on some military bases in the U.S. (DoD Domestic Elementary and Secondary Schools or DDESS). DoDDS is essentially an autonomous school system that has developed a mathematics curriculum based on the NCTM standards, adopted standards-based instructional materials for use throughout all the overseas schools, and is continually training teachers in these materials and strategies using teacher-leaders. DDESS schools operate independently and cooperate with local education areas in addressing standards. As the DoDEA structure evolves, there will be system-wide commonality in curriculum, instructional materials, and student assessment aligned with the NCTM standards.

The National Security Agency established a Mathematics Education Partnership Program (MEPP) in 1991. MEPP sponsors over a thousand talks per year to schools and colleges through its Speakers Bureau. It donates excess computers to classrooms, sponsors seminars and inservice teacher training, and conducts extended summer workshops for teachers at all levels. These MEPP activities, including projects such as collaboration with the University Corporation for Atmospheric Research's *Project SkyMath*, are all informed by the NCTM Standards, which are an explicit subject of study and reference at MEPP's Summer Institutes for Teachers. For a description, see www.nsa.gov.8080/programs/mepp.

Strengthening the Impact of Federal Resources

Using Existing Programs

[The first step in moving forward] is to make the most of existing programs aimed at improving student achievement through standards-based education across all subject areas and all grade levels. Such programs provide a fundamental level of information and opportunity important for progress, but currently have limited focus on mathematics in grades 5-8.

Within those existing programs, the participating agencies will promote means of emphasizing mathematics in grades 5-8. For example, the competitive programs at the National Science Foundation can incorporate priorities for work in this area in selection criteria, and the Department of Education can enhance the level of technical assistance it provides to State and local educational agencies. Expanding the scale of such programs will also help, as will the development of new programs in the individual agencies, but issues of scope and synergy remain.

Creating Synergy

The programs of the Department of Education and the National Science Foundation have different approaches and strengths. The Department generally provides large-scale, flexible support directly to State and/or local educational agencies for improving teaching and learning to high standards, coupling this support with technical assistance. NSF's portfolio is much smaller in scale, is targeted at improving mathematics, science, and technology education, and is established through competitive processes. To create synergy, this action strategy combines the agencies' strengths, permitting those involved with upgrading mathematics professional development and instruction through major Department of Education programs to draw on NSF's competitive programs to step up the pace of change.

The work of improving student achievement must be done at the State and local level, and,

most fundamentally, within individual schools. State and local educational agencies can maximize the impact of Federal resources by choosing to use them in a coordinated, concentrated way. Thus, the National Science Foundation and the Department of Education will champion State and local educational agencies in the strategic use of all types of Federal, State and local funds toward improving mathematics achievement, offer examples of effective coordination in the use of such funds, and provide incentives to initiate effective improvements. At the same time, they will work together to encourage the nation's colleges and universities to do a better job in educating future teachers for the work they will do in the schools and will combine with other agencies in a broad program of public information and engagement.

Pooling Resources to Enhance Student Achievement

Kenton Elementary School in Portland Oregon, and 12 other schools in the region decided to place a high priority on student achievement using Title I and other resources. During the 1995-96 school year, the schools held full-day, weekly workshops on best teaching practices as identified by the school principals. The principals developed a regional Title I plan and, with the help of consultants, have all staff working together to implement it. Title I staff worked with regular classroom teachers on new strategies, and Kenton staff agreed to use Title I benchmarks and assessments for all students.

Kenton's curriculum emphasizes interactive writing and vocabulary development, and uses innovative mathematics materials. Teachers use cooperative learning and peer tutoring to help students grow toward proficient and advanced levels, and students are encouraged to analyze, evaluate, and interpret information. Kenton teachers regularly meet with small groups of students outside of class to give extra help in mathematics, reading, or writing. Teachers also train the school's many volunteers to support the benchmarks while working with students. Assessments indicate some success in the early years of this effort to improve instruction. The percentage of third-graders scoring in the advanced category in mathematics increased from 15 percent to 35 percent.

New Joint Activities

The Department of Education and the National Science Foundation plan a set of joint activities that are the synergy-producing elements of the action strategy. They will include the other participating agencies to the extent possible.

- **Competitive planning grants to accelerate strategic use of resources in improving achievement in mathematics.**

The Department and the Foundation jointly will provide competitive planning grants to jump-start intensive, coherent efforts to upgrade mathematics instruction that use Federal, State, and local funds to sustain long-term improvements and provide models for the future. Funds may be used to initiate planning and to contribute toward one-time costs of initiating a coherent set of activities. A principal target for the agencies' cooperative activities will be middle schools with schoolwide Title I programs and districts with many such schools. This focus permits large numbers of disadvantaged students to benefit from the enhanced synergy of Department and Foundation programs.

To support the joint effort, the Department of Education will provide active encouragement and support, opportunities to pool resources originating in the Department through waivers for consolidated programming, and information and technical assistance, as appropriate. The National Science Foundation will emphasize support for development and implementation of State and local strategies for improving mathematics education in grades 5-8.

The Department and NSF will convene a national conference of key actors in determining how Federal resources are used by States and local districts. Participants will include state and local leaders of Title I, Goals 2000,

Eisenhower, and State, urban and rural systemic initiative activities.

Texas Statewide Systemic Initiative

The NSF-supported Texas Statewide Systemic Initiative (SSI) also operates the U.S. Department of Education's Comprehensive Assistance Center for Elementary and Secondary Act Programs in Texas, bringing into one unit the state's leadership both in science and mathematics education and in Title I technical assistance. In the past two years, the SSI has provided incentive grants and technical support in integrating their Title I, Eisenhower, and professional development activities in mathematics and science to more than 100 Title I schools serving more than 100,000 Title I students. In July, 1995, the SSI held an intensive summer institute designed to support Title I schools in (1) reconceptualizing the use of formula funds, (2) adopting standards-compatible mathematics curricula, and (3) adopting effective schoolwide program models. As a result of the SSI/Title I collaboration, state mathematics and science leaders are now active members of school support teams engaged in mentoring over 700 Texas Title I schools. At the same time, increasing numbers of teachers in high poverty/high minority schools are being trained as SSI mathematics, science, and technology specialists.

- **National Convocation on middle school mathematics.**

The two agencies will sponsor a national convocation on middle school mathematics to initiate a continuing dialogue on what students need to know and what this means for effective classroom practice.

- **Public Understanding and Engagement Mathematics Initiative.**

NSF and the Department will support a joint, multi-year effort to create a large-scale, national public education effort that is coupled with extensive opportunities for active engagement of students, parents, and the larger community in the support of mathematics education.

- **Coordinated research and informational activities.**

The Department and NSF will undertake a coordinated set of research and informational activities around mathematics in grades 5-8. These activities include release of a TIMSS resource kit that contains specific tools for professional development, curriculum analysis, and achievement benchmarking; readministering TIMSS in the spring of 1999 to get updated information on our international standing; a program of research informing continued development of the eighth grade national test over time; and a sustained agenda of basic research in teaching and learning of mathematics, including research on the use of learning technologies.

- **Systematic involvement of other agencies.**

The Department and the Foundation will work systematically with other agencies to enhance the impact of Federal resources by upgrading their activities to reinforce a standards-based approach for mathematics in grades 5-8.

Each of the specific items above will be aimed at mathematics in grades 5-8, reflecting the urgent need to raise achievement at this stage of the educational process. However, the activities described above can also serve as models for more effective approaches to educational change in the broader arena of mathematics and science education. The working group strongly endorses the idea of future efforts that would encompass additional aspects of K-12 mathematics and science education.

PRIME in Pittsburgh

The Pittsburgh Reform in Mathematics Education (PRIME) project supports teachers in the classroom implementation of standards-based mathematics instruction and assessment in grades K-12 through the use of exemplary materials. PRIME provides teachers with a broad knowledge base in both the mathematics content and the successful mathematics pedagogy needed to implement the new materials successfully.

Funded under National Science Foundation guidelines as a project of *Local Systemic Change through Teacher Enhancement in Mathematics*, PRIME provides all 924 Pittsburgh public school teachers of mathematics with a range of experiences that include summer workshops; release-day professional development workshops; and individualized, in-class support provided by demonstration teachers within each school. Teachers of grades 6-12 receive 234 hours of professional development, and teachers of grades K-5 receive 102-132 hours. By equipping *all* Pittsburgh mathematics teachers with the knowledge, skills, and support necessary for using exemplary materials and assessment, PRIME is designed to ensure that *all* students experience a coherent mathematics program that is expected to yield high achievement at *all* levels.

This four-year project, funded for over \$ 3 million, is a model for its ability to leverage an additional \$ 6.7 million in cost-sharing from district funds and commitments from Eisenhower and other Federal dollars.

IV. EQUIP TEACHERS TO TEACH CHALLENGING MATHEMATICS

In grades 5-8, students should begin to move from mastering the basics of arithmetic to using arithmetic in complex problems and learning the foundations of geometry, algebra, probability, and statistics. Teachers must know substantial mathematics and have strong pedagogical skills if they are to be effective in helping their students make this transition and meet high standards. Practices in teacher education, licensure and certification, and in-service teacher enhancement do not always reflect these needs.

Over the next ten years, approximately 2 million new teachers will enter the workforce. It is essential that these future teachers receive adequate preparation in mathematics content and pedagogy and in the use of contemporary technological tools before they enter the classroom. And many of the approximately 320,000 teachers who are already teaching mathematics in grades 5-8 would benefit from upgrading their math content knowledge and teaching skills.

Quantitative Literacy Program for Alabama K-12 Teachers

The Quantitative Literacy Program for Alabama K-12 Teachers, a project administered by the University of Alabama and supported by the Eisenhower Professional Development program, assists elementary and secondary teachers in implementing the probability and statistics goals for grades K-12 as outlined in the National Council of Teachers of Mathematics standards. The program's workshops teach quantitative concepts in the context of solving meaningful problems, with content taught in reference to teaching strategies that participants use when they return to their classrooms. The program includes a pre-workshop orientation, an intensive one-week training workshop, and two follow-up sessions. In the follow-up sessions, teachers describe how they planned, taught, and assessed their own Quantitative Literacy units. They also present examples of their students' projects. The project is currently operating in 14 of the 67 counties of the State.

This action strategy addresses both the professional development of teachers who are already in the classroom and the preparation of new teachers. In order to assist current teachers, the strategy promotes sustained and intensive professional development activities that are based on mastery of mathematical content and tied to high-quality instructional materials and technology. Teacher preparation activities will aim at preparing future teachers of grades 5-8 to teach effectively the challenging mathematics content geared to national standards of excellence.

The increased demand for high-quality professional development generated by these plans could, without action now, exceed the capacity of those individuals and organizations currently supplying it. Thus, an essential component of fully equipping teachers will be ensuring the presence of a sufficient cadre of individuals and institutions skilled in providing professional development. This will require working with the mathematics communities, institutions of higher education, and other Federal agencies to help ensure the capacity to respond effectively.

To address **professional development needs of current teachers**, the National Science Foundation and the Department of Education will:

- Stimulate state and local educational agencies to implement comprehensive programs of sustained, intensive, high-quality professional development for teachers of mathematics in grades 5-8. The two agencies will make such efforts the cornerstone of their new competitive planning grants, with emphasis on incorporating resources from Title I schoolwide programs and on involving all teachers in target schools. They will continue existing programs that provide resources for districts to implement professional development programs, incorporating priorities for activities involving teachers of mathematics in grades 5-8, where feasible.

- Initiate a short-term effort to strengthen the pool of talented, committed individuals able to provide exemplary professional development for classroom teachers. The agencies will provide opportunities for competitive support of projects that will provide intensive training experiences for those who will lead future teacher training efforts.
- Support the creation of materials for professional development of teachers of mathematics in grades 5-8 that are grounded in the NCTM standards, tied to newly emerging educational materials and technologies, and assist teachers to link mathematics to real-world skills and applications.
- Support wider opportunities for teachers to help one another with content knowledge and teaching skills through such activities as dissemination of information about effective forms of professional development and encouraging the development of master teachers (including those recognized through the Presidential Awards for Excellence in Mathematics and Science Teaching and the National Board for Professional Teaching Standards Certification), mathematics specialists, and teacher networks.

To promote **improved preparation of future mathematics teachers for grades 5-8**, the Department of Education and the National Science Foundation will:

- Prepare and disseminate widely a study on State licensure requirements, focusing particularly on requirements for middle school teachers of mathematics, comparisons to other nations, and the impact of licensure requirements on the knowledge of mathematical concepts that teachers bring to their work in the classroom.

Improving Teaching Through Distance Learning

The Department of Education's Star Schools Program provides quality, cost-effective instruction through distance education technologies to more than 1,640,000 learners annually in 50 states and U.S. territories. Although the program began with small rural schools in 1988, it is now equally valuable to schools in large urban areas.

The *Star Schools: The Next Generation* project of Oklahoma State University and Northern Arizona University delivers the "Getting Ready for Algebra" program, which provides simultaneous student instruction and teacher training to middle school students and teachers. Its units are student-centered and activity-oriented and emphasize learning by discovery. They focus on the big ideas common to arithmetic and algebra.

Similarly, the United Star Distance Learning Consortium project, led by Education Service Center-Region 20 in San Antonio, Texas, offers the *Algebra and Geometry Applications for Teachers* program, inservice training. The project models worthwhile mathematical tasks and helps teachers improve their ability to develop these tasks. The focus of the project is on mathematical topics that illustrate connections to real-life problems and exciting mathematics.

- Provide incentives for appropriate organizations to develop voluntary national standards for the preparation of teachers of mathematics.
- Support the development of materials for preparation of K-8 mathematics teachers that are grounded in the NCTM standards and tied to newly emerging instructional materials and educational technologies.

- Challenge the Nation's colleges and universities to step up to the needs for preparing a new generation of teachers for the 21st century by encouraging, supporting, and funding the development of teacher preparation approaches that:
 - more tightly link college departments of mathematics and schools of education;
 - include courses focusing on developing the background concepts for the rigorous mathematical content that future teachers of mathematics in grades 5-8 will teach;
 - demonstrate effective classroom practices; and
 - involve local K-12 schools in the design of teacher preparation requirements.

New Initiatives in Teacher Preparation

President Clinton has proposed a \$350 million initiative to attract talented people of all backgrounds into teaching at low-income schools across the U.S., and to improve dramatically the quality of training and preparation given to our future teachers, with an emphasis on mathematics and reading. Under the initiative, new scholarships would help bring nearly 35,000 outstanding new teachers into high-poverty schools in urban and rural areas over the next five years. These scholarships could cover costs of tuition, room, board, and other teacher preparation expenses -- and could help fund additional preparation during the first two years of teaching.

The initiative will also provide competitive five-year grants to 10-15 national lighthouse models of excellence -- institutions of higher education that operate the highest quality teacher education programs. Each institution receiving a lighthouse grant will use most of these resources to assist several other institutions of higher education improve their teacher preparation programs, helping to strengthen the preparation of future teachers at an estimated 150 institutions of higher education across the nation.

Teacher Preparation in Louisiana

What began as a movement to change the way mathematics is taught in grades K-8 in the Louisiana State Systemic Initiative has grown into a program that addresses the way in which teachers are taught. The NSF-funded Louisiana Collaborative for Excellence in the Preparation of Teachers is producing future teachers who will transform teaching practice in the state.

In the first three years of the program, over 100 college faculty (both mathematics faculty and education faculty) on 15 campuses across the state have been involved in the project, 69 courses for future teachers have been revamped, and approximately 20,000 future teachers have been affected.

The central principle is to incorporate in the education of future teachers the new methods of teaching mathematics that they will be expected to implement in the classroom. Examples of these methods include working in small groups on challenging problems and using technology resources such as calculators or the Internet.

V. IMPLEMENT CURRICULA, INSTRUCTIONAL MATERIALS, AND EDUCATIONAL TECHNOLOGIES IN CLASSROOMS

The TIMSS results showed that the content of curricula and instructional materials used in U.S. classrooms in the middle school years in 1995 differed from those in high performing countries in significant ways. The content taught in most U.S. eighth-grade mathematics classrooms would be found in the seventh grade in high-performing nations. Our low expectations for student performance are also shown by the fact that only about 25 percent of U.S. eighth grade students are enrolled in algebra courses, while in high-performing nations virtually all students have the opportunity to master the foundations of algebra and geometry by the end of eighth grade.

In addition, TIMSS noted that middle school mathematics materials covered more topics and were less focused in the U.S. than in leading countries. For example, typical American eighth grade mathematics textbooks in 1995 covered as many as 35 major topics compared to as few as 10 such topics in Japanese textbooks, leaving little time for teaching for student mastery and depth of understanding.

New, comprehensive mathematics instructional materials, linked with high standards for mathematical content and pedagogy and aligned with the NCTM standards, are now emerging from development and reaching the market. These materials provide a range of different approaches to classroom instruction, while focusing on 15 or fewer topics per year.

Supplementary materials can permit teachers to tailor instruction to particular classrooms, facilitating the transition to new curricula. They can be particularly helpful in taking advantage of new and emerging learning technologies and in providing examples from real life for new concepts.

Selection of comprehensive curricular materials usually takes place at the district or even the State level, whereas the choice of

supplementary materials is more likely to be made at the school level. Speeding the transition to more appropriate instructional materials, while tying in professional development for teachers, will have a significant impact on student achievement.

Open CESAME!

Northeastern University's Center for the Enhancement of Science and Mathematics Education (CESAME), through its Statewide Implementation Program (SIP), demonstrates how school districts can successfully implement challenging standards-based instructional materials. Through a contractual agreement, the project provides districts in Massachusetts with multi-year funding, technical assistance, professional development guided by curriculum developers, and linkages to statewide reform efforts. SIP also conducts research to determine the most effective model for disseminating such materials. Throughout, SIP works to make districts accountable by collecting data and continually focusing on achieving a sustained, high-quality materials implementation.

Funded by the National Science Foundation's Teacher Enhancement program, SIP provides expertise in implementing high quality materials to any Massachusetts district engaged in mathematics and science reform, and leads one of the five regional centers of the Massachusetts Statewide Systemic Initiative (SSI). This five-year project, funded for over \$4.4 million, has leveraged an additional \$3.8 million in cost-sharing from district funds, Northeastern University, and the Noyce Foundation.

To assist schools, districts, and States in choosing and implementing effective curricula and instructional materials for mathematics in grades 5-8, the National Science Foundation and the Department of Education will:

- Encourage and support coordinated efforts aimed at:
 - purchasing new instructional materials geared to rigorous standards;
 - providing high quality professional development connected to implementation of new materials; and
 - employment of highly skilled mathematics specialists who are prepared to teach the new materials and guide others in their implementation.

Each of these, for example, would be eligible for use of Title I funds, and could be part of the coordinated plans described in applications for the planning grants discussed above.

- Develop and disseminate guides to help interested schools and school districts select instructional materials and software most appropriate for their local needs and undertake the necessary steps to effective implementation. This effort will include reviews of instructional materials and software designated by experts as promising or exemplary.
- Provide technical assistance for schools and school districts in putting new mathematics instructional materials to work in the classroom. NSF-supported curriculum implementation sites dedicated to mathematics materials for grades 5-8 will work with broader technical assistance providers, including the Department's Eisenhower Regional Consortia and National Clearinghouse, as needed.
- Provide teachers and other educators with information on how they might use assessment in planning instructional improvement strategies. These materials will include information on how best to use results from the voluntary national mathematics test -- to interpret them to students and parents, place them in appropriate context, and improve mathematics instruction.
- Seed research and development of powerful models for integrating technology into classroom practice and informal learning environments. This will include support for critical expansion and evaluation efforts preceding commercialization of these models. K-8 mathematics will be a high priority in the near term.

Eisenhower Regional Consortia for Science and Mathematics Education

The mission of the ten Eisenhower Regional Consortia is to provide a field-based national infrastructure for systemic improvement of science and mathematics education. Projects provide information on curriculum, assessment, and teaching practice; conduct workshops and training; and serve as advisors to the field.

One example of the work of the consortia is the 1996 publication by the WestED consortium of Tales From the Electronic Frontier. This is a collection of ten teachers' narratives regarding their use of the Internet to enhance science and mathematics instruction and create opportunities for their own professional growth. The accounts describe using this resource for project-based learning, for making abstract scientific principles more concrete, and for promoting deeper understanding. Each story provides information on related resources and programs, and concludes with a section of questions and issues to stimulate further thought and discussion.

"Hoop Happenings" is the tale of a mathematics communication project between students at the Drexel Hill School in Philadelphia, Pennsylvania, and senior education majors at Iowa State University. During their teaching methods class for elementary mathematics, each student at Iowa State is paired with a group of students at the elementary school in Philadelphia with whom she interacts (via e-mail) over a math problem she defines each week. The interactive discussion provides the education majors with insight into children's thinking; for the children the project strengthens their abilities to solve problems and to discuss their problem solving approaches.

Tales can be found on WestED's WWW site at <http://www.wested.org/tales>.

- Continue competitive support for the development of supplementary materials, with new priority for efforts aimed at mathematics in grades 5-8, to assist schools and districts in making the transition to standards-based comprehensive materials.

While several other Federal agencies have long worked to support educational improvement efforts, in the past, few other agencies have contributed to the development of standards-based instructional materials in mathematics and science. This is changing, and there are significant contributions that other agencies can make in this area, consistent with their primary missions. The development of supplementary materials with mission-oriented situations that generate real-life problems and the delivery of such materials through technology are key potential contributions.

- Agencies will work in cooperation with NASA and NCTM to develop standards-based materials along the lines of NASA's "Mission Mathematics." These materials illustrate the use of mathematics in engaging, real world examples related to the agency mission.
- The Department of Education is chairing a Federal Government-wide working group that has already begun to promote and develop -- and make it easier for teachers and others to find -- high-quality educational materials, including instructional units and related materials, for use on the Internet. This group's role is to take the rich informational resources of organizations such as the Census Bureau or the U.S. Geological Survey, and make them easier for teachers and others to find and use. The first priority will be to identify materials that support teaching of challenging mathematics.
- The Departments of Defense and Education and the National Science Foundation are leading an interagency review of Federal activities related to research in learning technologies in order to establish effective practices for their use.

Each of these efforts could make new types of materials and capabilities possible in the future. Activities that enable students to achieve to high standards play an important role in all these Federal activities.

NASA's Mission Mathematics

The recent production of "Mission Mathematics" by NASA demonstrates how an agency can base its educational work on national standards. These three volumes of problems and activities are the descendants of NASA's first mathematics curriculum supplement, "Space Mathematics: A Resource for Teachers," published in 1972. That popular title was updated repeatedly over the years. "Mission Mathematics," however, is totally revamped to accord with national standards. Indeed, the subtitle is now "Linking Aerospace and the NCTM Standards." The three volumes are divided into K-6, 5-8, and 9-12, and the contents of each are keyed not only to NCTM's curriculum standards, but also to those for teaching and for student assessment. Examples of activities include calculating orbits, collecting and analyzing specimens, and planning for spaceflight needs.

This linking to standards was accomplished by making "Mission Mathematics" a joint project of NASA and NCTM. Writing teams included teachers, supervisor, and university professors working in consultation with NASA representatives. Their drafts were field-tested by classroom teachers and reviewed by NCTM's Educational Materials Committee. The results are attractive and modestly priced, with publicity, marketing, and distribution through NCTM's established network.

VI. BUILDING PUBLIC UNDERSTANDING AND SUPPORT.

All American students should leave eighth grade prepared to pursue the higher-level mathematics and science courses that are the gateway to college, good citizenship, productive employment, and lifelong learning. In realizing this vision, it is essential that educators, parents, and students themselves understand what high standards in mathematics look like and why they are important. This outcome requires activities and information that reinforce the classroom experience and convey the importance of mathematics achievement. Such activities should draw on the support of parents, the professional community of mathematicians, scientists, and engineers, business, and the broader public.

This section of the action strategy includes two complementary elements. The first consists of efforts to make high standards fully and clearly understood. If parents and students and teachers don't know where they should be headed -- what they agree students should know and be able to do -- it is hard to pull together to get there. Schools must have a clear sense of what they are doing and be able to communicate effectively with parents as well as work to invite active parental participation.

The second element builds on the first through partnerships that bring together the many groups that can contribute to helping students achieve high standards in mathematics. These partnerships will elevate the importance of mathematics achievement and provide clear avenues through which interested members of the mathematics, science, engineering, business and education communities, as well as parents and interested citizens, can contribute to efforts to raise mathematics achievement.

Saturday Schools Provide Tutoring Boost

The George B. Thomas Sr. Learning Academy Inc. (known as Saturday School), with modest support from the National Science Foundation, has provided free tutoring and mentoring to minority students in Montgomery County (MD) for nearly 11 years. Spearheaded by members of the Mu Nu chapter of the Omega Psi Phi fraternity, the program began in a public housing community's day-care center, but is now located at Sherwood High School (Olney, MD) and Springbrook High School (Silver Spring, MD).

About 180 students and 100 tutors--engineers, mathematicians and others (including high school students fulfilling Maryland's community service graduation requirement)--are registered at the centers; there is often a waiting list of pupils because there aren't enough tutors. Saturday School views itself as a partner with the students' schools; principals refer students to the program and teachers advise tutors on where students need help. Montgomery County Public Schools contributes classrooms, supplies, and training for tutors and parents. The sessions last 2 or more hours; tutors work with students on a wide range of mathematical topics and help students prepare for the Scholastic Assessment Test. Parental participation is required; about one-fifth of the parents tutor, with the remainder providing support and assistance in other ways.

The Department of Education, the National Science Foundation, and other Federal agencies will foster the partnerships by promoting a national dialogue on improving mathematics, acting as a clearinghouse for information and proven approaches to action, helping partners to develop exemplary materials that can be used in their State and local efforts, and mobilizing staff and resources to support local partnership efforts. Effective partnerships must build upon and complement what goes on in the schools. Thus, teachers and school administrators must be vital participants, either formally or informally.

In order to support these strategies, the Department of Education and the National Science Foundation have taken the initial steps to move forward on the ***Public Understanding and Engagement Mathematics Initiative***, an activity designed to create a large-scale, national public education effort that is coupled with extensive opportunities for active engagement of students, parents, and the larger community in the support of mathematics education.

Collectively, the projects selected through this initiative will:

- Use simple and compelling messages to tell the public what middle school students should know and be able to do in mathematics, illustrating the points through sample problems and student work;
- Emphasize important mathematics and interesting problems that engage both middle school students and the public;
- Illustrate the relevance of achievement in challenging mathematics to success in college and a wide range of careers;
- Create well-designed products that will engage the public in doing mathematics;
- Target a variety of media through a plan for disseminating the products;
- Support active partnerships to engage parents and the community, including those with professional organizations, scholarly societies, and the business sector;
- Mobilize adult volunteers to assist students in a variety of settings (for example, summer, after-school, and weekend programs; contests);
- Develop printed and Internet-based supporting materials as guides for volunteers; and
- Encourage highly visible local and national events and activities that engage the community.

In other activities designed to **build public understanding**, the Department and the Foundation will:

- Sponsor a national convocation on middle school mathematics to initiate a continuing dialogue on:
 - what we should expect our students to be able to achieve in mathematics by eighth grade and beyond;
 - exemplary practices in professional development, curricula, instructional materials, and technologies; and
 - opportunities for parental involvement and community support to help students meet high expectations.
- Seed the continuing national dialogue by providing a wide variety of sample items illustrating the level of expectations set in State and national standards, examples of student work, and information on curricula, instructional methods and technologies that support high standards.
- Create an easy-to-use mathematics Web site providing information on national standards; standards-based instructional units for teachers; information on the national test, including sample problems and examples of student solutions; and all the other materials developed or identified as part of this action strategy.

Additional **partnership activities** will take advantage of connections the Department and the Foundation maintain in the course of their on-going work. The agencies will:

- Facilitate the connection of national organizations having interests in helping to raise levels of achievement in mathematics and science (for example, professional societies of mathematicians, scientists, and engineers) with State, local and community-based organizations having similar purposes.
- Develop systematic mechanisms for the headquarters and field offices of relevant Federal agencies to participate in the partnerships.

The Department of Energy's STEM Initiative

DOE plays an important role in science education due especially to its premier national laboratories, which have a history of staff working in cooperation with the Nation's education system and other agencies. By opening DOE's laboratories to students and teachers, agency staff offer hands-on research opportunities and technical support for developing Internet and other technical tools to enhance educational experiences. The Department is in the process of creating a National Energy Laboratory Research Participation Program that will coordinate such activities across all DOE laboratories.

Among the Department's goals for science, technology, engineering and mathematics education, two are particularly relevant to this action strategy:

- Develop Internet based education technologies for elementary through college students and faculty; and
- Enhance DOE's community outreach activities for education at its R&D facilities and sites.

DOE strongly supports the revitalization of educational activities consistent with its energy and defense missions. An effort is underway to coordinate the use of DOE resources in promoting the public's understanding of science and ensuring a diverse workforce for the Nation's science and technology infrastructure.

VII. CONCLUSION

The time is ripe for a concerted effort to improve the achievement of U.S. students in mathematics and science. Recent results from international testing have raised the consciousness of the American public about the importance of establishing and meeting high standards in mathematics and science. As the test results have made clear, too many of our schools are failing to provide the instructional experiences that will enable our students to achieve at the levels we should expect from them.

By focusing our immediate attention on improving performance for middle school mathematics, we will be able to give local, State, and Federal educational agencies a target for action that is substantive, timely, and sufficiently constrained that it is reasonable to anticipate progress. As well as addressing an area of current concern, we can develop models for future action across disciplines and grades.

The interagency cooperation stimulated by the effort to produce this action strategy should have a lasting impact on the effectiveness of Federal programs and activities that support improving achievement in mathematics and science education. In addition to bringing the two agencies with the most extensive programming in this area together, the effort spurred further contact with other potential Federal partners, both those that have a tradition of strong presence in mathematics and science education and those that are new to such efforts.

The effort has been particularly timely in view of the growing interest among mathematicians, scientists and engineers in helping K-12 schools to improve the performance of their students in mathematics and science. The Department of Education, with its links to State and local education agencies and community groups, and the Federal science and technology agencies, with their ties to mathematicians, scientists, and engineers and their national professional organizations, can help make important connections to spur the development of effective partnerships.

**A New Federal Education Partnership
Program
at the Department of Transportation**

Magnetic levitation trains, highways that provide constant updates on traffic conditions ahead and geopositioning satellites that enable travelers to determine where they are anywhere on earth at any time: these are transportation "dreams" well on their way to becoming realities. Such dreams can lead to highly-paid jobs for those with the appropriate skills. Too many students, ill-prepared for such jobs, must leave the dreaming to others.

Through the new Garrett A. Morgan Technology and Transportation Futures Program, the Department of Transportation (DOT) will stimulate public-private partnerships to help students and their families understand the importance of mathematics and science for future careers and to make math and science relevant and exciting for students inside and outside the classroom. Such partnerships will encompass interagency collaboration, government-industry cooperation and community involvement. Sample activities include:

- With the Department of Education and its business and community partners, encouraging the transportation community to participate in the America Goes Back to School program, to build support for mathematics, science, and technology achievement.
- Helping to change public perceptions about the importance of studying mathematics and science by creating awareness of the wide variety of exciting jobs in transportation that require those skills.
- Building upon DOT's 300+ adopted schools to provide mentors, tutors, career information, and other forms of support for math literacy;
- Encouraging staff to support student mathematics achievement in their local communities, by supporting summer, after-school and weekend activities that help students learn or by serving as "telementors," helping students with homework over the Internet.
- Bringing together private sector sponsorships and expertise and nationally recognized teachers to develop exciting materials with a transportation focus for teaching mathematics, science, and technology.

But the action strategy is only the beginning of the effort. The interagency cooperation must continue and move to the substantive agenda of implementation. The Department of Education and the National Science Foundation are committed to meeting the challenge of continuing cooperation so that their programs work in concert. They will enable the development of appropriate mechanisms to keep other agencies and the professional scientists, mathematicians and engineers with whom they work actively involved in improving achievement in mathematics and science education. Perhaps most importantly, they will keep the goal of raising the achievement of all American students in mathematics and science at the forefront of their attention.

APPENDIX 1

PRESIDENTIAL DIRECTIVE

March 6, 1997

MEMORANDUM FOR THE:
SECRETARY OF EDUCATION
DIRECTOR OF THE NATIONAL SCIENCE FOUNDATION

SUBJECT: Preparing Students to Meet National Standards of Excellence in Eighth Grade
Math and Improving Math and Science Education

Since the early 1980's, U.S. elementary and secondary school students have begun taking tougher courses, and we are starting to see the results. National Assessment of Educational Progress scores have improved in math and science, with gains in mathematics equal to at least one grade level. On the SAT, average math scores are at their highest in 25 years, even as the number and diversity of test-takers have increased. However, the eighth-grade results of the 41-Nation Third International Math and Science Study (TIMSS), released this fall, show that the U.S. is below average in math and just above average in science. That isn't acceptable; in this technology-rich information era, our students need to perform much better in both subjects, but especially in math, if they are to excel at higher level math and science courses that are the gateway to college and to citizenship, productive employment, and lifelong learning.

The first step in raising achievement is lifting expectations and setting high standards for what students should know and be able to do. TIMSS, our National Assessment of Educational Progress, and the standards developed by the National Council of Teachers of Mathematics give us a solid framework to build on. Last month, to help parents and teachers learn who needs help, what changes in teaching to make, and which schools need to improve, I asked the Secretary of Education to develop a voluntary national test for individual eighth-grade students based on widely-accepted, challenging national standards in mathematics. The national test will be available to states and local school districts to give to their students in the spring of 1999, and will measure whether students have reached a high level of mathematics proficiency.

The primary responsibility for achieving high standards rests with students, teachers, parents, and schools in local communities across America. However, it is imperative that we work to ensure that federal resources support student success as well. We must ensure that federal programs, research, and human resources are used as effectively as possible to help improve teaching and learning.

Therefore, I direct the Department of Education and the National Science Foundation, together with other agencies identified in cooperation with the Office of Science and Technology Policy and the Domestic Policy Council, to develop an action strategy for using key federal resources to assist states and local school systems prepare students to meet challenging math standards in eighth grade, and for involving the mathematics, scientific, and technical communities in support of these efforts.

The action strategy should include recommendations for the use of federal resources to help states, local school districts and schools to improve teaching, upgrade curriculum, integrate technology and high-quality instructional materials into the classroom, as well as motivate students and help them understand how math concepts are applied in the real world. The strategy should identify significant federal programs, activities, and partnerships available to improve teaching and learning, ensure that these resources are appropriately focused on helping students reach challenging math standards, and determine how these resources can best support state and local reforms. In developing this strategy, the inter-agency group should review the current status of improvements in math education, and identify and address critical areas of need, drawing on research and input from educators and professional organizations.

Because teaching and learning in math and science are so integrally related, and because success in both subjects is vitally important in this information era, the working group should also review how federal resources and partnerships with other organizations can help improve student achievement in science.

The working group should make its recommendations and submit its action strategy to me within 90 days.

WILLIAM J. CLINTON

cc: ASSISTANT TO THE PRESIDENT FOR DOMESTIC POLICY
ASSISTANT TO THE PRESIDENT AND DIRECTOR OF THE OFFICE OF
SCIENCE AND TECHNOLOGY POLICY

APPENDIX 2

Voluntary National Tests in Reading and Math: A Strategy to Master the Basics and Reach High Standards

Clear standards of achievement are essential to help instill the skills, American values, and encouragement for hard work that our children need to succeed in school and in life. Toward that end, meaningful standards for what students should be expected to learn and achieve in the basic subjects of reading and mathematics are critical. Reading well by grade 4 and mastering mathematics -- including the foundations of algebra and geometry -- by grade 8 are the gateways for further learning and achievement.

Parents need to know that students have mastered the basics no matter where they live or move in this country. And they have the right to know how well their children are doing compared with students in other schools, states, and countries. To help give parents this information, the U.S. Department of Education is offering every state and school district the opportunity to use voluntary national tests of 4th grade reading and 8th grade mathematics, beginning in 1999.

These rigorous tests will provide parents, for the first time, scores for individual students, measured against widely accepted national and international standards of excellence. They will give states, local communities, teachers and parents the kind of accurate information they need to help students master basic and advanced skills and strengthen academic performance. Most importantly, they can galvanize a national effort to improve the odds for students and help ensure that all students master reading and math.

The tests will be modeled on the National Assessment of Educational Progress (NAEP) in 4th grade reading and 8th grade mathematics, and in the case of mathematics will be linked to the Third International Math and Science Study. The NAEP standards reflect a national consensus of what students should know and be able to do when they reach these crucial stages of learning.

The current NAEP is designed to assess how well a sample of students across the entire nation and individual states perform in reading and mathematics. A very small percentage of students participate in NAEP, and no parents know how their own children do on this test. In contrast, the voluntary national tests will provide students, parents, and teachers with meaningful scores to compare individual student performance to widely accepted national and international standards and to identify students and schools that need extra help. These standard measures of excellence will help parents hold schools accountable for improved performance, help teachers and principals improve curriculum and instruction, and give students a guide for charting their own progress.

The Department of Education recently submitted proposed legislation to Congress that would have the National Assessment Governing Board (NAGB) develop the tests. NAGB is a bipartisan, independent board created by Congress to oversee the NAEP. NAGB is expected to seek guidance in test development from a wide range of sources, including the most successful mathematics and reading teachers, parents, governors, and local and state education, civic and business leaders. Individual test scores will not be collected by the federal government; state and local school districts will decide how to use the data. Each test will require approximately 90 minutes of total testing time. States and school districts can administer the tests as part of their local testing programs.

APPENDIX 3

THE INTERAGENCY WORKING GROUP

In response to the memorandum from the President, the Department of Education and the National Science Foundation formed an interagency working group comprised of staff experienced in the areas under review. Officials of the Office of Science and Technology Policy, the Domestic Policy Council, and the Office of Management and Budget provided oversight.

Consistent with the directive, the interagency group immediately began a review of current Federal efforts in mathematics and science education with particular attention to mathematics education in kindergarten through eighth-grade. (See Appendix 4 for a summary of relevant programs in the two agencies.) In addition, as the memorandum instructed, the interagency group drew on research and input from educators and professional organizations, by reaching out to the broader mathematics and education community for advice and guidance. (See Appendix 5 for a summary of these outreach efforts, including a list of organizations with which the working group consulted.) The interagency group also consulted with appropriate staff in other agencies that have, or are interested in establishing, activities in elementary and secondary-level mathematics or science education. (See Appendix 6 for a list of the agencies consulted and a summary of their input.)

Early in its deliberations, the working group recognized the importance of developing an appropriate focus for the action strategy. Based on the results of the Third International Mathematics and Science Study (TIMSS) and the desire that students have proper preparation for the President's proposed national voluntary test in mathematics, the group concluded that in the near term, the action strategy should focus on mathematics in the middle grades (5-8). Thus, while the action strategy is designed to improve achievement in science and mathematics at all grade levels, it addresses that goal by concentrating on improving achievement in middle school mathematics first. To be fully effective in achieving the long term goals, this effort must broaden to include mathematics and science in all grades once the immediate concerns for mathematics in grades 5-8 have been addressed.

Participants in the Interagency Process

Secretary Richard Riley of the Department of Education and Neal Lane, Director of the National Science Foundation convened the interagency working group. Their acting deputies, Marshall Smith and Joseph Bordogna, respectively, provided guidance through regular interaction with the working group, as did Luther Williams, Assistant Director for Education and Human Resources at the National Science Foundation.

Several members of the staff of the Executive Office of the President were instrumental in the work of the interagency group, including: Michael Cohen, Domestic Policy Council; Clifford Gabriel, Office of Science and Technology Policy; Mary Cassell and Anne Tenney, Office of Management and Budget; and Daniel Goroff, Office of Science and Technology Policy. William Kincaid of the Domestic Policy Council and Daryl Chubin of the Office of Science and Technology Policy were particularly important to developing the action strategy and to keeping the working group on track.

Members of the Working Group

Co-Chairs

Thomas M. Corwin
Director, Division of Elementary,
Secondary, and Vocational Analysis
Budget Service
Department of Education

Judith Sunley
Assistant to the Director for
Science Policy and Planning
National Science Foundation

Committee Members

Carol Chelemer
Office of Educational Research and
Improvement
Department of Education

Diane Spreser
Program Director, Teacher Enhancement
(Mathematics)
National Science Foundation

Margaret Cozzens
Director
Division of Elementary, Secondary, and
Informal Education
National Science Foundation

Robert Stonehill
Director, State and Local Services Division
Office of Educational Research and
Improvement
Department of Education

Eric Hamilton
Program Director,
Educational System Reform
National Science Foundation

Larry Suter
Acting Director, Division of Research,
Evaluation, and Communication
National Science Foundation

Christine Jackson
Senior Program Officer, Eisenhower
Professional Development Program
Department of Education
(replaced Clare Banwart 4/97)

Judy Wurtzel
Director of the Mathematics Initiative
Office of the Acting Deputy Secretary
Department of Education

Deborah Spitz
Program Analyst
Office of the Undersecretary
Department of Education

APPENDIX 4

RELEVANT ACTIVITIES OF THE DEPARTMENT OF EDUCATION AND THE NATIONAL SCIENCE FOUNDATION

DEPARTMENT OF EDUCATION

The Department of Education provides flexible support, technical assistance, and research-based materials to assist state and local education agencies in improving teaching and learning. This year, the Department has identified seven national priorities that will guide its activities building on President Clinton's Call-to-Action over the next four years. The first three focus on specific results that all students should achieve: reading independently by the end of third grade; mastering challenging mathematics (including the foundations of algebra and geometry) by the end of eighth grade; and being prepared for and able to afford college by 18 years of age. The remaining four priorities address key strategies to enable students to achieve these goals: challenging standards and accountability for every school; a talented, dedicated, and well-prepared teacher in every classroom; Internet access in every classroom with technologically literate students; and strong, safe, and drug-free schools. The following programs provide valuable support to States and schools in their efforts to reach the goal of providing high-quality education in mathematics for all students.

Flexible Support to States, Communities, and Schools to Improve Teaching and Learning:

The **Title I Education for the Disadvantaged** program is the Federal Government's largest program that supports elementary and secondary education, with current funding of almost \$7.2 billion for grants to local educational agencies. Title I provides funds to help low-achieving children, particularly those in high poverty schools, learn to high standards. Title I can give disadvantaged children the benefit of, for example, more individualized and accelerated instruction, extended-day programs, and learning laboratories in mathematics, science, and computers. Mathematics has always been a major focus of the Title I program: according to the most recent data, 48 percent of 9 million participating children receive some instruction in mathematics.

The 1994 reauthorization of Title I emphasizes holding students participating in Title I to the same high standard as all students. By the 1997 - 1998 school year, all States must adopt challenging standards in reading and mathematics. By 2001, States must implement high-quality assessment systems aligned to the standards to assess the performance of Title I schools in relation to State standards.

Schools that serve an area in which the percentage of children living in poverty exceeds 50 percent may use their Title I funds, in combination with other Federal, State, and local funds, to upgrade the school's entire instructional program. These programs are called "school-wide programs." Other schools use the money to help those children most in need of supplementary services. In addition, the Title I statute emphasizes the professional development of educators; every local educational agency participating in the Title I program must provide high-quality professional development, geared to challenging State standards, to improve teaching of academic subjects.

Goals 2000: Educate America Act -- currently funded at \$476 million, is the primary Federal program supporting standards-based state education improvement. All 50 States now participate. Goals 2000 provides flexible funding to the States to enable them to

develop and implement their own strategies for achieving the National Education Goals (including the goal of becoming first in the world in mathematics and science). With funding from the program, States are establishing challenging academic standards with which they are aligning their student assessment programs, teacher preparation and licensure requirements, parental and community involvement, and other aspects of their education systems.

Professional development is also an important component of Goals 2000. Program funds allow States to make competitive subgrants for activities to improve pre-service teacher education and support intensive, sustained professional development for educators and other school personnel. Many States and school districts are also using Goals 2000 funds to support effective use of educational technology.

Professional Development in Mathematics and Science:

Eisenhower Professional Development State Grants, currently funded at \$310 million, support a wide array of professional development activities in the core academic subjects. By statute, at least \$250 million of the Eisenhower funds must be spent on professional development in mathematics and science. The strengths of the program are its reach -- funds flow to States and school districts by formula, and the vast majority of local educational agencies participate -- and the flexibility it provides to State and local administrators to carry out program activities that meet particular State and local needs. The 1994 program reauthorization established requirements that the program fund only professional development that is tied to challenging State content standards and is of sufficient intensity and duration to have a positive and lasting impact on teachers' classroom performance. In fiscal year 1998, the program should reach almost 350,000 educators.

The **Eisenhower Professional Development Federal Activities** program supports an array of national professional development initiatives. The Eisenhower program supports the National Board for Professional Teaching Standards (NBPTS), which establishes national standards of excellence in teaching and recognizes teachers attaining these standards through a rigorous assessment process. The Department has requested increased funding to enable 105,000 teachers to become board certified by the year 2006 on average, one for every elementary and secondary school in the nation. The Department's proposed budget would also speed the development of certification frameworks and assessments so that by 2002, certificates for 25 teaching fields will be available. Eisenhower also supports nine state-wide projects across the nation that are working on improving preservice education, licensure requirements and the experience of teachers during their first three years of teaching.

The **Telecommunications Demonstration Project** (PBS Mathline) uses the professional teaching standards of the National Council of Teachers of Mathematics (NCTM) as the basis for its year-long professional development program called the Elementary School Mathematics Project. This project, which complements Mathline's already-successful Middle School Mathematics Project, allows teachers to learn at times and locations they find convenient. It uses a series of 20 videos, each accompanied by a guide that includes lesson plans, ideas for extending the lesson, additional resources, and discussion topics relating the video content to the NCTM standards. Teachers also participate in a year-long, online learning community of 25-30 fellow teachers, with an accomplished practicing teacher serving as mentor and facilitator. Over the course of three years, PBS Mathline has provided more than 4000 teachers of K-8 mathematics in 36 states

with in-depth, standards-based training and has been recognized by the NCTM as an effective professional development program.

Technical Assistance and Information Sharing:

The **Eisenhower Mathematics and Science Regional Consortia** provide professional support to help teachers teach to high standards. The ten Regional Consortia have three primary objectives: 1) to collaborate and form coalitions with other organizations involved in mathematics and science education improvement; 2) to provide technical assistance and facilitate the use of technology as a tool for instruction and professional development; and 3) to identify and disseminate materials on exemplary instruction in mathematics and science.

The **Eisenhower National Clearinghouse for Mathematics and Science Education (ENC)**, funded under Eisenhower Federal Activities, collects a wide range of materials in mathematics and science and makes them available on-line and on CD-ROM. As of September 1996, which concluded its fourth year of operation, ENC had collected a total of 7,055 records and was in the process of identifying over 4,500 more. Between October of 1995 and June of 1996, the Clearinghouse reported over three million "hits" to its Web site. ENC Online (www.enc.org) has been recognized as an exemplary Internet site by Classroom Connect, Syllabus Magazine, Geometry Forum, Education Index, and Multimedia Schools. ENC also works with the Regional Consortia to create demonstration sites throughout the country, where educators can interact with the latest technological developments.

Information is also disseminated through the **Educational Resources Information Center (ERIC)**, a national system of specialized clearinghouses that maintain and provide access to the world's largest electronic database of education-related materials.

Research, Statistics, and Assessment:

The **National Research Center on Achievement in School Mathematics and Science** is housed at the Wisconsin Center for Education Research at the University of Wisconsin. The Center is a collaboration with the Technical Education Research Center (TERC), Vanderbilt University/Peabody College, the University of Pittsburgh, and the University of Massachusetts-Dartmouth. The Center's mission is to create and validate a set of principles for designing classrooms that promote student understanding in mathematics and science.

Data relating to education are collected, analyzed, and reported by the **National Center for Education Statistics (NCES)**. In collaboration with the National Science Foundation, NCES is currently reporting the results of the Third International Mathematics and Science Study (TIMSS), and providing follow-up information on those results. Other NCES studies collect detailed, reliable information on the conditions of schools, teachers, and students throughout the nation. The National Assessment of Educational Progress (NAEP) measures the progress of the nation's students in core subjects, including mathematics and science.

NATIONAL SCIENCE FOUNDATION

Since its inception in 1950, the National Science Foundation (NSF) has served the Nation by investing in research and education in science, mathematics, technology, and engineering. NSF's goals for education and training require attention to needs at every level of schooling and access to quality science, mathematics, engineering, and technology educational opportunities for all members of society.

PreK-12 Systemic Reform

Systemic refers to fundamental, comprehensive, and coordinated changes made in science, mathematics, technology, and engineering education through attendant changes in policy, financing, governance, management, content, instruction, and assessment. Systemic reform occurs when all essential features of institutions and systems are engaged and operating in concert; when policy is aligned with a clear set of goals and standards; and when the improvements and innovations become an intrinsic part of the ongoing educational system for all participants and are incorporated in budgets.

PreK-12 systemic reform is supported through NSF state, urban, local, and rural systemic initiatives. The implementation of high-quality, standards-based instructional materials, assessment systems, and professional development are keys to success of all initiatives. Essential components to the immediate and long-term sustainability of the reform activities include: (1) development and administration of coherent policies and legislation to support science and mathematics education; convergence of resources to support a single, unitary program; (2) promotion of effective partnerships with the private sector and higher education institutions; (3) achievement of support from the community, parents in particular; collection, interpretation and effective use of data, including student achievement; and (4) cohesive, coherent strategic planning to ensure the improvement of all students' achievement. Since 1996, the systemic initiatives have begun to make the transition from building an infrastructure to supporting science and mathematics education reform to the classroom implementation of standards-based curricula, instruction, and assessment. Extensive leveraging of funds from business, industry and other federal agencies occurs in all systemic initiatives, in some case as much as 4 to 1 with NSF dollars.

The Statewide Systemic Initiative (SSI) Program has supported a total of 25 states and the Commonwealth of Puerto Rico to establish comprehensive changes in mathematics and science education through the implementation of K-12 standards-based instructional programs, professional development, and assessment systems; new policies; and effective partnerships. A total of 20 eligible cities with the largest numbers of school-age children living in poverty have been funded under the Urban Systemic Initiative Program (USI). A total of four rural, economically disadvantaged regions are implementing programs to promote high-quality science, mathematics, and technology education through the Rural Systemic Initiatives (RSI). RSI programs have focused on the implementation of instruction through the use of advanced telecommunications networking and distance delivery of quality programs and professional development.

Building Blocks of System Reform:

Systemic reform is built on a foundation of quality instructional materials, initial education and professional development of teachers in both content and pedagogy, new strategies for the assessment of student learning, a diverse teacher population, and appropriate use of

technology. Thus a major focus of activities and budget at NSF is assuring that these building blocks are available and in place.

Teacher Education: Teachers must have a high level of content knowledge and pedagogical skills and be prepared to utilize the most effective instructional materials, assessment strategies, and educational technologies. Teacher education includes both preservice and inservice education.

Over 40,000 teachers in 1,930 schools, reaching over 1.3 million students annually, participate in intensive professional development activities through the **Local Systemic Change (LSC) Initiatives**. Teachers of mathematics or science receive a minimum of 100 hours of professional development (for K-8 teachers) or 130 hours (for teachers in grades 7-12) and receive ongoing support through the academic year. They implement quality standards-based instructional materials and reform the mathematics and science programs in their schools as a whole. Extensive leveraging of Title 1, Eisenhower, district, and industry funds occurs in at least an amount equivalent to the NSF award in each LSC project. In addition to the Local Systemic Change projects, the Teacher Enhancement Program supports **leadership projects** that train teachers and other professionals to deliver quality professional development. NSF supports the enhancement of approximately 60,000 teachers annually, of whom, at this time, fewer than half are teachers of mathematics. Only about 10,000 are middle school teachers of mathematics.

Comprehensive Partnerships for Mathematics and Science Achievement projects provide students and teachers with standards-based curriculum reform for K-12, teacher enhancement, strategic use of resources, student enrichment activities, and summer research experiences and related activities. Approximately 5,000 teachers are affected annually.

The **NSF Collaboratives for Excellence in Teacher Preparation (CETP)** support efforts to achieve comprehensive change in the undergraduate education of future teachers and to increase the quality and number of teachers in science and mathematics. All of the activities are characterized by strong collaboration between discipline-based faculty in schools of science/engineering and faculty from schools of education. Participating institutions of higher education vary from tribal colleges to major research institutions. CETP projects will affect 78,000 future teachers in 110 participating institutions over a five year period, and approximately 30% of the CETP collective effort is focused on future teachers of K-12 mathematics.

Instructional Materials: Instructional and assessment materials influence what students are taught and how teachers and faculty teach. An innovative, comprehensive, and diverse portfolio of instructional materials and assessment tools that implement standards-based reform in mathematics, the natural and social sciences, engineering, and technology education are required for preK-12 education. These materials must be of sufficient quality to be widely adopted and used in schools nationally.

The development of sixteen sets of comprehensive standards-based mathematics instructional materials for K-12 students was begun in 1990. These materials were completed and became available for use beginning in 1996. A report describing the success of these materials in field test sites was released by the University of Chicago, The Success of Standards-Based Mathematics Curricula for all Students, a Preliminary Report in FY 1996. Extensive evaluation data of student achievement in the field testing of these new materials demonstrates improved performance for students using them.

Assessment: NSF supported research and development in assessment of student learning during the mid-1990's through 20 projects. Each of these projects has come to completion. The tools they developed and the increased understanding of student learning that resulted are now being used by schools throughout the country. The Balanced Assessment in Mathematics Project was among the projects funded to develop assessment tools for middle school mathematics. The tools and test items the project generated have become the central component of the New Standards Mathematics assessments now used in numerous schools throughout the country. NSF continues to fund new assessment projects.

Technology: Research efforts in technology are developing new methodology and pedagogy for improving the achievement of students in science and mathematics, especially those who have not been well served by the education system. The new methodologies will make use of advances in technologies such as visualization and simulation that build on different learning styles among students. Funded projects successfully create new forms of visualization of scientific and mathematical concepts. NSF has supported more than 20 projects that successfully create new forms of visualization such as graphics, and simulations. Full and sustainable integration of technology into the fabric of the educational system is required for these to have wide impact on education systems.

Informal Science Education: The Informal Science Education sector reaches out to all segments of population to engage them in self-directed learning in the areas of science, mathematics, and technology. Because, over a lifetime, people spend more hours learning out of school than they do in school, a strong informal science education program is critical in the comprehensive education of our citizens. Members of the public who participate in informal science education learn about the process of science and scientific thinking; are motivated to participate in science and mathematics activities; are aware of the relevance of science, mathematics, and technology in their everyday lives; and increase their knowledge about specific topics and about scientists and careers in the sciences.

Support is provided for informal learning science, mathematics, and technology projects designed to reach large numbers of the general public through television and radio series; public films on the process and substance of science and mathematics; exhibits or other educational activities at science and natural history museums, science-technology centers, aquaria, nature centers, botanical gardens, arboreta, zoological parks, and libraries; and educational programs and activities at community and youth centers.

APPENDIX 5

CONSULTATION WITH EXTERNAL ORGANIZATIONS

In the course of developing this action strategy, the interagency working group solicited input from a wide range of interested organizations. The mathematics and mathematics education communities in particular are well organized to respond to the President's challenge. The working group met with two umbrella organizations that provided access to many sources of input from these communities: the Mathematical Sciences Education Board (MSEB) of the National Research Council (NRC) and the Conference Board of the Mathematical Sciences (CBMS). Each organization includes stakeholder representatives ranging from school teachers to university mathematicians and from educational researchers to those in industry using mathematics on a daily basis. Their recommendations to the working group are summarized below.

In addition, both the National Science Foundation and the Department of Education consulted with a wide range of potential stakeholders, including informal discussion with winners of the Presidential Award for Excellence in Mathematics and Science Teaching, meetings with the Eisenhower Regional Consortia, meetings of advisory committees, and meetings of professional organizations of teachers, principals, superintendents, mathematicians, scientists, and engineers.

While the working group focused its information gathering on strategies to support improving achievement toward high standards in mathematics, many of the individuals and organizations that provided input were keenly interested in the nature of the voluntary national test. Thus, the discussions with these groups included the exchange of information about the test of mathematics in eighth grade as well as about the working group's objectives. This interest in the test is reflected in the recommendations made. The working group was reminded, both implicitly and explicitly, that the voluntary national test is only a means to an end. The end must be kept in sight, both in test development and in the strategies the working group might develop to improve achievement.

In addition to meeting with these groups, the working group asked MSEB for a letter report addressing the issues raised in the President's Directive. MSEB offered three overarching recommendations:

1. Construct and sustain a Federal effort that brings together, in a coherent framework for decision-making, the various National Science Foundation and U.S. Department of Education programs that will significantly influence K-8 mathematics education.
2. Devise a long-term plan (8-10 years, offset from political cycles) of interactive development involving test redesign and strategy adjustment, with ongoing monitoring and oversight.
3. Invest in a sustained agenda of basic research to better understand what mathematical thinking is, how to foster it through curricular choices and instructional practice, and how to support teachers in doing so.

Within the framework of the President's Directive, all groups emphasized the importance of teacher education (both initial preparation and subsequent professional development), with both MSEB and CBMS highlighting this area in their written input. CBMS and MSEB emphasized the need for establishing certification programs for middle school teachers in mathematics. They cited the importance of an enhanced role for higher education in preparing teachers and in providing support for teachers through on-going professional development.

MSEB and CBMS also pointed to the emergence of new and innovative middle school mathematics curricula. They urged that the action strategy include ways to publicize, promote, and provide adoption guidance concerning model programs. They also agreed that technologies ranging from the Web to calculators have potential to help improve mathematics education. However, MSEB noted the importance of technical support for use of technology in the classroom and of equity issues in the use of that technology.

The outside groups also recognized the value of a public information campaign that can, in the words of the MSEB letter report, highlight "the importance of mathematics in applications, the beauty of mathematics as a field, and the role of mathematics as a gateway to careers and to higher education." Several of the mathematics and mathematics education organizations stand ready to assist in the development of such a campaign. MSEB recommends that public information efforts address coordination of the national test with associated action strategies.

APPENDIX 6

FEDERAL AGENCY ACTIVITIES THAT SUPPORT K-12 MATHEMATICS EDUCATION

The Department of Education (ED) and the National Science Foundation (NSF) have principal responsibility, among the Federal agencies, for K-12 education and for science and mathematics, respectively. However, a dozen other departments and agencies sponsor activities that relate to, and could promote, standards-based education that improves students' mathematics and science learning and overall academic performance.

Executive Order 12821 of November 16, 1992, instructs those Federal departments and agencies with scientific missions, employees, or laboratories to "assist in the mathematics and science education of our Nation's students, teachers, parents, and the public by establishing programs at their agency to provide for training elementary and secondary school teachers to improve their knowledge of mathematics and science." Many agencies had such programs in place even before this Order was issued. On April 17, 1996, it was superseded by Executive Order 12999 on *Educational Technology*, which "streamlines the transfer of excess and surplus Federal computer equipment to our nation's classrooms and encourages Federal employees to volunteer their time and expertise to assist teachers and to connect classrooms." The Eisenhower National Clearinghouse catalogues current programs in its "Guidebook of Federal Resources for K-12 Mathematics and Science" (see www.enc.org/reform/guidebk).

The working group met with designated representatives from 11 agencies (the Departments of Agriculture, Commerce, Defense, Energy, Interior, Transportation, and Veterans Affairs, EPA, NASA, NIH, and the Smithsonian) to discuss relevant programs and activities sponsored by their agencies. In general, the agencies focus far more on science than mathematics, and commit modest resources to improving K-12 education. Most offer staff and facilities, often on a volunteer basis, to support local schools and teachers. And all have developed and are sharing supplementary instructional materials on their Web sites. Some examples of works in progress can be cited. For more extended, specific examples, see sidebars in the report.

- NASA has completely revamped its educational programs to reflect the development of the National Council of Teachers of Mathematics' (NCTM) standards for mathematics and the more recent standards for science developed through the National Research Council (NRC). The agency has developed supplementary instructional materials in conjunction with NCTM that provide sample problems based on space-related examples.
- The Department of Defense schools have redesigned curriculum and teacher professional development to incorporate standards-based approaches. Other parts of DoD have outreach programs that stress the importance of mathematics to national security.

- The Department of Energy, NIH, and USDA are conducting an inventory of their activities, identifying their impacts and exploring opportunities to expand. Among ideas that warrant further consideration are virtual teacher training based at DOE's Lawrence Berkeley Lab in partnership with the University of California system; USDA's 4-H Clubs as an after-school, weekend, and summer vehicle for promoting math skills; EPA's use of the training-of-trainer model for teacher development in environmental education; and NIH's middle-school curriculum supplements, to be developed among three Institutes and the NRC.
- The Department of Transportation is about to embark on an extensive effort to improve K-12 education in mathematics and science, including participation of staff as volunteers. The Smithsonian Institution has both formal and informal ties into schools. Other agencies are ready to play an appropriate role in improving K-12 education, and are looking for guidance on how best to proceed.

We must learn more quickly and more systematically about approaches and innovations that support students and teachers of mathematics both in and outside of schools, taking into account high standards like those of the NCTM and the NRC to reference, guide, coordinate, and set priorities among the many educational programs managed by Federal agencies. Continued coordination among all of the agencies involved in the working group's deliberations, and others that might be brought in over time, can set the stage for more effective use of Federal resources. The Department of Education and the National Science Foundation will work to ensure such coordination in the future.



OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Science Division

Executive Office of the President

436 Old Executive Office Building

Washington, DC 20502

202-456-6130

202-456-6027 (FAX)

FAX TRANSMITTAL SHEET

DATE: 12/9/97

TO: BILL KINCAID
PHONE NUMBER:
FAX NUMBER: 6-7028
FROM: DARYL CHUBIN

NUMBER OF PAGES (INCLUDING COVER SHEET): 5

Bill: OMB memo plus suggested
edits by VA + EPA.

Best,
Daryl

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20507

December 9, 1997

MEMORANDUM TO SARAH HERRIGAN,
OFFICE OF MANAGEMENT AND BUDGET

THROUGH: Arthur Bienenstock, Associate Director, OSTP/Science Division

FROM: Daryl Chubin/OSTP and Bill Kincaid/DPC

SUBJECT: Clearance of Department of Education-National Science Foundation
Interagency Working Group Report, *An Action Strategy for Improving
Achievement in Mathematics and Science*

Enclosed for your review and approval for transmittal to the President is *An Action Strategy for Improving Achievement in Mathematics and Science*, the final report of the Department of Education (ED)-National Science Foundation (NSF) Interagency Working Group on Improving Math and Science Education. A Presidential Directive created this Working Group on March 6, 1997.

ED, NSF, and the agencies they consulted (DOC, DOD, DOE, DOI, DOT, EPA, NASA, NIH, USDA, VA) have approved the document. Minor edits to three pages (attached here) will be made as a result of the agency review and concurrence process. OMB's timely review of this document is appreciated. Please contact Daryl Chubin at 6-6129 with any questions, and return your comments to him by fax at 6-6027.

Thank you for your attention to this matter.

_____	OMB approves publication of this report.
_____	OMB approves publication subject to the resolution of the issues indicated on the attached pages.
_____	OMB requires discussion with OSTP/DPC before publication may proceed.

name

date

Enclosures

Working DRAFT
11/5/97

APPENDIX 6

FEDERAL AGENCY ACTIVITIES THAT SUPPORT
K-12 MATHEMATICS EDUCATION

The Department of Education (ED) and the National Science Foundation (NSF) have principal responsibility, among the Federal agencies, for K-12 education and for science and mathematics, respectively. However, a dozen other departments and agencies sponsor activities that relate to, and could promote, standards-based education that improves students' mathematics and science learning and overall academic performance.

Executive Order 12821 of November 16, 1992, instructs those Federal departments and agencies with scientific missions, employees, or laboratories to "assist in the mathematics and science education of our Nation's students, teachers, parents, and the public by establishing programs at their agency to provide for training elementary and secondary school teachers to improve their knowledge of mathematics and science." Many agencies had such programs in place even before this Order was issued. On April 17, 1996, it was superseded by Executive Order 12999 on *Educational Technology*, which "streamlines the transfer of excess and surplus Federal computer equipment to our nation's classrooms and encourages Federal employees to volunteer their time and expertise to assist teachers and to connect classrooms." The Eisenhower National Clearinghouse catalogues current programs in its "Guidebook of Federal Resources for K-12 Mathematics and Science" (see www.ene.org/reform/guidebk).

most The working group met with designated representatives from 11 agencies (the Departments of Agriculture, Commerce, Defense, Energy, Interior, Transportation, and Veterans Affairs, EPA, NASA, NIH, and the Smithsonian) to discuss relevant programs and activities sponsored by their agencies. In general, the agencies focus far more on science than mathematics, and commit modest resources to improving K-12 education. Most offer staff and facilities, often on a volunteer basis, to support local schools and teachers. And all have developed and are sharing supplementary instructional materials on their Web sites. Some examples of works in progress can be cited. For more extended, specific examples, see sidebars in the report.

- NASA has completely revamped its educational programs to reflect the development of the National Council of Teachers of Mathematics' (NCTM) standards for mathematics and the more recent standards for science developed through the National Research Council (NRC). The agency has developed supplementary instructional materials in conjunction with NCTM that provide sample problems based on space-related examples.
- The Department of Defense schools have redesigned curriculum and teacher professional development to incorporate standards-based approaches. Other parts of DoD have outreach programs that stress the importance of mathematics to national security.

Working DRAFT
11/5/97

reach the National Education Goals, including the goal of becoming first in the world in mathematics and science. The Eisenhower program places an explicit focus on science and mathematics. Of the \$310 million appropriated for FY 1997, \$250 million was required to go to mathematics and science.

The 1994 reauthorization of Title I placed new emphasis on helping disadvantaged students meet the same challenging academic standards expected of all children. States are currently developing standards and standards and assessments in reading and mathematics consistent with that emphasis. The Department of Education works actively with States and school districts on identifying actions that can be taken to achieve significant change, provides information and examples, and makes technical assistance available as needed.

Title I Schoolwide Programs

The 1994 reauthorization of Title I gave the program an entirely new purpose, namely, to teach disadvantaged students to the same high standards to which all other students are held. States are now in the process of establishing assessment mechanisms to measure students' progress against such standards, in at least reading and mathematics. In addition, the reauthorization lowered the eligibility threshold for Title I schoolwide programs. Schools with at least a 50 percent child poverty rate may now use their Title I funds (along with other Federal, State, and local funds) to make comprehensive improvements in the instructional program of the entire school, rather than providing discrete services to individual children. This change gives those schools the flexibility, for instance, to use Title I funds to upgrade the mathematics curriculum for all students.

A dozen other departments and agencies sponsor activities that relate to, and could promote, standards-based education that improves students' mathematics and science learning and overall academic performance. In general, these agencies focus far more on science than mathematics, and commit

modest resources to improving K-12 education. Most offer staff and facilities, often on a volunteer basis, to support local schools and teachers. ^{most} And all have developed and are sharing supplementary instructional materials on their Web sites. ^{↑ a}

Mathematics Education and the Department of Defense

Two agencies within the Department of Defense (DoD) offer complementary approaches to introducing rigorous national standards in their educational activities.

The DoD Education Activity (DoDEA) provides education for military and civilian dependents overseas (DoD Dependents Schools or DoDDS) and on some military bases in the U.S. (DoD Domestic Elementary and Secondary Schools or DDESS). DoDDS is essentially an autonomous school system that has developed a mathematics curriculum based on the NCTM standards, adopted standards-based instructional materials for use throughout all the overseas schools, and is continually training teachers in those materials and strategies using teacher-leaders. DDESS schools operate independently and cooperate with local education areas in addressing standards. As the DoDEA structure solidifies, there will be system-wide commonality in curriculum, instructional materials, and student assessment aligned with the NCTM standards.

The National Security Agency established a Mathematics Education Partnership Program (MEPP) in 1991. MEPP sponsors over a thousand talks per year to schools and colleges through its Speakers Bureau. It donates excess computers to classrooms, sponsors seminars and inservice teacher training, and conducts extended summer workshops for teachers at all levels. These MEPP activities, including projects such as collaboration with the University Corporation for Atmospheric Research's *Project SkyMath*, are all informed by the NCTM Standards, which are an explicit subject of study and reference at MEPP's Summer Institutes for Teachers. For a description, see www.nsa.gov.8080/programs/mepp.

GRA

Action Strategy for Improving Achievements in Mathematics and Science

Insert on page 6, last paragraph of first column, under the "Title I" box:

Dozens of other departments and agencies sponsor activities that relate to, and could promote standards-based education that improves students' mathematics and science learning and overall academic performance.

For example, under the National Environmental Education Act of 1990, the U.S. Environmental Protection Agency has awarded 1,500 grants worth \$16 million to schools, state agencies, nonprofit organizations and others to support environmental education programs. Many of these programs take place in schools across the country and focus on environmental science. More recently grants have also been directed toward programs that tie environmental education to state and local education reform goals. Under the Act, EPA also supports a five year \$9 million consortium of nonprofit organizations and universities which delivers environmental education training to K-12 teachers and other education professionals in all 50 states and several U.S. territories. As part of this effort, national guidelines for environmental education are being developed and correlated to various national and state standards for math, science, and other disciplines.

In general, these agencies focus far more on science than mathematics, and commit modest resources to improving K-12 education. Most offer staff and facilities, often on a volunteer basis, to support local schools and teachers. And all have developed and are sharing supplementary instructional materials on their Web sites.

more high school

Admin. & Finance

National?

Dept. of Education

**Funding for the Mathematics Initiative in FY99;
Proposed Increases in Eisenhower Professional Development (Federal) Activities
and Eisenhower Regional Mathematics and Science Education Consortia**

Earlier this year the President directed the Department of Education (ED) and the National Science Foundation (NSF) to create an action strategy for improving the use of federal resources to help students meet challenging mathematics standards in the eighth grade. The three major priority areas in the soon-to-be released action strategy are: (1) promoting public understanding and engagement; (2) assisting communities in selecting and implementing appropriate instructional materials and technology; and (3) improving the mathematics teaching of elementary and middle school teachers by improving teacher preparation and on-going professional development. An important cross-cutting strategy is the improved coordination of ED and NSF programs in order to build on their strengths and leverage reform. The action strategy lays out a series of programmatic and policy directions for the two agencies. The Department's 1999 request for a \$40 million increase in the Eisenhower Professional Development (Federal) Activities and Eisenhower Regional Mathematics and Science Education Consortia is necessary to implement the strategies laid out in the action strategy -- particularly those concerning professional development -- and to the Department's effort to support its priority that all student's master challenging mathematics by the eighth grade.

FY 99 will be an input you are build for
the 1999 to 12th grade from school.

Joint Competitive Planning Grants to Jumpstart Mathematics Improvement in Grades 5-8:

Strengthening the impact of federal resources to upgrade mathematics instruction is a major priority of the action strategy. This joint initiative will award \$50,000 planning grants to school districts that develop strategies to better coordinate and leverage Title I, Eisenhower, NSF and other funds to improve elementary and middle school mathematics. The resources will target mid-size districts that do not receive Urban Systemic Initiative (USI) grants from NSF, and, within those districts, on high poverty schools. (\$10 million)

The National Mathematics Project: Teacher networks are an extremely powerful and relatively inexpensive way to improve the teaching workforce. Based on the National Writing Project, this project will support the development of five national models for improving mathematics content knowledge of elementary and middle school teachers with the goal of enhancing participants' fundamental knowledge of mathematics. These funds will be used for the research and development of the materials and professional development models. Ultimately, participants can be supported with funds from local, state and other federal funds (including SSI, USI, Eisenhower state grants and Title I) to participate in the network of their choice. (\$5 million)

half a
sentence
on how
they would
do it?

Leadership Training: Another important finding from the action strategy is that there is a shortage of well-informed and well-trained leaders who can help schools improve mathematics instruction nationally. This program will help develop experts who can provide technical assistance and professional development to schools on improving mathematics instruction in ways that are suggested by the findings of the Third International Mathematics and Science Study (TIMSS). The initiative would also share these professional development models and materials, including materials on TIMSS and the support materials developed around the Voluntary National Test in Mathematics. This program will focus primarily on developing leadership capacity of

not required

?

school and district-based leaders and professional developers to match NSF's commitment to developing leadership capacity among university-based mathematics educators. (\$3 million)

Technology-Based Professional Development: Technology has the potential to be a powerful tool for professional development. Through video, CD-ROM, Internet and other technology, teachers can actually see models of effective teaching and upgrade their mathematical skills and knowledge. Currently, very few such materials exist. This initiative would fund a number of projects to create more high-quality, technology-based professional development materials and to build professional development curriculum around these materials. Funding would be provided to states, districts, teacher centers and other high-quality professional development providers to create effective strategies for using these materials and accompanying curriculum in mid- to large-scale professional development efforts, including intensive training of teacher leaders and the creation of networks to provide ongoing support in using the materials for professional development. (\$5 million)

Teaching for Understanding: TIMSS and other research show that many of the countries with high levels of mathematical performance concentrate on developing the conceptual understanding of mathematical principles in students. In contrast, research shows that the U.S. concentrates more on teaching procedural knowledge -- or how to do things -- without tying this knowledge to mathematical concepts. This program will develop professional development materials and training models that are designed to help teachers, particularly middle school teachers, develop pedagogical approaches that emphasize conceptual understanding of mathematics in students. (\$5 million)

while
insur
the
studier
master
looking

National Mathematics and Science Education Materials Clearinghouse: Increased funds for the Eisenhower National Clearinghouse will help support the Department's Mathematics Initiative by furthering materials development, the creation of Web sites, access to information via technology, and TIMSS-related activities. The Clearinghouse works in conjunction with the mathematics and science education regional consortia to provide assistance across the country to upgrade teaching and learning in mathematics and science consistent with challenging academic standards. (\$2 million)

Eisenhower Regional Mathematics and Science Consortia: This increase would provide an additional \$1 million to each consortium to help train a cadre of leaders in ways to improve mathematics education consistent with the results of TIMSS, with a focus on teaching more advanced mathematics content in middle school and raising students' conceptual understanding of mathematics. The increase would also be used to support partnerships of regional consortia with urban and rural school districts that require more intensive technical assistance in planning, training, and identifying and using the best resources to improve teaching and learning to higher mathematics standards. (\$10 million)



OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Science Division

Executive Office of the President
436 Old Executive Office Building
Washington, DC 20502

202-456-6130

202-456-6027 (FAX)

FAX TRANSMITTAL SHEET

DATE: 11/25/97

TO:

BILL KNOX

PHONE NUMBER:

FAX NUMBER:

6-7028

FROM:

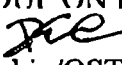
DARYL CHUBIN

NUMBER OF PAGES (INCLUDING COVER SHEET): 3

Bill: The attached plus
a copy of the WB report
& exec sum (not the
draft transmittal letter)
will be hand-delivered
to most of the agency
reps this pm, the rest
tomorrow am. Best, D

November 25, 1997

MEMORANDUM TO AGENCY REPRESENTATIVES TO THE DEPARTMENT OF
EDUCATION-NATIONAL SCIENCE FOUNDATION INTERAGENCY
WORKING GROUP ON IMPROVING MATH AND SCIENCE EDUCATION

FROM:  Daryl Chubin/OSTP and Bill Kincaid/DPC

SUBJECT: Clearance of *An Action Strategy for Improving Achievement in Mathematics and Science*

Enclosed for your review and approval for transmittal to the President is *An Action Strategy for Improving Achievement in Mathematics and Science*, the final report of the Department of Education (ED)-National Science Foundation (NSF) Interagency Working Group on Improving Math and Science Education. A Presidential Directive created this Working Group on March 6, 1997.

ED and NSF have tentatively approved this document. It is a revision of the draft report on which your agency commented last August. Your timely review of this document, especially with respect to your agency's programs, is appreciated. Please send your clearance, using the attached form, by facsimile to Daryl Chubin at (202) 456-6027 by close of business December 4, 1997. No response by this deadline will be taken as concurrence.

Thank you for your attention to this matter.

Enclosures

**OFFICE OF SCIENCE AND TECHNOLOGY POLICY/
DOMESTIC POLICY COUNCIL**

CONCURRENCE SHEET

RETURN BY WEDNESDAY, December 4, 1997

To assist in clearance of the report below, please check the applicable box and provide the requested information:

An Action Strategy for Improving Achievement in Mathematics and Science

- _____ a. I approve publication of the report.
- _____ b. I approve publication of the report with editing (attach comments).
- _____ c. I would like to have further discussion with the ED and NSF co-chairs before publication of the report.

Name

Agency

Date

Telephone

Return by FAX to:

**Daryl Chubin
(202) 456-6027**

**PLEASE RESPOND BY WEDNESDAY, DECEMBER 4, 1997, OR
WE WILL PRESUME YOUR CONCURRENCE**

Please contact Daryl Chubin (202)456-6129, or Bill Kincaid (202)456-2857, should you have any questions. Thank you.

Saxed 11/7

AB

—

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20502

November 10, 1997

MEMORANDUM TO AGENCY REPRESENTATIVES TO THE DEPARTMENT OF
EDUCATION-NATIONAL SCIENCE FOUNDATION ^(le) WORKING GROUP ON
IMPROVING MATH AND SCIENCE EDUCATION

FROM: Daryl E. Chubin/OSTP and ^{Bill} William Kincaid/DPC

SUBJECT: Clearance of An Action Strategy for Improving Achievement in
Mathematics and Science

Enclosed for your review and approval for transmittal to the President is *An Action
Strategy for Improving Achievement in Mathematics and Science*, the final report of the
Department of Education (ED)-National Science Foundation (NSF) ^(le) Working Group on
Improving Math and Science Education. A Presidential Directive created this Working
Group on March 6, 1997. ^{In L. ay}

ED and NSF have ^{agency} already tentatively approved this document. It is a revision of the
draft report on which you commented last August. Your timely review and
clearance of this document is appreciated. Please send your clearance, using the
attached form, by facsimile to Daryl Chubin at (202) 456-6027 by close of business
November 14, 1997. No response by this deadline will be taken as concurrence.

Thank you for your attention to this matter and continued support of the EOP.

Enclosures

Especially
with
respect
to your
agency's
programs

**OFFICE OF SCIENCE AND TECHNOLOGY POLICY/
DOMESTIC POLICY COUNCIL**

CONCURRENCE SHEET

RETURN BY FRIDAY, November 14, 1997

To assist in clearance of the report below, please check the applicable box and sign in space provided. *provide the requested information.*

An Action Strategy for Improving Achievement in Mathematics and Science

- ☐ a. I approve publication of the report.
- ☐ b. I approve publication of the report with editing (attach comments).
- ☐ c. I would like to have further discussion with the ED and NSF co-chairs before publication of the report.

Signature Name Agency Date Telephone

Return by FAX to:

**Daryl Chubin
(202) 456-6027**

Please respond by
FAILURE TO RESPOND BY FRIDAY, NOVEMBER 14, 1997, or we will
PRESUME CONCURRENCE
your

Please contact Daryl Chubin (202)456-6129, or Bill Kincaid (202)456-2857, should you have any questions. Thank you.

Summary of Math Action Strategy

- Developed by ED and NSF, working with other agencies, in response to President's directive from Michigan trip.
- Based on TIMSS findings and preparation for national test, focus is on raising math achievement in grades 5-8.
- Focus is on better using federal resources and other approaches to strengthen three key areas:
 - Improving teacher preparation and professional development so they are equipped to teach challenging math.
 - Helping states and local school districts select and implement standards-based curricula and instructional materials, and use technology effectively.
 - Building public understanding of what challenging math looks like and strengthening support for teaching students to such standards.
- Professional development strategies:
 - For current teachers:
 - ED and (especially NSF) will increase and focus its investment in professional development, targeted on teaching middle school math in low income districts and schools.
 - Support intense, short-term effort to increase the pool of qualified professional development leaders in middle school math.
 - Support creation of high quality professional development materials linked to NCTM standards and real-world applications.
 - For new teachers:
 - Conduct a national study of state licensure requirements for middle school math teachers.
 - Challenge colleges to strengthen teacher prep programs for middle school math teachers by linking education schools with math programs and including more deep content.
 - Support development of high quality teacher prep materials for K-8 math tied to standards.

- Curriculum/Instructional Materials/Technologies
 - Develop and disseminate guides to help schools and districts select standards based materials and software, including reviews of promising or exemplary materials and software.
 - Provide technical assistance for schools and districts putting upgraded materials to work in the classroom.
 - Help other federal agencies make their materials standards based, like NASA mission math.
- Public understanding
 - National convocation on middle school math.
 - Weekly math problems.

- We talk about this as a real partnership between ED and NSF, and we phrased the strategy so that it is very difficult to distinguish clearly which agency does what. However, as I read through the draft carefully appears to me that we really have to parallel sets of activities with a tenuous connections. Would a well-connected person in the field (i.e., someone active in reform activities and aware of ED and NSF programs) really find anything new in this document? If it were someone in a state committed to taking the voluntary national exam, would they feel federal government was providing a significant new option for getting assistance?

I am particularly concerned about the last of these items. I would like suggest the addition, either in the body of the text or in the transmit letter from Riley and Lane, of a truly joint program between the two agencies that would start on a pilot basis in 98, moving to full activity in 99 using new funds requested through the 99 budget process. See number 3 below.

2. America Counts/MathAmerica (ac/ma)

If anyone needs to see the memo I sent two weeks ago on this, let me know and I will forward it again. In the meantime, NSF (Midge Cozzens) asked that MSEB not send the proposals related to ac/ma to NSF. It appears that she and Luther had concerns similar to mine, but had not voiced them clearly prior to seeing a copy of my e-mail. I have since checked with NSF's General Counsel and with the National Science Board office, and have expressed concerns about initiating an activity with high visibility and significant NSF involvement that did not incorporate competitive merit review. In the course of NSF's attempting to provide a venue for a fund transfer from ED on another activity, we discovered that OERI funds are constrained to competitive review of unsolicited proposals. The ED General Counsel would not permit the fund transfer because the vehicle being used at NSF was an unreviewed conference proposal. (Judy, you might want to check out that I have this right. I don't know if it affects all OERI funding, or if it is more limited in scope.)

Thus, I believe the issue of how we support the ac/ma activities is real and we need to address it now. NSF is willing to fund a jointly convened workshop to explore the concepts around ac/ma and determine how we might best implement it. The workshop could be pulled together in September.

This is a really exciting idea, with a lot of potential for reaching groups as yet uninvolved in math education reform. It must be implemented properly, or we pose risks for both agencies, the White House, and any potential partners.

3. A joint program for ED and NSF

Finally, I would like to suggest that we add to our action strategy a joint ED/NSF program to be started on a pilot basis in FY 1998 and implemented

fully in FY 1999 through additional funds to be requested by both agency in the FY 1999 budget process. This would add something truly new to the strategy and would be a powerful signal to the community that NSF and E were serious about cooperation.

I envision three components to the effort:

- planning and implementation grants for local education agencies develop and initiate implementation of rational plans for use of Federal and local funds in support of standards-based education in middle school math; focus would be on teacher training and implementation of new curricula and instructional materials; keep at planning grants for FY98 (\$50K max); add implementation component (up to \$500K) in FY99
- expanded support for development and use of networking and other learning technologies in middle school math education with an emphasis on prototypes and testbeds
- putting math appropriate to high standards for grades 5-8 constantly in front of the public -- students, parents, teachers, community leaders, business people, etc -- in a consistent, engaging format; use to build on local partnerships for education and to draw in community organizations and professional scientists, engineers, and mathematicians provide mentoring to students in grades 5-8 (similar to the America Counts/MathAmerica suggestions currently under consideration, possibly under such a name, highlighting the concept of the problem of the week)

All aspects of the program would be administered using competitive merit review. We could consider limiting eligibility in the first year (e.g. districts with significant Title I schoolwide participation). This would recognize the importance of getting a critical mass of districts with functioning models of standards-based education in math in grades 5-8 to provide visible evidence to other districts that there are models that work and that are worth the effort to change. It would also recognize that it may be hard to tackle all aspects of standards-based education reform at once; that if districts try the grade 5-8 math piece of the problem, they may find that an initial success can stimulate broader efforts.

My suggestion is that the two agencies try to scrape up between \$10M and \$20M total to do the pilot effort in FY 1998. NSF would be willing to request about \$25M in new money in FY 1999, the bulk of which would go to the joint program. If ED were to request a like amount, there would be great leverage. As I understand it, at present ED plans to request additional funds for the Math Initiative largely through OERI. I see this as representing a partnership between OERI and NSF that uses competitive processes to leverage the ED formula funding. This is in contrast to trying to create a separate pool of Title I funds, or something of that sort as we discussed earlier.

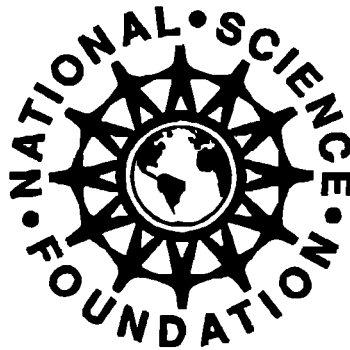
If we were to make this work, we would need to make sure that both the ED and NSF portions of this request were addressed under the President's education priority. NSF's preliminary OMB budget guidance for FY 1999

☐ ☐

reflects that our education programs have, in the past, not been consid
among the education priorities. Our base guidance is actually below ou
1997 Current Plan, which means that we must stretch our resources even
further just to be able to make the kinds of adjustments we had planned
make in order to emphasize 5-8 mathematics within an FY 1999 budget
anticipated to be at the same level as FY 1998.

That's about it for now. I look forward to hearing from you all. Welc
back, Judy!

Judy S.



National Science Foundation
Office of the Director
4201 Wilson Boulevard
Room 1205
Arlington, Virginia 22230

Phone: 703-306-1018

Fax 703-306-0109

Date: 10/14/97
To: Bill Kincaid
DPC
Fax No.: 202/456-7028
From: Judy Sunley
Pages: 19 *(Including Cover Sheet)*
Comments:

Please call the number above if you experience transmission problems.

Working DRAFT
10/13/97

AN ACTION STRATEGY FOR IMPROVING ACHIEVEMENT IN MATHEMATICS AND SCIENCE

I. INTRODUCTION

On March 6, 1997, the President issued a memorandum (Appendix 1) directing the Secretary of Education and the Director of the National Science Foundation to form an interagency working group to develop an action strategy for using Federal resources to assist States and local school systems in preparing students to meet challenging mathematics standards in the eighth grade, and for involving the mathematical, scientific, and technical communities in support of those efforts.

The Presidential Directive

The Presidential directive specified that the action strategy include recommendations for the use of Federal resources to help States, local school districts, and schools improve teaching, upgrade curriculum, integrate technology and high-quality instructional materials into the classroom, and motivate students to help them understand how mathematical concepts are applied in today's global workplace. It called for the interagency group to review the current status of improvements in mathematics education and identify critical issues of need, drawing on research and input from educators and professional organizations. In addition, it called for the working group to review how Federal resources and partnerships with other organizations can help improve student achievement in science.

The Need for Action

The Third International Mathematics and Science Study

One of the immediate inspirations for this attention to high standards in mathematics and science education in eighth grade is the Third International Mathematics and Science

Study (TIMSS), which involved 30,000 students in the United States. Results of tests administered in 1995 to students in grades 4 and 8 are now available. The fourth grade results show US students above the international average in both science and mathematics. In science, US students were outperformed only by those in Korea. However, the eighth grade results show lackluster performance by US students, with scores only a bit above the international average in science, and below the international average in mathematics. These results clearly indicate that mathematics and science education in the middle school years should be an important focus for national efforts to help ensure that our students meet world-class standards.

The Third International Mathematics and Science Study (TIMSS)

TIMSS is the largest and most ambitious of a series of international comparative studies of educational achievement. The Department of Education and the National Science Foundation sponsored the U.S. testing, done in 1995, and subsequent analysis.

TIMSS involved more than half a million students in 45 countries. The relative performance of U.S. students in comparison to students of other countries improved over performance on similar international comparisons of earlier years. However, the U.S. was the only country whose students performed above average at grade 4 and below average at grade 8 in either science or mathematics.

TIMSS results show that

- US student performance increases more slowly between elementary and middle school years than in most other countries;
- The US curriculum is not as well focused on topics that would propel students toward more advanced levels of understanding as are curricula in other countries;
- US teachers work longer hours, have less time during the day for preparing classes, and experience more disruption in their classrooms than do their counterparts in other countries.

Doesn't make sense of grade 4 & 8 results

Working DRAFT
10/13/97

TIMSS results for the fourth grade are much more positive than the results of similar international comparisons in the past. They demonstrate that it is possible to make significant progress in international comparisons over time, and that US students can compete favorably with those of other nations in mathematics and science achievement. Our National Education Goals proclaim our intent that US students will be first in the world in mathematics and science achievement by the year 2000. In the early grades, we are making demonstrable progress toward that goal.

While collecting achievement data in each participating country, TIMSS researchers also developed a wealth of information about teachers and teaching, about curricula and instructional materials, about classroom lessons and interactions, and about student attitudes and habits outside the classroom. Thus, the TIMSS results have become a source of constructive motivation for mounting an action strategy, taking the issue well beyond the simple comparison of scores in international test taking.

Opportunities for the Future

Eighth grade is a critical point in mathematics education, as achievement at that stage paves the way for students to take the advanced high school mathematics and science courses that are keys to college entrance and well-paid jobs. Today, too many students enter high school without this solid grounding in mathematics and never gain it, closing doors to opportunities for the future. Often students and their families do not even know that the doors are closing, leading to a mismatch between their expectations for the future and their actions in the present. This is particularly true for students from disadvantaged backgrounds. It is a factor in perpetuating inequities both in participation in advanced education and in lifetime income.

A Voluntary National Test in Mathematics

The President has proposed a voluntary national test in mathematics, to be taken near the end of eighth grade, as a very visible part of an ambitious, sustained drive for higher,

more challenging standards of learning for all students. The test will be based on the content strands of the National Assessment of Educational Progress (NAEP). It will be available by the spring of 1999 for those States and districts that wish to participate. Parents and teachers will receive an individual score for each student who takes the test. That score will be linked to national and international benchmarks, which will provide additional context. For more information, see Appendix 2.

The voluntary national test is only one element of the comprehensive effort needed to accomplish the objective of having all students achieve challenging national standards for performance. This effort will require many individuals -- students, parents, teachers, and community leaders -- working in concert with a common understanding of what they want to see happen. The test, in combination with a national effort to boost achievement, will provide a powerful lever to amplify the effects of existing efforts at local, State, and national levels to improve student achievement in mathematics and science.

Immediate Focus on Mathematics

The TIMSS results show the need for an immediate focus on mathematics education in grades 5-8, where the serious drop in performance compared to international norms threatens achievement in both mathematics and science at higher grade levels. The President's proposed national voluntary test in mathematics in eighth grade provides a tool to measure progress and also challenges us to provide students with the mathematics in grades 5-8 that will enable them to perform well on it. The National Council of Teachers of Mathematics (NCTM) has developed sets of standards for content, teaching, and assessment that provide a strong footing for standards-based instruction.

To meet the challenges of the near term, this action strategy focuses on mathematics education in grades 5-8. It builds on a strong foundation of activity underway across the country to improve elementary and secondary mathematics and science education. It requires that these activities continue, at all

Working DRAFT
10/13/97

levels in both mathematics and science, and lays the groundwork in both substance and process for expanded activities in the future.

Raising Achievement for Disadvantaged Students

Efforts to raise student achievement in mathematics and science must be particularly intensive in high-poverty communities and schools. The National Assessment of Educational Progress (NAEP) in mathematics shows that students from poor families perform significantly less well than other students. In 1996, the average score on the 500 point NAEP scale was 252 for 8th graders who are eligible for free and reduced price lunch as compared to 280 for ineligible students.

On July 25, 1997, fifteen urban school districts, including the three largest pledged to participate in the voluntary national test. They sent a clear signal that students in inner city schools can and should be held to the same challenging standards that are being set for all students throughout the nation. These communities recognize that setting high standards is a prerequisite for improved teaching and learning. Research and experience shows that students can meet high standards, and that low expectations lead to low achievement.

Challenges for All Parties

Our vision is that all American students will leave eighth grade prepared to pursue the higher-level mathematics and science courses that are the gateway to college, productive employment, lifelong learning, and effective citizenship. Reaching this vision will require:

- High expectations, held by teachers, school administrators, parents, and students themselves, for student performance in mathematics and science;
- Challenging standards for content of curriculum, teaching, assessment, and student achievement;
- Instructional materials and technology of high quality that incorporate these challenging standards;

- Teachers with the pedagogical skills and rigorous knowledge of mathematics and science needed to teach these subjects effectively; and
- Activities outside the classroom that reinforce the classroom experience by drawing on the support of parents, the professional communities of mathematicians, scientists, and engineers, business leaders, and the broader public.

Thus, the action strategy

- Challenges the Department of Education and the National Science Foundation to work together more closely and to partner with other Federal agencies and with State and local educational agencies to strengthen the impact of the Federal investments in mathematics and science education.
- Challenges State and local level superintendents, mathematics supervisors, school boards, principals and other educators to take a fresh, critical look at curricula, instructional materials, and professional development strategies (and the use of Federal resources in these areas) in light of TIMSS and other recent research results and to be prepared, as needed, to reformulate current approaches to improve effectiveness.
- Challenges the nation's colleges and universities to develop rigorous new programs for teacher preparation, stressing both subject matter expertise and pedagogical mastery and to take a far more active role in enhancing the skills and knowledge of today's teachers, working closely with States, local school districts and schools in the process.
- Challenges professional organizations in mathematics, science, engineering and technology to partner with schools, parents, students, community organizations, and business and industry in developing a strong network of local partnerships aimed at raising student achievement.

Working DRAFT
10/13/97

- Challenges US families to provide strong support and encouragement for their children to reach high standards of achievement in mathematics and science.

To help meet these challenges, based on the rationale described above, the Department of Education and the National Science Foundation will focus their immediate actions -- individually and jointly -- on mathematics in grades 5-8. To be fully effective, this effort must broaden to include both mathematics and science in all grades once the immediate needs of mathematics in grades 5-8 have been addressed.

II. PRIORITIES FOR ACTION

Consistent with the President's directive, this action strategy identifies steps that Federal agencies, along with their partners, can take to help students reach challenging standards in mathematics in grades 5-8 and to ensure that Federal resources will effectively support State and local reforms. The interagency working group, through review of the current state of mathematics education, consultation with outside organizations, and review of Federal programs, identified three priority areas for action. (See Appendices 3-6 for more detailed information.)

Priorities for Action

- Equipping teachers in grades 5-8 with the skills and knowledge to teach challenging mathematics content in effective ways, with high expectations for their students;
- Helping States and school districts select and implement high-quality, standards-based curricula and instructional materials, including effective use of educational technologies
- Building public understanding of challenging mathematics in grades 5-8, and gaining public support for raising student achievement toward high standards.

While education is a national priority, it is primarily a State and local responsibility.

The Federal role is to provide good information, effective tools, and financial support that will assist States and local communities in ensuring that all of their students have the mathematical skills they need to succeed in the workplace as productive citizens. This includes promoting effective partnerships that mobilize support from the community -- students, parents, educators, business leaders, volunteers, and concerned citizens from all walks of life -- to that end.

Scope and Scale

Department of Education statistics show that in grades 5-8 there are approximately 13.5 million students taught by about 320,000 teachers of mathematics. These students and teachers are found in about 34,000 schools in close to 15,000 districts. Many of these schools and districts are already actively involved in setting high standards for instruction and student achievement and are implementing plans to achieve them. Their priorities in such efforts are very similar to the school-based priorities identified above. }

The core of this action strategy is making more effective use of Federal resources in assisting schools and districts to make a focused effort to address these priorities with respect to mathematics in grades 5-8. The participating agencies will provide opportunities for districts to accelerate their progress toward improved achievement in this area through incentives for enhanced coordination, planning and implementation.]

The goal is to involve a critical mass of 3,000 to 4,500 districts in such focused efforts between FY 1998 and FY 2002, with approximately 1,000 provided opportunities for extended implementation efforts that can serve as models for all districts. Districts that serve large numbers of disadvantaged students will receive particular attention.

At the same time, an effort at public information and engagement is needed to reach a broader base of students and their parents in a more timely fashion than can be accomplished through these core activities. The participating agencies, with their ties into the science, mathematics, engineering and

Working DRAFT
10/13/97

technology communities, are well-positioned to encourage these communities to cooperate in spurring such an effort.

Finally, it is not enough to deal only with today's teachers and with implementation of instructional materials and technologies available now. Approximately 30,000 new teachers of mathematics in grades 5-8 are needed each year. At the same time, development of learning technologies is extremely rapid, and adaptation of curricula to accommodate this pace is a continuing concern. Addressing these issues is also an important part of the action strategy.

III. ACTIONS TO STRENGTHEN THE IMPACT OF FEDERAL RESOURCES

The bulk of the Federal resources for improvement in K-12 mathematics and science education flows from the programs of the Department of Education and the National Science Foundation. (See Appendix 3 for a summary.) Developing a coherent approach to strengthening the impact of Federal resources use to improve mathematics achievement in grades 5-8 requires taking differences among these programs into account. Drawing on the resources of other Federal agencies in an effective manner can then follow.

Current Federal Resources

In FY 1997, the National Science Foundation invested \$377 million in K-12 science and mathematics education, including investments in the undergraduate preparation of teachers. The funds go largely to colleges and universities, State and local educational agencies, and nonprofit organizations. They are awarded through competitive review of proposals for funding of specific projects. Over the past few years, the Foundation has placed a high priority on system-wide reform of mathematics and science education. It asks local and State educational agencies to align resources of all types, including those obtained through other Federal programs, to effect change. The Foundation highlights specific areas of emphasis within broader

programming, establishes clear priorities for funding within the criteria for selection of awards, and holds grantees accountable for performance. Over the years, projects aimed at mathematics in grades 5-8 have been scarce in comparison to those in science or to those in mathematics aimed at other grade levels.

The Department of Education allocated approximately \$8 billion in FY 1997 through three major formula-drive programs (Goals 2000; Eisenhower Professional Development State Grants; and Title I: Education for the Disadvantaged) that include improved achievement in mathematics and science among their objectives. Goals 2000 aids States and school districts to develop and implement challenging academic standards and upgrade teaching and learning in order to reach the National Education Goals, including the goal of becoming first in the world in mathematics and science. The Eisenhower program places an explicit focus on science and mathematics. Of the \$310 million appropriated for FY 1997, \$250 million was required to go to mathematics and science.

Title I Schoolwide Programs

The 1994 reauthorization of Title I gave the program an entirely new purpose, namely, to teach disadvantaged students to the same high standards to which all other students are held. States are now in the process of establishing assessment mechanisms to measure students' progress against such standards, in at least reading and mathematics. In addition, the reauthorization lowered the eligibility threshold for Title I schoolwide programs. Schools with at least a 50 percent child poverty rate may now use their Title I funds (along with other Federal, State, and local funds) to make comprehensive improvements in the instructional program of the entire school, rather than providing discrete services to individual children. This change gives those schools the flexibility, for instance, to use Title I funds to upgrade the mathematics curriculum for all students.

The 1994 reauthorization of Title I placed new emphasis on helping disadvantaged students meet the same challenging academic

Working DRAFT
10/13/97

standards expected of all children. States are currently developing standards and plans consistent with that emphasis. The Department of Education works actively with States and school districts on identifying actions that can be taken to achieve significant change, provides information and examples, and makes technical assistance available as needed.

A dozen other departments and agencies sponsor activities that relate to, and could promote, standards-based education that improves students' mathematics and science learning and overall academic performance. In general, these agencies focus far more on science than mathematics, and commit modest resources to improving K-12 education. Most offer staff and facilities, often on a volunteer basis, to support local schools and teachers. And all have developed and are sharing supplementary instructional materials on their Web sites.

The Department of Energy's STEM Initiative

Department of Energy (DOE) Secretary Pena has launched for FY 1998 a renewed effort to support education consistent with DOE's energy and defense missions. The Science, Technology, Engineering, and Math Education (STEM) Initiative will coordinate DOE resources to promote the public's understanding of science and provide a diverse workforce for the Nation's science and technology infrastructure.

DOE plays an important role in science education due especially to its premier national laboratories, which have a history of staff working in cooperation with the Nation's education system and other agencies. By opening DOE's laboratories to students and teachers, agency staff offer hands-on research opportunities and technical support for developing Internet and other technical tools to enhance educational experiences. One of the key elements of the STEM Initiative is the creation of a National Energy Laboratory Research Participation Program that will coordinate such activities across all DOE laboratories.

Among STEM's five goals, two are particularly relevant to this action strategy:

- Develop Internet based education technologies for elementary through college students and faculty; and
- Enhance DOE's community outreach activities in science, technology, engineering, and mathematics education at its R&D facilities and sites.

Strengthening the Impact of Federal Resources

Using Existing Programs

The first step in moving forward is to ~~maintain~~ ^{and improve} existing programs aimed at improving student achievement through standards-based education across all subject areas and all grade levels. Such programs provide a fundamental level of information and opportunity important for progress, but they have only a minimum of activity focused on mathematics in grades 5-8.

Within those existing programs, the participating agencies will create areas of emphasis for mathematics in grades 5-8. This can be done to a limited extent through reorganizing existing resources. However, such a reorganization of funds would have an impact on the scope of other aspects of the agencies' educational activities and would limit the number of districts, schools, teachers, and students served to unacceptably low levels (approximately 1000 districts over five years). Expanding the scale of existing programs will help, as will new programs of individual agencies, but issues of scope and synergy would remain.

Creating Synergy

The programs of the Department of Education and the National Science Foundation have different approaches and strengths. The Department generally provides large-scale, flexible support directly to State and/or local educational agencies for improving teaching and learning to high standards, coupling this support with technical assistance. NSF's portfolio is much smaller in scale, is targeted at improving mathematics, science, and technology education, and is established through competitive processes. To create synergy, this action strategy combines the agencies' strengths, permitting those involved with upgrading mathematics professional development and instruction through major Department of Education programs to draw on NSF's competitive programs to step up the pace of change.

Working DRAFT
10/14/97

The work of improving student achievement must be done at the State and local level, and, most fundamentally, within individual schools. State and local educational agencies can maximize the impact of Federal resources by choosing to use them in a coordinated, concentrated way. Thus, the National Science Foundation and the Department of Education will champion State and local educational agencies in the strategic use of all types of Federal, State and local funds toward improving mathematics achievement, offer examples of effective coordination in the use of such funds, and provide incentives to initiate effective improvements. At the same time, they will work together to encourage the nation's colleges and universities to do a better job in educating future teachers for the work they will do in the schools and will combine with other agencies in a broad program of public information and engagement.

A Title I Schoolwide Example

Kenton Elementary School in Portland Oregon, and 12 other schools in the region decided to place a high priority on student achievement using Title I and other resources. During the 1995-96 school year, the schools held full-day, weekly workshops on best teaching practices as identified by the school principals. The principals developed a regional Title I plan and, with the help of consultants, have all staff working together to implement it. Title I staff worked with regular classroom teachers on new strategies, and Kenton staff agreed to use Title I benchmarks and assessments for all students.

Kenton's curriculum emphasizes interactive writing and vocabulary development, and uses innovative mathematics materials. Teachers use cooperative learning and peer tutoring to help students grow toward proficient and advanced levels, and students are encouraged to analyze, evaluate, and interpret information. Kenton teachers regularly meet with small groups of students outside of class to give extra help in mathematics, reading, or writing. Teachers also train the school's many volunteers to support the benchmarks while working with students. Assessments indicate some success in the early years of this effort to improve instruction. The percentage of third-graders scoring in the advanced category in mathematics increased from 15 percent to 35 percent.

IV. THE ELEMENTS OF AN ACTION PLAN

Three priorities for action are identified above. Progress in one area will often depend on and demand improvement in others. For instance, the introduction of high-quality instructional materials will have little impact if teachers are not trained to use those materials effectively. We must be working on all fronts in order to make progress toward improved student achievement. The elements of the action plan provided below are organized around the three priority areas, with an introductory section that describes plans for synergistic use of federal funds across the priority areas.

Cross-Cutting Elements

As noted above, the Department of Education and the National Science Foundation plan a set of joint activities, including the other participating agencies to the extent possible, aimed at addressing school-based priorities.

- The Department and the Foundation will assist State and local educational agencies in the strategic use of all types of Federal, State, and local funds toward improving mathematics achievement.

- The Department of Education will provide active encouragement and support, opportunities to pool resources originating in the Department, and information and technical assistance, as appropriate.

- The National Science Foundation will emphasize support for development and implementation of State and local strategies for improving mathematics education in grades 5-8.

- The Department and the Foundation jointly will provide competitive planning and implementation grants to jump-start intensive, coherent efforts to upgrade mathematics instruction that use Federal, State, and local funds to sustain long-term improvements and provide models for the future.

Working DRAFT
10/13/97

- The principal target for the agencies' cooperative activities will be middle schools with schoolwide Title I programs and districts with many such schools. This focus permits large numbers of disadvantaged students to benefit from the enhanced leverage of funds awarded competitively by the Foundation to schools and districts with the large resource base of the Department's Title I program.

- The Department and NSF will convene a national conference of State and local leaders of Eisenhower, Title I, Goals 2000, and State, urban and rural systemic initiatives, and other key actors to help participants maximize the impact of Federal resources in improving mathematics education in grades 5-8.

- The Department and NSF will undertake a coordinated set of research and informational activities around mathematics in grades 5-8. These activities include release of a TIMSS resource kit that contains specific tools for professional development, curriculum analysis, and achievement benchmarking; readministering TIMSS in the spring of 1999 to get updated information on our international standing; a program of research informing continued development of the eighth grade national test over time; and a sustained agenda of basic research in teaching and learning of mathematics.

- The Department and the Foundation will work systematically with other agencies to enhance the impact of Federal resources by upgrading their activities to reinforce a standards-based approach for mathematics in grades 5-8.

Each of the specific items above will be aimed at mathematics in grades 5-8, reflecting the urgent need to raise achievement at this stage of the educational process. However, the activities described above can also serve as models for more effective approaches to educational change in the broader arena of

mathematics and science education. The working group strongly endorses the idea of future efforts that would encompass additional aspects of K-12 mathematics and science education.

Texas Statewide Systemic Initiative

The NSF-supported Texas Statewide Systemic Initiative (SSI) also operates the U.S. Department of Education's Comprehensive Assistance Center for Elementary and Secondary Act Programs in Texas, bringing into one unit the state's leadership both in science and mathematics education and in Title I technical assistance. In the past two years, the SSI has provided incentive grants and technical support in integrating their Title I, Eisenhower, and professional development activities in mathematics and science to more than 100 Title I schools serving more than 100,000 Title I students. In July, 1995, the SSI held an intensive summer institute designed to support Title I schools in (1) reconceptualizing the use of formula funds, (2) adopting standards-compatible mathematics curricula, and (3) adopting effective schoolwide program models. As a result of the SSI/Title I collaboration, state mathematics and science leaders are now active members of school support teams engaged in mentoring over 700 Texas Title I schools. At the same time, increasing numbers of teachers in high poverty/high minority schools are being trained as SSI mathematics, science, and technology specialists.

Equipping teachers in grades 5-8 with the skills and knowledge to teach challenging mathematics content in effective ways, with high expectations for their students

In grades 5-8, students should begin to move from mastering the basics of arithmetic to using arithmetic in complex problems and learning the foundations of geometry, algebra, probability, and statistics. Teachers must know substantial mathematics and have strong pedagogical skills if they are to be effective in helping their students make this transition and meet high standards. Practices in teacher education, licensure and certification, and in-service teacher enhancement do not always reflect these needs.

Working DRAFT
10/13/97

Over the next ten years, approximately 2 million new teachers will enter the workforce. It is essential that these future teachers receive adequate preparation in mathematics content and pedagogy and in the use of contemporary technological tools before they enter the classroom. And many of the approximately 320,000 teachers who are already teaching mathematics in grades 5-8 would benefit from upgrading their math content knowledge and teaching skills.

Quantitative Literacy Program for Alabama K-12 Teachers

The Quantitative Literacy Program for Alabama K-12 Teachers, a project administered by the University of Alabama and supported by the Eisenhower Professional Development program, assists elementary and secondary teachers in implementing the probability and statistics goals for grades K-12 as outlined in the National Council of Teachers of Mathematics standards. The program's workshops teach quantitative concepts in the context of solving meaningful problems, with content taught in reference to teaching strategies that participants use when they return to their classrooms. The program includes a pre-workshop orientation, an intensive one-week training workshop, and two follow-up sessions. In the follow-up sessions, teachers describe how they planned, taught, and assessed their own Quantitative Literacy units. They also present examples of their students' projects. The project is currently operating in 14 of the 67 counties of the State.

This action strategy addresses both the professional development of teachers who are already in the classroom and the preparation of new teachers. In order to assist current teachers, the strategy promotes sustained and intensive professional development activities that are based on mastery of mathematical content and tied to high-quality instructional materials and technology. Teacher preparation activities will aim at preparing future teachers of grades 5-8 to teach effectively the challenging mathematics content geared to national standards of excellence.

The increased demand for high-quality professional development generated by these plans could, without action now, exceed the capacity of those individuals and organizations currently supplying it. Thus, an essential component of fully equipping teachers will be ensuring the presence of a sufficient cadre of individuals and institutions skilled in providing professional development. This will require working with the mathematics communities, institutions of higher education, and other Federal agencies to help ensure the capacity to respond effectively.

To address professional development needs of current teachers, the National Science Foundation and the Department of Education will:

- Support sustained, intensive, high-quality professional development of teachers of mathematics in grades 5-8 as the cornerstone of their cooperative efforts to enhance the impact of Federal resources, emphasizing coverage of all teachers of mathematics in grades 5-8 in particular schools or districts. The agencies aim to help districts provide such professional development for twenty to thirty percent of the approximately 320,000 teachers of mathematics in grades 5-8, with particular attention to those who teach the largest numbers of disadvantaged students. *Flip and cover teacher prep*
- Initiate a short-term effort to strengthen the pool of talented, committed individuals able to provide exemplary professional development for classroom teachers. The agencies will support projects that will provide intensive training experiences for those who will lead future teacher training efforts. *Competition grant proposals? which program?*
- Support the creation of materials for professional development of teachers of mathematics in grades 5-8 that are grounded in the NCTM standards, tied to newly emerging educational materials and technologies, and assist teachers to link mathematics to real-world skills and applications.

Working DRAFT
10/13/97

PRIME in Pittsburgh

The Pittsburgh Reform in Mathematics (PRIME) project supports teachers in the classroom implementation of standards-based mathematics instruction and assessment in grades K-12 through the use of exemplary materials. PRIME provides teachers with a broad knowledge base in both the mathematics content and the successful mathematics pedagogy needed to implement the new materials successfully.

Funded ^{by the} under National Science Foundation guidelines as a project of Local Systemic Change through Teacher Enhancement in Mathematics, PRIME provides all 924 Pittsburgh public school teachers of mathematics with a range of experiences that include summer workshops; release-day professional development workshops; and individualized, in-class support provided by demonstration teachers within each school. Teachers of grades 6-12 receive 234 hours of professional development, and teachers of grades K-5 receive 102-132 hours. By equipping all Pittsburgh mathematics teachers with the knowledge, skills, and support necessary for using exemplary materials and assessment, PRIME will ensure that all students experience a coherent mathematics program that is expected to yield high achievement at all levels.

This four-year project, funded for over \$ 3 million, is a model for its ability to leverage an additional \$ 6.7 million in cost-sharing from district funds and commitments from Eisenhower and other Federal dollars.

- Support wider opportunities for teachers to help one another with content knowledge and teaching skills through such activities as dissemination of information about effective forms of professional development and encouraging the development of master teachers (including those recognized through the Presidential Awards for Excellence in Mathematics and Science Teaching and the National Board for Professional Teaching Standards Certification), mathematics specialists, and teacher networks.

To promote improved preparation of future mathematics teachers for grades 5-8, the Department of Education and the National Science Foundation will:

- Prepare and disseminate widely a study on State licensure requirements, focusing particularly on requirements for middle school teachers of mathematics, comparisons to other nations, and the impact of licensure requirements on the knowledge of mathematical concepts that teachers bring to their work in the classroom.

Teacher Preparation in Louisiana

What began as a movement to change the way mathematics is taught in grades K-8 in the Louisiana State Systemic Initiative has grown into a program that addresses the way in which teachers are taught. The NSF-funded Louisiana Collaborative for Excellence in the Preparation of Teachers is producing a set of future teachers who will transform teaching practice in the state.

In the first three years of the program, over 100 college faculty (both mathematics faculty and education faculty) on 15 campuses across the state have been involved in the project, 69 courses for future teachers have been revamped, and approximately 20,000 future teachers have been affected.

The central ^{principle} ~~principle~~ is to model in the education of future teachers the new methods of teaching mathematics that they will be expected to implement in the classroom, for example, working in small groups on challenging problems and using technology resources such as calculators or the Internet.

Louisiana red flag?

Working DRAFT
10/13/97

- Challenge the Nation's colleges and universities to step up to the needs for preparing a new generation of teachers for the 21st century by encouraging, supporting, and funding the development of teacher preparation approaches that:

- more tightly link college departments of mathematics and schools of education;
- include mathematics courses focusing on the deep concepts in mathematics related to the mathematical content that future teachers of mathematics in grades 5-8 will teach;
- demonstrate effective classroom practices; and
- involve local K-12 schools in the design of teacher preparation requirements.

rigorous

New Initiatives in Teacher Preparation

President Clinton has proposed a \$350 million initiative to attract talented people of all backgrounds into teaching at low-income schools across the U.S., and to dramatically improve the quality of training and preparation given to our future teachers, with an emphasis on mathematics and reading. Under the initiative, new scholarships would help bring nearly 35,000 outstanding new teachers into high-poverty schools in urban and rural areas over the next five years. These scholarships could cover costs of tuition, room, board, and other teacher preparation expenses — and could help fund additional preparation during the first two years of teaching.

The initiative will also provide competitive five-year grants to 10-15 national lighthouse models of excellence — institutions of higher education that operate the highest quality teacher education programs. Each institution receiving a lighthouse grant will use a majority of these resources to help several other institutions of higher education improve their teacher preparation programs, helping to improve the preparation of future teachers at an estimated 150 institutions of higher education across the nation.

strengthening

- Support the development of materials for preparation of K-8 mathematics teachers that are grounded in the NCTM standards and tied to newly emerging instructional materials and educational technologies.

Improving Teaching Through Distance Learning

The Department of Education's Star Schools Program provides quality, cost-effective instruction through distance education technologies to more than 1,640,000 learners annually in 50 states and U.S. territories. Although the program began with small rural schools in 1988, it is now equally valuable to schools in large urban areas.

The *Star Schools: The Next Generation* project of Oklahoma State University and Northern Arizona University delivers the "Getting Ready for Algebra" program, which provides simultaneous student instruction and teacher training to middle school students and teachers. Its units are student-centered and activity-oriented and emphasize learning by discovery. They focus on the big ideas common to arithmetic and algebra. Similarly, the United Star Distance Learning Consortium project led by Education Service Center—Region 20 in San Antonio, Texas, offers the *Algebra and Geometry Applications for Teachers* program, inservice training that models worthwhile mathematical tasks and helps teachers improve their ability to develop these tasks. The focus of the project is on mathematical topics that illustrate connections to real-life problems and exciting mathematics.

Implementing high-quality, standards-based curricula and instructional materials, including curricula that use educational technologies, in grade 5-8 mathematics classrooms

The TIMSS results showed that the content of curricula and instructional materials used in US classrooms in the middle school years in 1995 differed from those in high performing countries in significant ways. The content taught in most U.S. eighth-grade mathematics classrooms would be found in

Working DRAFT
10/13/97

the seventh grade in high-performing nations. Our low expectations for student performance are also shown by the fact that only about 25 percent of U.S. eighth grade students are enrolled in algebra courses, while in high-performing nations virtually all students have the opportunity to master the foundations of algebra and geometry by the end of eighth grade.

In addition, TIMSS noted that middle school mathematics materials covered more topics and were less focused in the U.S. than in leading countries. For example, typical American eighth grade mathematics textbooks in 1995 covered as many as 35 major topics compared to as few as 10 such topics in Japanese textbooks, leaving little time for teaching for student mastery and depth of understanding.

New, comprehensive mathematics instructional materials, linked with high standards for mathematical content and pedagogy and aligned with the NCTM standards, are now emerging from development and reaching the market. These newer materials provide a range of different approaches to classroom instruction, but generally focus on 15 or fewer topics per year.

Supplementary materials that are linked to the topics of the comprehensive materials can permit teachers to tailor instruction to particular classrooms, facilitating the transition to new curricula. They can be particularly helpful in taking advantage of new and emerging learning technologies and in providing examples from real life for new concepts.

Selection of comprehensive curricular materials usually takes place at the district or even the State level, whereas the choice of supplementary materials is more likely to be made at the school level. Speeding the transition to more appropriate instructional materials, particularly when this is tied to effective professional development for teachers, will have a significant impact on student achievement.

Open CESAME!

Northeastern University's Center for the Enhancement of Science and Mathematics Education (CESAME), through its Statewide Implementation Program (SIP), demonstrates how school districts can successfully implement challenging standards-based instructional materials. Through a contractual agreement, the project provides districts in Massachusetts with multi-year funding, technical assistance, professional development guided by curriculum developers, and linkages to statewide reform efforts. SIP also conducts research to determine the most effective model for disseminating such materials. Throughout, SIP works to make districts accountable by collecting data and continually focusing on achieving a sustained, high-quality materials implementation.

Funded by the National Science Foundation's Teacher Enhancement program, SIP provides expertise in implementing high quality materials to any Massachusetts district engaged in mathematics and science reform, and leads one of the five regional centers of the Massachusetts Statewide Systemic Initiative (SSI). This five-year project, funded for over \$ 4.4 million, has leveraged an additional \$ 3.8 million in cost-sharing from district funds, Northeastern University, and the Noyce Foundation.

To assist schools, districts, and States in choosing and implementing effective curricula and instructional materials for mathematics in grades 5-8, the National Science Foundation and the Department of Education will:

- Encourage and support coordinated efforts aimed at:
 - Facilitate upgrading of mathematics instruction through encouragement and support for coordinated planning and action aimed at:
 - purchase of new instructional materials geared to rigorous standards; *providing high quality*
 - necessary professional development *aimed at their implementation*, and *connected to new materials implementation*
 - employment of highly skilled mathematics specialists who are prepared to teach the new materials and guide others in their implementation.
- Such efforts*
Each of these, for example, would be eligible for use of Title I funds, and could be part of the coordinated plans described in the section on cross-cutting activities.
of the report

Working DRAFT
10/13/97

- Develop and disseminate guides to help ^{interest} schools and school districts select instructional materials and software most appropriate for their local needs and undertake the necessary steps to effective implementation. This effort will include reviews of instructional materials and software designated by experts as promising or exemplary. ^{outside}
- Provide technical assistance for schools and school districts in putting updated mathematics instructional materials to work in the classroom. NSF-supported curriculum implementation sites dedicated to mathematics materials for grades 5-8 will work with broader technical assistance providers, including the Department's Eisenhower Regional Consortia and National Clearinghouse, as needed.
- Continue to support development of supplementary materials, with new priority for efforts aimed at mathematics in grades 5-8, to assist schools and districts in making the transition to standards-based comprehensive materials.
- Seed research and development of powerful models for integrating technology into classroom practice and informal learning environments. This will include support for critical expansion and evaluation efforts preceding commercialization of these models. K-8 mathematics will be a high priority in the near term.

Eisenhower Regional Consortia for Science and Mathematics Education

The mission of the ^{sc} ten regional consortia is to provide a field-based national infrastructure for systemic improvement of science and mathematics education. Projects provide information on curriculum, assessment, and teaching practice; conduct workshops and training; and serve as advisors to the field. ^{jargon}

One example of the work of the consortia is the 1996 publication by the WestED consortium of Tales From the Electronic Frontier. This is a collection of ten teachers' narratives regarding their use of the Internet to enhance science and mathematics instruction and create opportunities for their own professional growth. The accounts describe using this resource for project-based learning, for making abstract scientific principles more concrete, and for promoting deeper understanding. Each story provides information on related resources and programs, and concludes with a section of questions and issues to stimulate further thought and discussion.

"Hoop Happenings" ^{verb} ^{nenses?} was the tale of a math communication project between students at the Drexel Hill School in Philadelphia, Pennsylvania, and senior education majors at Iowa State University. During their teaching methods class for elementary mathematics, each student ^(is) paired with a group of students at an elementary school with whom she interacts (via e-mail) over a math problem she defines each week. The interactive discussion provides the education majors with insight into children's thinking; for the children the project strengthens their abilities to solve problems and to discuss their problem solving approaches.

Tales can be found on WestED's WWW site at <http://www.wested.org/tales>.

Working DRAFT
10/13/97

While several other Federal agencies have long worked to support educational improvement efforts, in the past, few other agencies have contributed to the development of standards-based instructional materials in mathematics and science. This is changing, and there are significant contributions that other agencies can make in this area, consistent with their primary missions. The development of supplementary materials with *mission-oriented situations that generate real-life problems* and the delivery of such materials through technology are key potential contributions.

- Agencies will work in cooperation with NASA and NCTM to develop standards-based materials along the lines of NASA's "Mission Mathematics." These materials illustrate the use of mathematics in engaging, real world examples related to the agency mission.
- The Department of Education is chairing a Federal Government-wide working group that has already begun to promote and develop -- and make it easier for teachers and others to find -- high-quality educational materials, including instructional units and related materials, for use on the Internet. The purpose of this group is to take the rich informational resources of organizations such as the Census Bureau or the U.S. Geological Survey, and make them easier for teachers and others to find and use. The first priority of this group will be to identify materials that support teaching of challenging mathematics.
- The Departments of Defense and Education and the National Science Foundation are leading an interagency review of Federal activities related to research in learning technologies in order to establish effective practices for their use.

Each of these efforts could make new types of materials and capabilities possible in the future. Activities that enable students to

achieve to high standards play an important role in all these Federal activities.

NASA's Mission Mathematics

The recent production of "Mission Mathematics" by NASA demonstrates how an agency can base its educational work on national standards. These three volumes of problems and activities are the descendants of NASA's first mathematics curriculum supplement, "Space Mathematics: A Resource for Teachers," published in 1972. That popular title was updated repeatedly over the years. "Mission Mathematics," however, is totally revamped to accord with national standards. Indeed, the subtitle is now "Linking Aerospace and the NCTM Standards." The three volumes are divided into K-6, 5-8, and 9-12 to accord with the Standards, and the contents of each are keyed not only to NCTM's curriculum standards, but also to those for teaching and for student assessment. Examples of activities include calculating orbits, collecting and analyzing specimens, planning for spaceflight needs, etc.

This linking to standards was accomplished by making "Mission Mathematics" a joint project of NASA and NCTM. Writing teams included teachers, supervisors, and university professors working in consultation with NASA representatives. Their drafts were field-tested by classroom teachers and reviewed by NCTM's Educational materials Committee. The results are attractive and modestly priced, with publicity, marketing, and distribution through NCTM's established network.

Building public understanding of challenging mathematics in grades 5-8, and gaining public support for raising student achievement toward high standards.

All American students should leave eighth grade prepared to pursue the higher-level mathematics and science courses that are the gateway to college, good citizenship, productive employment, and lifelong learning. In realizing this vision, it is essential that educators, parents, and students themselves understand what high standards in mathematics look like and why they are important. This outcome requires activities

Working DRAFT
10/13/97

and information that reinforce the classroom experience and convey the importance of mathematics achievement. Such activities should draw on the support of parents, the professional community of mathematicians, scientists, and engineers, business, and the broader public.

This section of the action strategy includes two complementary elements. The first consists of efforts to make standards fully and clearly understood. If parents and students and teachers don't know where they should be headed -- what they agree students should know and be able to do -- it is hard to pull together to get there. Schools must have a clear sense of what they are doing and be able to communicate effectively with parents as well as work to invite active parental participation.

Saturday Schools Provide Tutoring Boost

The George B. Thomas Sr. Learning Academy Inc. (known as Saturday School) has provided free tutoring and mentoring to minority students in Montgomery County (MD) for nearly 11 years. Spearheaded by members of the Mu Nu chapter of the Omega Psi Phi fraternity, the program began in a public housing community's day-care center, but is now located at Sherwood High School (Olney, MD) and Springbrook High School (Silver Spring, MD).

About 180 students and 100 tutors--engineers, mathematicians and others (including high school students fulfilling Maryland's community service graduation requirement)--are registered at the centers; there is often a waiting list of pupils because there aren't enough tutors. Saturday School views itself as a partner with the students' schools; principals refer students to the program and teachers advise tutors on where students need help. Montgomery County Public Schools contributes classrooms, supplies, and training for tutors and parents. The sessions last 2 or more hours; tutors work with students on a wide range of mathematical topics and help students prepare for the Scholastic Assessment Test. Parental participation is required; about one-fifth of the parents tutor.

The second element builds on the first through partnerships that bring together the many groups that can contribute to helping students achieve high standards in mathematics. These partnerships will elevate the importance of mathematics achievement and provide clear avenues through which interested members of the mathematics, science, engineering, business and education communities, as well as parents and interested citizens, can contribute to efforts to raise mathematics achievement.

The Department of Education, the National Science Foundation, and other Federal agencies will foster the partnerships by promoting a national dialogue on improving mathematics, acting as a clearinghouse for information and proven approaches to action, helping partners to develop exemplary materials that can be used in their State and local efforts, and mobilizing staff and resources to support local partnership efforts. Effective partnerships must build upon and complement what goes on in the schools. Thus, teachers and school administrators must be vital participants, either formally or informally.

In order to support these strategies, the Department of Education and the National Science Foundation will:

- Sponsor a national convocation on middle school mathematics to initiate a continuing dialogue on:
 - what we should expect our students to be able to achieve in mathematics by eighth grade and beyond;
 - exemplary practices in professional development, curricula, instructional materials, and technologies; and
 - opportunities for parental involvement and community support to help students meet high expectations.
- Seed the continuing national dialogue by providing a wide variety of sample items illustrating the level of standards, examples of student work, and information on curricula, instructional

Vague -
what refers
to?

?
which
standards?
high
standards?

Working DRAFT
10/13/97

methods and technologies that support high standards.

- vehicles?*
- Provide teachers and other educators with information on how they might use assessment in planning instructional improvement strategies. These materials will include information on how best to use results from the voluntary national mathematics test -- to interpret them to students and parents, place them in appropriate context, and improve mathematics instruction.
 - Create an easy-to-use mathematics Web site providing information on the standards-based instructional units for teachers; information on the national test, including sample problems and examples of student solutions; and all the other materials developed or identified as part of this action strategy.
- national standards?*
and possibly link to other math vehicles?

Partnership activities will be focused at State and local levels, with the Federal Government fostering their development, largely by drawing on the strengths of national organizations that would then work through their State and local affiliates. These partnerships will be designed to draw students, parents, teachers, and others important in influencing student decisions on course-taking into an engaging setting for the practice of mathematics. If such partnerships could reach 1 million students in grades 5-8 per year, they could have a significant impact on improving mathematics achievement for all students in those grades.

state or local?

The Department and the Foundation will

- Connect national organizations with interests in helping to raise levels of achievement in mathematics and science (for example, professional societies of mathematicians, scientists, and engineers) with State, local and community-based organizations having similar purposes, particularly those already linked to ongoing agency activities.

- Develop systematic mechanisms for the headquarters and field offices of relevant Federal agencies to participate in the partnerships.
- Arrange for the development and dissemination of a weekly series of high-quality, engaging mathematical exercises for students in grades 5-8 that can be used as a common core activity in State and local partnership efforts. It is *such* anticipated that exercises would appear in a recognizable format in many different places using a variety of media. Each would have introductory material designed to provide motivation for the exercise, possibly through the use of celebrities or through a clear description of how the material was generated from real-life situations. Guides for use of the exercises within the partnership efforts and information on how to find hints, help and related materials would also be provided.
- Support a continuing campaign of public information and engagement through existing and newly developing joint programs.

The partnership activities themselves might take many forms, with each dictated by the needs of the State or locality in which they are active. Some may require seed funding from Federal agencies, while others will form of themselves. Examples of partnership options that currently exist, might be expanded, or might be incorporated in newly forming partnerships at local, State, or national levels include:

as appropriate to

- Institutions of higher education or Federal agencies partnering with local K-12 schools and their parent organizations to build understanding and support for teachers and administrators implementing reform activities;
- Professional societies in mathematics, science, and engineering providing guidance for their members on interacting with schools and teachers productively;

Working DRAFT
10/13/97

- Summer mathematics efforts that keep students growing mathematically, modeled after the Department of Education's successful summer reading effort;
- Mathematics ~~fitness~~ ^{discussion} circles or networks taking advantage of the weekly problems, including discussions of how these problems illustrate the standards and the importance of mathematics for future education and work;
- Support for students via telementoring by adults actively using mathematics in their work;
- After school and evening use of facilities (such as space or computers) of local businesses, academic institutions, local government, and community organizations for mathematics- oriented activities for students and their parents.

Mathematics Education and the Department of Defense

Two agencies within the Department of Defense (DoD) represent contrasting approaches to introducing rigorous national standards in their education activities.

Unique among the agencies are the DoD Dependents Schools (DoDDS), which run as essentially autonomous school systems overseas and on military bases in the U.S. They certify teachers and develop leader-teachers, tutors, and mentors who, like the DoDDS math curriculum used world-wide (K-8 and 9-12), embrace the NCTM standards. ^{based on} *challenging standards*

The National Security Agency established a Mathematics Education Partnership Program (MEPP) in 1991. MEPP provides over a thousand talks per year to schools and colleges through its Speakers Bureau. It donates excess computers to classrooms, sponsors seminars and inservice teacher training, and conducts extended summer workshops for teachers at all levels (for a description, see www.nsa.gov.8080/programs/mepp). These MEPP activities, including projects such as collaboration with the University Corporation for Atmospheric Research's Project SkyMath, are all informed by the NCTM Standards, which are an explicit subject of study and reference at MEPP's Summer Institutes for Teachers.

Working DRAFT
10/13/97

V. CONCLUSION

too inward looking

The interagency cooperation stimulated by the effort to produce this action strategy should have a lasting impact on the effectiveness of Federal programs and activities that support improving achievement in mathematics and science education. In addition to bringing the two agencies with the most extensive programming in this area together, it spurred further contact with other potential Federal partners, both those that have a tradition of strong presence in mathematics and science education and those who are new to such efforts.

The effort has been particularly timely in view of the growing interest among mathematicians, scientists and engineers in helping K-12 schools to improve the performance of their students in mathematics and science. The Department of Education, with its links to State and local education agencies and community groups, and the Federal science and technology agencies, with their ties to mathematicians, scientists, and engineers and their national professional organizations, can help make important connections to spur the development of effective partnerships.

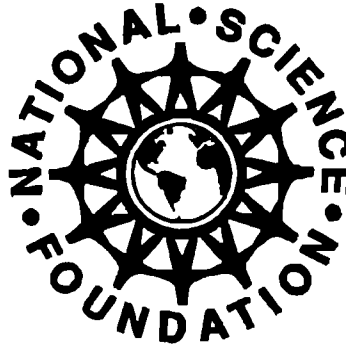
But the action strategy is only the beginning of the effort. The interagency cooperation must continue and move to the substantive agenda of implementing the strategy. The Department of Education and the National Science Foundation are committed to meeting the challenge of continuing cooperation so that their programs work in concert. They will enable the development of appropriate mechanisms to keep other agencies and the professional scientists, mathematicians and engineers with whom they work actively involved in improving achievement in mathematics and science education. Perhaps most importantly, they will keep the goal of raising the achievement of all American students in mathematics and science at the forefront of their attention.

A New Federal Education Partnership Program at the Department of Transportation

Magnetic levitation trains, highways that provide constant updates on traffic conditions ahead, ~~tollbooths subtracting tolls automatically from encoded stickers on cars~~, and geopositioning satellites that enable travelers to determine where they are anywhere on earth at any time: these are transportation "dreams" well on their way to becoming realities, dreams that can lead to highly-paid jobs for those with the appropriate skills. Too many students, ill-prepared for such jobs, must leave the dreaming to others.

Through the new Garrett A. Morgan Technology and Transportation Futures Program, the Department of Transportation (DOT) will stimulate public-private partnerships to help students and their families understand the importance of mathematics and science for future careers and to make math and science relevant and exciting for students in ^{Six} and outside the classroom. Such partnerships will encompass interagency collaboration, government-industry cooperation and community involvement. Sample activities include:

- With the Department of Education and its business and community partners, DOT will encourage the transportation community to participate in the America Goes Back to School program, to build support for mathematics, science, and technology achievement.
- Help ^{to} change public perceptions about the importance of studying mathematics and science by creating awareness of the wide variety of exciting jobs in transportation that require those skills.
- Build ^{up} DOT's 300+ adopted schools to provide mentors, tutors, career information, and other forms of support for math literacy;
- Encourage ^{staff} to support student mathematics achievement in their local communities, by supporting summer, after-school and weekend activities that help students learn or by serving as "telementors," helping students with homework over the Internet.
- Bring ^{to} together private sector sponsorships and expertise and nationally recognized teachers to develop exciting materials with a transportation focus for teaching mathematics, science, and technology.



National Science Foundation

Office of the Director

4201 Wilson Boulevard
Room 1205
Arlington, Virginia 22230

Phone: 703-306-1002 Fax 703-306-0109

Date: 10/27/97

To: Bill Kinkaid, Domestic Policy Council

Fax No.: 202/456-7028

From: Judy Sunley

Pages: 16 *(Including Cover Sheet)*

Comments:

This is Part 1 of two faxes.

Please call the number above if you experience transmission problems.

APPENDIX 1

PRESIDENTIAL DIRECTIVE

March 6, 1997

MEMORANDUM FOR THE:
SECRETARY OF EDUCATION
DIRECTOR OF THE NATIONAL SCIENCE FOUNDATION

SUBJECT: Preparing Students to Meet National Standards of Excellence in Eighth Grade Math and Improving Math and Science Education

Since the early 1980's, U.S. elementary and secondary school students have begun taking tougher courses, and we are starting to see the results. National Assessment of Educational Progress scores have improved in math and science, with gains in mathematics equal to at least one grade level. On the SAT, average math scores are at their highest in 25 years, even as the number and diversity of test-takers have increased. However, the eighth-grade results of the 41-Nation Third International Math and Science Study (TIMSS), released this fall, show that the U.S. is below average in math and just above average in science. That isn't acceptable; in this technology-rich information era, our students need to perform much better in both subjects, but especially in math, if they are to excel at higher level math and science courses that are the gateway to college and to citizenship, productive employment, and lifelong learning.

The first step in raising achievement is lifting expectations and setting high standards for what students should know and be able to do. TIMSS, our National Assessment of Educational Progress, and the standards developed by the National Council of Teachers of Mathematics give us a solid framework to build on. Last month, to help parents and teachers learn who needs help, what changes in teaching to make, and which schools need to improve, I asked the Secretary of Education to develop a voluntary national test for individual eighth-grade students based on widely-accepted, challenging national standards in mathematics. The national test will be available to states and local school districts to give to their students in the spring of 1999, and will measure whether students have reached a high level of mathematics proficiency.

The primary responsibility for achieving high standards rests with students, teachers, parents, and schools in local communities across America. However, it is imperative that we work to ensure that federal resources support student success as well. We must ensure that federal programs, research, and human resources are used as effectively as possible to help improve teaching and learning.

Therefore, I direct the Department of Education and the National Science Foundation, together with other agencies identified in cooperation with the Office of Science and Technology Policy and the Domestic Policy Council, to develop an action strategy for using key federal resources to assist states and local school systems prepare students to meet challenging math standards in eighth grade, and for involving the mathematics, scientific, and technical communities in support of these efforts.

The action strategy should include recommendations for the use of federal resources to help states, local school districts and schools to improve teaching, upgrade curriculum, integrate technology and high-quality instructional materials into the classroom, as well as motivate students and help them understand how math concepts are applied in the real world. The strategy should identify significant federal programs, activities, and partnerships available to improve teaching and learning, ensure that these resources are appropriately focused on helping students reach challenging math standards, and determine how these resources can best support state and local reforms. In developing this strategy, the inter-agency group should review the current status of improvements in math education, and identify and address critical areas of need, drawing on research and input from educators and professional organizations.

Because teaching and learning in math and science are so integrally related, and because success in both subjects is vitally important in this information era, the working group should also review how federal resources and partnerships with other organizations can help improve student achievement in science.

The working group should make its recommendations and submit its action strategy to me within 90 days.

WILLIAM J. CLINTON

cc: ASSISTANT TO THE PRESIDENT FOR DOMESTIC POLICY
ASSISTANT TO THE PRESIDENT AND DIRECTOR OF THE OFFICE OF
SCIENCE AND TECHNOLOGY POLICY

Working DRAFT; 10/24/97

APPENDIX 2

Voluntary National Tests in Reading and Math: A Strategy to Master the Basics and Reach High Standards

Clear standards of achievement are essential to help instill the skills, American values, and encouragement for hard work that our children need to succeed in school and in life. Toward that end, meaningful standards for what students should be expected to learn and achieve in the basic subjects of reading and mathematics are critical. Reading well by grade 4 and mastering mathematics -- including the foundations of algebra and geometry -- by grade 8 are the gateways for further learning and achievement.

Parents need to know that students have mastered the basics no matter where they live or move in this country. And they have the right to know how well their children are doing compared with students in other schools, states, and countries. To help give parents this information, the U.S. Department of Education is offering every state and school district the opportunity to use voluntary national tests of 4th grade reading and 8th grade mathematics, beginning in 1999.

These rigorous tests will provide parents, for the first time, scores for individual students, measured against widely accepted national and international standards of excellence. They will give states, local communities, teachers and parents the kind of accurate information they need to help students master basic and advanced skills and strengthen academic performance. Most importantly, they can galvanize a national effort to improve the odds for students and help ensure that all students master reading and math.

The tests will be modeled on the National Assessment of Educational Progress (NAEP) in 4th grade reading and 8th grade mathematics, and in the case of mathematics will be linked to the Third International Math and Science Study. The NAEP standards reflect a national consensus of what students should know and be able to do when they reach these crucial stages of learning.

The current NAEP is designed to assess how well a sample of students across the entire nation and individual states perform in reading and mathematics. A very small percentage of students participate in NAEP, and no parents know how their own children do on this test. In contrast, the voluntary national tests will provide students, parents, and teachers with meaningful scores to compare individual student performance to widely accepted national and international standards and to identify students and schools that need extra help. These standard measures of excellence will help parents hold schools accountable for improved performance, help teachers and principals improve curriculum and instruction, and give students a guide for charting their own progress.

The Department of Education recently submitted proposed legislation to Congress that would have the National Assessment Governing Board (NAGB) develop the tests. NAGB is a bipartisan, independent board created by Congress to oversee the NAEP. NAGB is expected to seek guidance in test development from a wide range of sources, including the most successful mathematics and reading teachers, parents, governors, and local and state education, civic and business leaders. Individual test scores will not be collected by the federal government; state and local school districts will decide how to use the data. Each test will require approximately 90 minutes of total testing time. States and school districts can administer the tests as part of their local testing programs.

Working DRAFT
10/24/97

APPENDIX 3

THE INTERAGENCY WORKING GROUP

In response to the memorandum from the President, the Department of Education and the National Science Foundation formed an interagency working group comprised of staff experienced in the areas under review. Officials of the Office of Science and Technology Policy, the Domestic Policy Council, and the Office of Management and Budget provided oversight.

Consistent with the directive, the interagency group immediately began a review of current Federal efforts in mathematics and science education with particular attention to mathematics education in kindergarten through eighth-grade. (See Appendix 4 for a summary of relevant programs in the two agencies.) In addition, as the memorandum instructed, the interagency group drew on research and input from educators and professional organizations, by reaching out to the broader mathematics and educational community for advice and guidance. (See Appendix 5 for a summary of these outreach efforts, including a list of organizations with which the working group consulted.) The interagency group also consulted with appropriate staff in other agencies that have, or are interested in establishing, activities in elementary and secondary-level mathematics or science education. (See Appendix 6 for a list of the agencies consulted and a summary of their input.)

Early in its deliberations, the working group recognized the importance of developing an appropriate focus for the action strategy. Based on the results of the Third International Mathematics and Science Study (TIMSS) and the desire that students have proper preparation for the President's proposed national voluntary test in mathematics, the group concluded that in the near term, the action strategy should focus on mathematics in the middle grades (5-8). Thus, while the action strategy is designed to improve achievement in science and mathematics at all grade levels, it addresses that goal by concentrating on improving achievement in middle school mathematics first. To be fully effective in achieving the long term goals, this effort must broaden to include mathematics and science in all grades once the immediate concerns for mathematics in grades 5-8 have been addressed.

Participants in the Interagency Process

Secretary Richard Riley of the Department of Education and Neal Lane, Director of the National Science Foundation convened the working group. Their acting deputies, Marshall Smith and Joseph Bordogna, respectively, provided guidance through regular interaction with the working group, as did Luther Williams, Assistant Director for Education and Human Resources at the National Science Foundation.

Several members of the staff of the Executive Office of the President were instrumental in the work of the interagency group, including: Michael Cohen, Domestic Policy Council; Clifford Gabriel, Office of Science and Technology Policy; Mary Cassell and Anne Tenney, Office of Management and Budget; and Daniel Goroff, Office of Science and Technology Policy. William Kincaid of the Domestic Policy Council and Daryl Chubin of the Office of Science and Technology Policy were particularly important to developing the action strategy and to keeping the working group on track.

Working DRAFT
10/24/97

Members of the Working Group

Co-Chairs

Thomas M. Corwin
Director, Division of Elementary,
Secondary, and Vocational Analysis
Budget Service
Department of Education

Judith Sunley
Assistant to the Director for
Science Policy and Planning
National Science Foundation

Committee Members

Carol Chelemer
Office of Educational Research and
Improvement
Department of Education

Diane Spreser
Program Officer, Teacher Enhancement
(Mathematics)
National Science Foundation

Margaret Cozzens
Director
Division of Elementary, Secondary, and
Informal Education
National Science Foundation

Robert Stonehill
Director, State and Local Services Division
Office of Educational Research and
Improvement
Department of Education

Eric Hamilton
Program Director,
Educational System Reform
National Science Foundation

Larry Suter
Acting Director, Division of Research,
Evaluation, and Communications
National Science Foundation

Christine Jackson
Senior Program Officer, Eisenhower
Professional Development Program
Department of Education
(replaced Clare Banwart 4/97)

Judy Wurtzel
Director of the Mathematics Initiative
Office of the Acting Deputy Secretary
Department of Education

Deborah Spitz
Program Analyst
Office of the Undersecretary
Department of Education

Working DRAFT
10/25/97

APPENDIX 4

RELEVANT ACTIVITIES OF THE DEPARTMENT OF EDUCATION AND THE NATIONAL SCIENCE FOUNDATION

DEPARTMENT OF EDUCATION

The Department of Education provides flexible support, technical assistance, and research-based materials to assist state and local education agencies in improving teaching and learning. This year, the Department has identified seven national priorities that will guide its activities building on President Clinton's Call-to-Action over the next four years. The first three focus on specific results that all students should achieve: reading independently by the end of third grade; mastering challenging mathematics (including the foundations of algebra and geometry) by the end of eighth grade; and being prepared for and able to afford college by 18 years of age. The remaining four priorities address key strategies to enable students to achieve these goals: challenging standards and accountability for every school; a talented, dedicated, and well-prepared teacher in every classroom; Internet access in every classroom with technologically literate students; and strong, safe, and drug-free schools. The following programs provide valuable support to States and schools in their efforts to reach the goal of providing high-quality education in mathematics for all students.

Flexible Support to States, Communities, and Schools to Improve Teaching and Learning:

The Title I Education for the Disadvantaged program is the Federal Government's largest program that supports elementary and secondary education, with current funding of almost \$7.2 billion for grants to local educational agencies. Title I provides funds to help low-achieving children, particularly those in high poverty schools, learn to high standards. Title I can give disadvantaged children the benefit of, for example, more individualized and accelerated instruction, extended-day programs, and learning laboratories in mathematics, science, and computers. Mathematics has always been a major focus of the Title I program: according to the most recent data, 48 percent of 9 million participating children receive some instruction in mathematics.

The 1994 reauthorization of Title I emphasizes holding students participating in Title I to the same high standard as all students. By the 1997 - 1998 school year, all States must adopt challenging standards in reading and mathematics. By 2001, States must implement high-quality assessment systems aligned to the standards to assess the performance of Title I schools in relation to State standards.

Schools that serve an area in which the percentage of children living in poverty exceeds 50 percent may use their Title I funds, in combination with other Federal, State, and local funds, to upgrade the school's entire instructional program. These programs are called "school-wide programs." Other schools use the money to help those children most in need of supplementary services. In addition, the Title I statute emphasizes the professional development of educators; every local educational agency participating in the Title I program must provide high-quality professional development, geared to challenging State standards, to improve teaching of academic subjects.

Goals 2000: Educate America Act --currently funded at \$476 million, is the primary Federal program supporting standards-based state education improvement. All 50 States now participate. Goals 2000 provides flexible funding to the States to enable them to

Working DRAFT
10/25/97

develop and implement their own strategies for achieving the National Education Goals (including the goal of becoming first in the world in mathematics and science). With funding from the program, States are establishing challenging academic standards with which they are aligning their student assessment programs, teacher preparation and licensure requirements, parental and community involvement, and other aspects of their education systems.

Professional development is an important component of Goals 2000. Program funds allow States to make competitive subgrants for activities to improve pre-service teacher education and support intensive, sustained professional development for educators and other school personnel. Many States and school districts are also using Goals 2000 funds to support effective use of educational technology.

Professional Development in Mathematics and Science:

Eisenhower Professional Development State Grants, currently funded at \$310 million, support a wide array of professional development activities in the core academic subjects. By statute, at least \$250 million of the Eisenhower funds must be spent on professional development in mathematics and science. The strengths of the program are its reach -- funds flow to States and school districts by formula, and the vast majority of local educational agencies participate -- and the flexibility it provides to State and local administrators to carry out program activities that meet particular State and local needs. The 1994 program reauthorization established requirements that the program fund only professional development that is tied to challenging State content standards and is of sufficient intensity and duration to have a positive and lasting impact on teachers' classroom performance. In fiscal year 1998, the program should reach almost 350,000 educators.

The **Eisenhower Professional Development Federal Activities** program supports an array of national professional development initiatives. The Eisenhower program supports the National Board for Professional Teaching Standards (NBPTS), which establishes national standards of excellence in teaching and recognizes teachers attaining these standards through a rigorous assessment process. The Department has requested increased funding to enable 105,000 teachers to become board certified by the year 2006 on average, one for every elementary and secondary school in the nation. The Department's proposed budget would also speed the development of certification frameworks and assessments so that by 2002, certificates for 25 teaching fields will be available. Eisenhower also supports nine state-wide projects across the nation that are working on improving preservice education, licensing requirements and the experience of teachers during their first three years of teaching.

The **Telecommunications Demonstration Project** (PBS Mathline) uses the professional teaching standards of the National Council of Teachers of Mathematics (NCTM) as the basis for its year-long professional development program called the Elementary School Mathematics Project. This project, which complements Mathline's already-successful Middle School Mathematics Project, allows teachers to learn at times and locations they find convenient. It uses a series of 20 videos, each accompanied by a guide that includes lesson plans, ideas for extending the lesson, additional resources, and discussion topics relating the video content to the NCTM standards. Teachers also participate in a year-long, online learning community of 25-30 fellow teachers, with an accomplished practicing teacher serving as mentor and facilitator. Over the course of three years, PBS Mathline has provided more than 4000 teachers of K-8 mathematics in 36 states

Working DRAFT
10/25/97

with in-depth, standards-based training and has been recognized by the NCTM as an effective professional development program.

Technical Assistance and Information Sharing:

The **Eisenhower Mathematics and Science Regional Consortia** provide professional support to help teachers teach to high standards. The ten Regional Consortia have three primary objectives: 1) to collaborate and form coalitions with other organizations involved in mathematics and science education improvement; 2) to provide technical assistance and facilitate the use of technology as a tool for instruction and professional development; and 3) to identify and disseminate materials on exemplary instruction in mathematics and science.

The **Eisenhower National Clearinghouse for Mathematics and Science Education (ENC)**, funded under Eisenhower Federal Activities, collects a wide range of materials in mathematics and science and makes them available on-line and on CD-ROM. As of September 1996, which concluded its fourth year of operation, ENC had collected a total of 7,055 records and was in the process of identifying over 4,500 more. Between October of 1995 and June of 1996, the Clearinghouse reported over three million "hits" to its Web site. ENC Online (www.enc.org) has been recognized as an exemplary Internet site by Classroom Connect, Syllabus Magazine, Geometry Forum, Education Index, and Multimedia Schools. ENC also works with the Regional Consortia to create demonstration sites throughout the country, where educators can interact with the latest technological developments.

Information is also disseminated through the **Educational Resources Information Center (ERIC)**, a national system of specialized clearinghouses that maintain and provide access to the world's largest electronic database of education-related materials.

Research, Statistics, and Assessment:

The **National Research Center on Achievement in School Mathematics and Science** is housed at the Wisconsin Center for Education Research at the University of Wisconsin. The Center is a collaboration with the Technical Education Research Center (TERC), Vanderbilt University/Peabody College, the University of Pittsburgh, and the University of Massachusetts-Dartmouth. The Center's mission is to create and validate a set of principles for designing classrooms that promote student understanding in mathematics and science.

Data relating to education are collected, analyzed, and reported by the **National Center for Education Statistics (NCES)**. In collaboration with the National Science Foundation, NCES is currently reporting the results of the Third International Mathematics and Science Study (TIMSS), and providing follow-up information on those results. Other NCES studies collect detailed, reliable information on the conditions of schools, teachers, and students throughout the nation. The National Assessment of Educational Progress (NAEP) measures the progress of the nation's students in core subjects, including mathematics and science.

Working DRAFT
10/25/97

NATIONAL SCIENCE FOUNDATION

Since its inception in 1950, the National Science Foundation (NSF) has served the Nation by investing in research and education in science, mathematics, technology, and engineering. NSF's goals for education and training require attention to needs at every level of schooling and access to quality science, mathematics, engineering, and technology educational opportunities for all members of society.

PreK-12 Systemic Reform

Systemic refers to fundamental, comprehensive, and coordinated changes made in science, mathematics, technology, and engineering education through attendant changes in policy, financing, governance, management, content, instruction, and assessment. Systemic reform occurs when all essential features of institutions and systems are engaged and operating in concert; when policy is aligned with a clear set of goals and standards; and when the improvements and innovations become an intrinsic part of the ongoing educational system for all participants and are incorporated in budgets.

PreK-12 systemic reform is supported through NSF state, urban, local, and rural systemic reform initiatives. The implementation of high-quality, standards-based instructional materials, assessment systems, and professional development are keys to success of all initiatives. Development and administration of coherent policies and legislation to support science and mathematics education; convergence of resources to support a single, unitary program; promotion of effective partnerships with the private sector and higher education institutions; achievement of support from the community, parents in particular; collection, interpretation and effective use of data, including student achievement; and cohesive, coherent strategic planning to ensure the improvement of all students' achievement are essential components to the immediate and long-term sustainability of reform activities. Since 1996, the systemic initiatives have begun to make the transition from building an infrastructure to supporting science and mathematics education reform to the classroom implementation of standards-based curricula, instruction, and assessment. Extensive leveraging of funds from business, industry and other federal agencies occurs in all systemic initiatives, in some case as much as 4 to 1 with NSF dollars.

The Statewide Systemic Initiative (SSI) Program has supported a total of 25 states and the Commonwealth of Puerto Rico to establish comprehensive changes in mathematics and science education through the implementation of K-12 standards-based instructional programs, professional development, and assessment systems; new policies; and effective partnerships. A total of 20 eligible cities with the largest numbers of school-age children living in poverty have been funded under the Urban Systemic Initiative Program (USI). A total of four rural, economically disadvantaged regions are implementing programs to promote high-quality science, mathematics, and technology education through the Rural Systemic Initiatives (RSI). RSI programs have focused on the implementation of instruction through the use of advanced telecommunications networking and distance delivery of quality programs and professional development.

Building Blocks of System Reform:

Systemic reform is built on a foundation of quality instructional materials, initial education and professional development of teachers in both content and pedagogy, new strategies for the assessment of student learning, a diverse teacher population, and appropriate use of

Working DRAFT
10/25/97

technology. Thus a major focus of activities and budget at NSF is assuring that these building blocks are available and in place.

Teacher Education: Teachers must have a high level of content knowledge and pedagogical skills and be prepared to utilize the most effective instructional materials, assessment strategies, and educational technologies. Teacher education includes both preservice and inservice education.

Over 40,000 teachers in 1,930 schools, impacting over 1.3 million students annually, participate in intensive professional development activities through the **Local Systemic Change (LSC) Initiatives**, K-8 in Mathematics and Science and 7-12 in Mathematics. These teachers receive a minimum of 100 hours for K-8 or 140 hours for 7-12 of professional development and receive ongoing support through the academic year. They implement quality standards-based instructional materials and reform the mathematics and science programs in their schools as a whole. Extensive leveraging of Title I, Eisenhower, district, and industry funds occurs in at least an amount equivalent to the NSF award in each LSC project. In addition to the Local Systemic Change projects, the Teacher Enhancement Program supports **leadership projects** that train teachers and other professionals to deliver quality professional development. NSF supports the enhancement of approximately 60,000 teachers annually, of whom, at this time, fewer than half are teachers of mathematics. Only about 10,000 are middle school teachers of mathematics.

Comprehensive Partnerships for Mathematics and Science Achievement projects provide students and teachers with standards-based curriculum reform for K-12, teacher enhancement, strategic use of resources, student enrichment activities, and summer research experiences and related activities. Approximately 5,000 teachers are impacted annually.

The **NSF Collaboratives for Excellence in Teacher Preparation (CETP)** support efforts to achieve comprehensive change in the undergraduate education of future teachers and to increase the quality and number of teachers in science and mathematics. All of the activities are characterized by strong collaboration between discipline-based faculty in schools of science/engineering and faculty from schools of education. Participating institutions of higher education vary from tribal colleges to major research institutions. CETP projects will affect 78,000 future teachers in 110 participating institutions over a five year period, and approximately 30% of the CETP collective effort is focused on future teachers of K-12 mathematics.

Instructional Materials: Instructional and assessment materials influence what students are taught and how teachers and faculty teach. An innovative, comprehensive, and diverse portfolio of instructional materials and assessment tools that implement standards-based reform in mathematics, the natural and social sciences, engineering, and technology education are required for preK-12 education. These materials must be of sufficient quality to be widely adopted and used in schools nationally.

The development of sixteen sets of comprehensive standards-based mathematics instructional materials for K-12 students was begun in 1990. These materials were completed and became available for use beginning in 1996. A report describing the success of these materials in field test sites was released by the University of Chicago, The Success of Standards-Based Mathematics Curricula for all Students, a Preliminary Report in FY 1996. Extensive evaluation data of student achievement in the field testing of these new materials demonstrates improved performance for students using them.

Working DRAFT
10/25/97

Assessment: NSF supported research and development in assessment of student learning during the middle 90's through 20 projects. Each of these projects has come to completion and the tools developed and understandings about student learning are being implemented in schools throughout the country. Additional assessment projects continue to be funded. The Balanced Assessment in Mathematics Project was among the projects funded in the middle 90's to develop assessment tools for middle school mathematics. These tools and test items have become the central component of the New Standards Mathematics assessments now used in numerous schools throughout the country.

Technology: Research efforts in technology are developing new methodology and pedagogy for improving the achievement of students in science and mathematics, especially those who have not been well served by the education system. The new methodologies will make use of scientific advances in technology (visualization and simulation, for example) that build on different learning styles among students. Funded projects successfully create new forms of visualization of scientific and mathematical concepts. NSF has supported more than 20 projects that successfully create new forms of visualization such as graphics, and simulations. Full and sustainable integration of technology into the fabric of the educational system is required for these to have wide impact on education systems.

Informal Science Education: The Informal Science Education sector reaches out to all segments of population to engage them in self-directed learning in the areas of science, mathematics, and technology. Because, over a lifetime, people spend more hours learning out of school than they do in school, a strong informal science education program is critical in the comprehensive education of our citizens. Members of the public who participate in informal science education learn about the process of science and scientific thinking; are motivated to participate in science and mathematics activities; are aware of the relevance of science, mathematics, and technology in their everyday lives; and increase their knowledge about specific topics and about scientists and careers in the sciences.

Support is provided for informal learning science, mathematics, and technology projects designed to reach large numbers of the general public through television and radio series; public films on the process and substance of science and mathematics; exhibits or other educational activities at science and natural history museums, science-technology centers, aquaria, nature centers, botanical gardens, arboreta, zoological parks, and libraries; and educational programs and activities at community and youth centers. Approximately 40% of the funding went to museum activities, 40% to media activities, and 20% to community activities.

Working DRAFT
10/25/97

APPENDIX 5

CONSULTATION WITH EXTERNAL ORGANIZATIONS

In the course of developing this action strategy, the Working Group solicited input from a wide range of interested organizations. The mathematics and mathematics education communities are well organized to respond to the President's challenge. The Working Group met with two umbrella organizations that provided access to many sources of input from these communities: the Mathematical Sciences Education Board (MSEB) of the National Research Council (NRC) and the Conference Board of the Mathematical Sciences (CBMS). Each organization includes stakeholder representatives ranging from school teachers to university mathematicians and from educational researchers to mathematical workers in industry. Their recommendations to the Working Group are summarized below.

In addition, both the National Science Foundation and the Department of Education consulted with a wide range of potential stakeholders, including informal discussion with winners of the Presidential Award for Excellence in Mathematics and Science Teaching, meetings with the Eisenhower Regional Consortia, meetings of advisory committees, and meetings of professional organizations of teachers, principals, superintendents, mathematicians, scientists, and engineers.

While the Working Group focused its information gathering on strategies to support improving achievement toward high standards in mathematics, many of the individuals and organizations that provided input were keenly interested in the nature of the voluntary national test. Thus, the discussions with these groups included the exchange of information about the test of mathematics in eighth grade as well as about the Working Group's objectives. This interest in the test is reflected in the recommendations made. The Working Group was reminded, both implicitly and explicitly, that the test is only a means to an end. The end must be kept in sight, both in test development and in the strategies the Working Group might develop.

In addition to meeting with these groups, the Working Group asked MSEB for a letter report addressing the issues raised in the President's Directive. MSEB offered three overarching recommendations:

1. Construct and sustain a Federal effort that brings together, in a coherent framework for decision-making, the various National Science Foundation and U.S. Department of Education programs that will significantly influence K-8 mathematics education.
2. Devise a long-term plan (8-10 years, offset from political cycles) of interactive development involving test redesign and strategy adjustment, with ongoing monitoring and oversight.
3. Invest in a sustained agenda of basic research to better understand what mathematical thinking is, how to foster it through curricular choices and instructional practice, and how to support teachers in doing so.

**Working DRAFT
10/25/97**

Under the broad categories for consideration of the Working Group as found in the President's Directive, all groups emphasized the importance of teacher education (both initial preparation and subsequent professional development), with both MSEB and CBMS highlighting this area in their written input. CBMS and MSEB emphasized the need for establishing certification programs for middle school teachers in mathematics. They cited the importance of an enhanced role for higher education in preparing teachers and in providing support for teachers through on-going professional development.

MSEB and CBMS also pointed to the emergence of new and innovative middle school mathematics curricula. They urged that the Action Strategy include ways to publicize, promote, and provide adoption guidance concerning model programs. They also agreed that technologies ranging from the Web to calculators have potential to help improve mathematics education. However, MSEB noted the importance of technical support for use of technology in the classroom and of equity issues in the use of that technology.

The outside groups also recognized the value of a public information campaign that can, in the words of the MSEB letter report, highlight "the importance of mathematics in applications, the beauty of mathematics as a field, and the role of mathematics as a gateway to careers and to higher education." Several of the mathematics and mathematics education organizations stand ready to assist in the development of such a campaign. MSEB recommends that public information efforts address coordination of the national test with associated action strategies.

Working DRAFT
10/25/97

APPENDIX 6

FEDERAL AGENCY ACTIVITIES THAT SUPPORT K-12 MATHEMATICS EDUCATION

The Department of Education (ED) and the National Science Foundation (NSF) have principal responsibility, among the Federal agencies, for K-12 education and for science and mathematics, respectively. However, a dozen other departments and agencies sponsor activities that relate to, and could promote, standards-based education that improves students' mathematics and science learning and overall academic performance.

Executive Order 12821 of November 16, 1992, instructs those Federal departments and agencies with scientific missions, employees, or laboratories to "assist in the mathematics and science education of our Nation's students, teachers, parents, and the public by establishing programs at their agency to provide for training elementary and secondary school teachers to improve their knowledge of mathematics and science." Many agencies had such programs in place even before this Order was issued. On April 17, 1996, it was superseded by Executive Order 12999 on *Educational Technology*, which "streamlines the transfer of excess and surplus Federal computer equipment to our nation's classrooms and encourages Federal employees to volunteer their time and expertise to assist teachers and to connect classrooms." The Eisenhower National Clearinghouse catalogues current programs in its "Guidebook of Federal Resources for K-12 Mathematics and Science" (see www.enc.org/reform/guidebk).

The Working Group met with designated agency representatives from 11 agencies (the Departments of Agriculture, Commerce, Defense, Energy, Interior, Transportation, and Veterans Affairs, EPA, NASA, NIH, and the Smithsonian) to discuss relevant programs and activities sponsored by their agencies. In general, the agencies focus far more on science than mathematics, and commit modest resources to improving K-12 education. Most offer staff and facilities, often on a volunteer basis, to support local schools and teachers. And all have developed and are sharing supplementary instructional materials on their Web sites.

Some examples of works in progress can be cited. For more extended, specific examples, see sidebars in the report. NASA has completely revamped its educational programs to reflect the development of the National Council of Teachers of Mathematics' (NCTM) standards for mathematics and the more recent standards for science developed through the National Research Council (NRC). The agency has developed supplementary instructional materials in conjunction with NCTM that provide sample problems based on space-related examples. The Department of Defense schools have redesigned curriculum and teacher professional development to incorporate standards-based approaches. Other parts of DOD have outreach programs that stress the importance of mathematics to national security.

The Department of Energy, NIH, and USDA are conducting an inventory of their activities, identifying their impacts and exploring opportunities to expand. Among ideas that warrant further consideration are virtual teacher training based at DOE's Lawrence Berkeley Lab in partnership with the University of California system; USDA's 4-H Clubs as an after-

Working DRAFT
10/25/97

school, weekend, and summer vehicle for promoting math skills; EPA's use of the training-of-trainer model for teacher development in environmental education; and NIH's middle-school curriculum supplements, to be developed among three Institutes and the NRC.

The Department of Transportation is about to embark on an extensive effort to improve K-12 education in mathematics and science, including participation of staff as volunteers. The Smithsonian Institution has both formal and informal ties into schools. Other agencies are ready to play an appropriate role in improving K-12 education, and are looking for guidance on how best to proceed.

We must learn more quickly and more systematically about approaches and innovations that support students and teachers of mathematics both in and outside of schools, taking into account high standards like those of the NCTM and the NRC to reference, guide, coordinate, and set priorities among the many educational programs managed by Federal agencies. Continued coordination among all of the agencies involved in the Working Group's deliberations, and others that might be brought in over time, can set the stage for more effective use of Federal resources. The Department of Education and the National Science Foundation will work to ensure such coordination in the future.