U.S. DEPARTMENT OF EDUCATION
OFFICE OF EDUCATIONAL RESEARCH AND IMPROVEMENT

NATIONAL CENTER FOR EDUCATION STATISTICS

FEB 24 1998

Mr. William Kincaid
Office of Domestic Policy
Old Executive Office Building
Room 218
Washington, D.C. 20500

Dear Mr. ~~Kincaid~~ Bill

I am pleased to send you a copy of the third and final report from our *Pursuing Excellence* series of the Third International Mathematics and Science Study (TIMSS) released on February 24, 1998. The data associated with this third and final age cohort -- 12th graders -- represents the culmination of a three-year study that has tested some 500,000 students in 41 countries, involving some 30 languages. The other groups for which TIMSS data have been released in 1996 and 1997 were for 8th and 4th graders respectively.

The current report, *Pursuing Excellence, A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*, shows how U.S. secondary school students perform relative to their international counterparts. The students were tested on general mathematics and science knowledge, but the report also compares students who have taken advanced mathematics and science courses.

TIMSS is the largest and most comprehensive study ever undertaken to compare academic performance in science and mathematics across countries. It is coordinated by the International Association for the Evaluation of Education Achievement (IEA) and funded by the National Center for Education Statistics and the National Science Foundation.

I hope you find this report informative. If you have any questions, please contact Maureen E. Treacy, NCES Communications Officer, at 202/219-1329.

Best regards,

Pascal D. Forgione, Jr.

Pascal D. Forgione, Jr., Ph.D.
Commissioner

Enclosure

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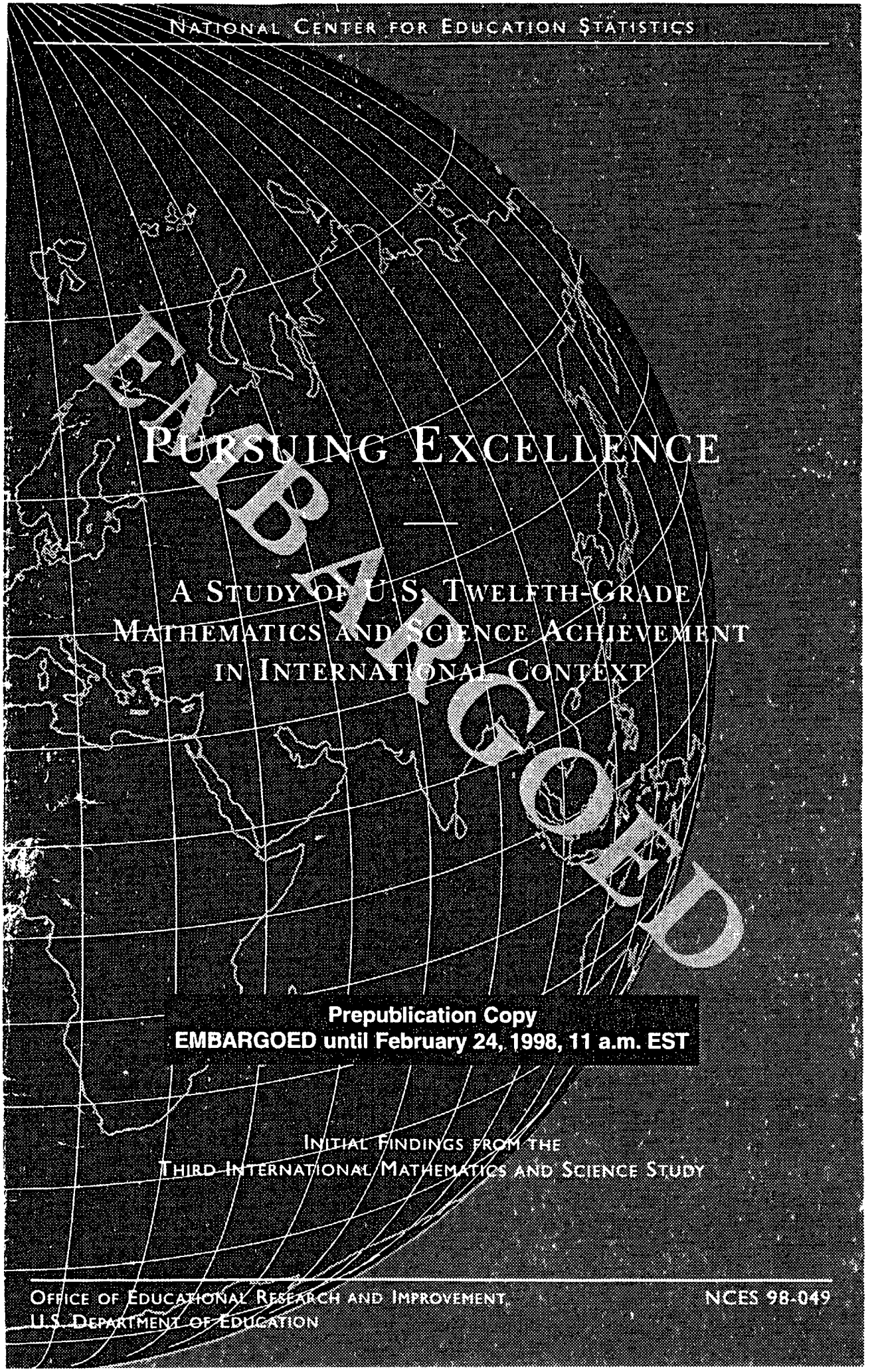
National Center for Education Statistics



Pursuing Excellence

A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context

Prepublication Copy
EMBARGOED until February 24, 1998, 11 a.m. EST

Initial Findings from the
Third International Mathematics and Science Study

Office of Educational Research and Improvement
U.S. Department of Education

NCES 98-049

UNITED STATES DEPARTMENT OF EDUCATION
OFFICE OF THE SECRETARY

FAX TRANSMITTAL

TO: Mike Cohen/Bill Kincaid

ORGANIZATION:

PHONE NUMBER:

FAX NUMBER:

FROM: Julie Green

PHONE NUMBER:

MESSAGE: Riley remarks on TIMSS

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UNITED STATES
DEPARTMENT OF EDUCATION

NEWS

Embargoed for Release Until:
11am February 24, 1998

Contact: Julie Green (202) 401-3026

Remarks as Prepared for Delivery by
U.S. Secretary of Education Richard W. Riley
Press Conference on 12th grade TIMSS Results

Thank you Pat. Good morning. These are very important results from the Third International Math and Science Study concerning our nation's 12th graders. These results are entirely unacceptable, and absolutely confirm our need to raise our standards of achievement, testing, and teaching, especially in our middle and high schools --and to get more serious about taking math and science courses.

Let me outline five basic steps we need to take. First, we need to build a firm foundation for our students during the middle school years; second, state assessments and standards must be raised; third, we must expect more high school students to take four years of math and science, including physics, chemistry, trigonometry, and calculus; fourth, more teachers must be prepared to teach these subjects; and fifth, as a nation we must make sure that all students --not just the elite or the brightest --understand the importance of math and science in their lives.

I am confident that Americans --and American students --have the ability to be competitive with the best students in the world. Consider, for example, the most recent TIMSS measurement of U.S. 4th graders. It showed that our students are well *above* the international average in mathematics and very near the top in achievement in science. This and other assessments show that we are making progress. Unfortunately, we are not gaining fast enough --and the rest of the world is not standing still.

We give our children a good foundation in the basics. Unfortunately, math and science education gets "stuck in a rut" in the middle grades. We run in place and then allow the majority of our students to "check out" of rigorous math and science courses in high school.

The U.S. was the only country in TIMSS whose students dropped in ranking from above average performance in mathematics at the fourth grade to slightly below average performance at the eighth grade.

By the 12th grade, our students' standing has fallen even further. We must recognize why the drop-off occurred and act aggressively to fix it.

The first reason, and the real core of the problem, is the low expectations and low standards we have for what our students can and should learn in math and science from 4th to 12th grade. At the 8th grade, for example, many state standards and tests are far less rigorous than national and international standards of excellence.

That is why President Clinton, Vice President Gore, and I have encouraged the development of a voluntary national test in eighth grade mathematics. It would be highly inconsistent to condemn the performance of a sample of U.S. students on this test and then turn around and deny parents and teachers the chance to see how their children would perform individually on a rigorous voluntary national test in math that is linked to TIMSS and NAEP, the National Assessment of Education Progress.

Second, taking the tough courses, including challenging mathematics and science, makes a powerful difference. All students must master the traditional basics of arithmetic early on --and then move on to more challenging courses.

Unfortunately, too many students --particularly during the middle school and high school years --are not taking the rigorous or advanced courses in mathematics and science. By the 8th grade, less than one quarter of American students have taken algebra, while almost all students in the rest of the developed world by that time have studied the fundamentals of algebra and some geometry. Among our high school students only 25% take physics and 10% take calculus.

What classes students take is so vitally important because it affects *all* students --those in public and private schools; across all economic levels; from the highest achieving down to the lowest. A large scale study by the Department confirms that it is the courses students take --not whether they are taken in public or private schools that make a difference.

The third major reason our success in the early years hasn't continued is that too many math and science teachers are teaching out of field. In 1993-94, 28% of public high school math teachers in the U.S. were teaching without a major or a minor and 55% in physics. It's time we overhaul the recruitment, preparation and ongoing professional development of our science and math teachers.

Fourth, we must purge the view that it is ok to be illiterate in math or science --that these are subjects only for the elite among us. Across our society, demands for specialized skills requiring mathematics, science and technology are growing. Almost 90 percent of new jobs require *more* than a high school level of literacy and math skills. We have all heard about the tremendous shortage of Information Technology workers in America.

The major burden in addressing these issues and overcoming the challenge is on local schools, communities, and states. I've seen communities --a group of 20 school districts near Chicago called the First in the World Consortium, for instance --that have taken comprehensive and successful steps toward achieving significantly better results.

Their students recently took the TIMSS test and their students placed among the best in the world in 12th grade in both math and science. They did it by involving parents, teachers, students, and entire communities in developing a rigorous curriculum and high quality teaching and testing. Over 70% of their high school seniors have taken advanced math and physics courses. Half took algebra by the eighth grade.

We want to support local communities in these kinds of efforts. That is why President Clinton has developed a number of proposals to raise standards and achievement in math and science. His most recent budget proposal includes a $60 million request to Congress to fund an Action Strategy --coordinated by my Department and the National Science Foundation --to strengthen the teaching of mathematics in middle schools.

The President also has proposed $350 million over five years to help local communities get qualified teachers into every classroom, with a special emphasis on math and reading. And his $22 billion school modernization proposal will help upgrade math and science classrooms and laboratories in many overcrowded and outdated schools.

I would add one final thought. Let's put an end to the shortsighted, politicized, and harmful bickering over the teaching and learning of mathematics going on in California and elsewhere across this country. We need less ideology and more geometry; less dogmatism and more trigonometry and physics. Failing to focus on what really helps kids learn is an enormous waste of time and a misdirection of our energies. I am confident that if all students and schools were immersed in rigorous teaching and learning environments we would be in the top tier at all levels.

I challenge local schools, school boards, and communities to take a close, hard look at what your students are learning. I urge you to meet and discuss these results. Take a look at the TIMSS questions and answers, which are readily available for your review on the Internet and elsewhere. They are challenging questions.

I hope local communities will compare their tests against national and international standards. Determine what is needed in their districts and schools. And then institute more challenging classes and more rigorous teaching.

This is indeed a great challenge --but one that befits a great nation. Thank you so much.

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U.S. DEPARTMENT OF EDUCATION
OFFICE OF THE DEPUTY SECRETARY
600 INDEPENDENCE AVENUE, S.W.
WASHINGTON, D.C. 20202-0500

DATE: 2/23

TO: Bill Kincaid

ORGANIZATION:

PHONE: FAX: 456-5581

FROM: John Luczak

PHONE: 205-7848 FAX: (202) 401-9027

COMMENTS:

TOTAL PAGES (including cover): 4

Key Findings from Twelfth Grade TIMSS

ACHIEVEMENT

General knowledge

- U.S. twelfth graders scored below the 21-nation average in both mathematics and science.
  - In science, U.S. twelfth graders were outperformed by students in the last year of secondary school in 11 countries (including Canada, Australia, and Switzerland). U.S. students outperformed those in 2 countries and were similar to those in seven countries (including Germany, France, Italy and the Russian Federation).
  - In mathematics, U.S. twelfth graders were outperformed by students in 14 countries (including Switzerland, France, Australia, Canada, and Germany), outperformed those in 2 countries, and were similar to those in four countries (including Italy and the Russian Federation).

Advanced students

- U.S. twelfth graders scored below the 16-nation average in physics and in advanced mathematics.
  - In physics, U.S. students who had taken or were taking physics were outperformed by students in 14 countries (including Germany, Australia, Switzerland, Canada, and France). U.S. students outperformed no countries and were similar to those in 1 country (Austria).
  - In advanced mathematics, U.S. twelfth graders who had taken or were taking precalculus or calculus were outperformed by students in 11 countries (including France, the Russian Federation, Switzerland, Australia, and Canada), outperformed those in no countries, and were similar to those in 4 countries (including Italy and Germany).

COMPARISONS

Mathematics and science

- Our students' performance was stronger in science than in mathematics on the general knowledge assessments relative to the other countries participating in TIMSS, a pattern that was also evident at both fourth and eighth grades.

Eighth and twelfth grades

- Our students' international standing was stronger at the eighth grade than at the twelfth grade (general knowledge) in both mathematics and science.

Gender

- There was no significant gender gap among U.S. students on the mathematics general knowledge assessment. There was a gender gap in science general knowledge, physics, and advanced mathematics.

Key Findings from Fourth, Eighth, and Twelfth Grade TIMSS

ACHIEVEMENT

Fourth grade

- U.S. fourth graders scored above the 26-nation average in both mathematics and science.
  - In science, U.S. fourth graders were outperformed by students in only one country (Korea). U.S. students outperformed those in 19 countries (including England, Canada, and Singapore) and were similar to those in five countries (including Japan, Australia, and the Czech Republic).
  - In mathematics, U.S. fourth graders were outperformed by students in seven countries (including Singapore, Korea, Japan, and the Czech Republic), outperformed those in 12 countries (including England and Norway), and were similar to those in six countries (including Australia and Canada).

Eighth grade

- U.S. eighth graders scored above the 41-nation average in science and below the international average in mathematics.
  - In science, U.S. eighth graders were outperformed by students in nine countries (including Singapore, the Czech Republic, Japan, and Korea). U.S. students outperformed those in 15 countries (including France) and were similar to those in 16 countries (including England, Australia, the Russian Federation, Germany, and Canada).
  - In mathematics, U.S. eighth graders were outperformed by students in 20 countries (including Singapore, Korea, Japan, the Czech Republic, France, the Russian Federation, Australia, and Canada), outperformed those in 7 countries, and were similar to those in 13 countries (including Germany and England).

Twelfth grade - General knowledge

- U.S. twelfth graders scored below the 21-nation average in both mathematics and science.
  - In science, U.S. twelfth graders were outperformed by students in the last year of secondary school in 11 countries (including Canada, Australia, and Switzerland). U.S. students outperformed those in 2 countries and were similar to those in seven countries (including Germany, France, the Russian Federation, and Italy).
  - In mathematics, U.S. twelfth graders were outperformed by students in 14 countries (including Switzerland, France, Australia, Canada, and Germany), outperformed those in 2 countries, and were similar to those in four countries (including Italy and the Russian Federation).

Twelfth grade - Advanced students

- U.S. twelfth graders scored below the 16-nation average in physics and in advanced mathematics.
  - In physics, U.S. students who had taken or were taking physics were outperformed by advanced science students in 14 countries (including Germany, Australia, Switzerland, Canada, and France). U.S. students did not outperform any country and were similar to those in 1 country (Austria).
  - In advanced mathematics, U.S. twelfth graders who had taken or were taking precalculus or calculus were outperformed by advanced mathematics students in 11 countries (including France, the Russian Federation, Switzerland, Australia, and Canada), did not outperform those in any country, and were similar to those in 4 countries (including Italy and Germany).

COMPARISONS

Mathematics and science

- Our students' performance was stronger in science than in mathematics in fourth, eighth, and twelfth (general knowledge) grades relative to the other countries participating in TIMSS.

Fourth, eighth, and twelfth grades

- Our students' international standing was stronger at the fourth grade than at the eighth grade in both mathematics and science relative to the 26 countries that participated in TIMSS at both grade levels.
- Our students' international standing was stronger at the eighth grade than at the last year of secondary school (general knowledge) in both mathematics and science relative to the 20 countries that participated in TIMSS at both levels.

Gender

- There was no significant gender gap in fourth-grade or eighth grade mathematics achievement or eighth grade science achievement. The U.S. was one of ten countries with a gender gap in fourth grade science achievement.
- There was no significant gender gap among U.S. twelfth grade students on the mathematics general knowledge assessment. There was a gender gap among U.S. twelfth graders in science general knowledge, physics, and advanced mathematics.

UNITED STATES DEPARTMENT OF EDUCATION
OFFICE OF THE SECRETARY

FAX TRANSMITTAL

TO: Mike Cohen / Bill Kincaid

ORGANIZATION: APC

PHONE NUMBER:

FAX NUMBER: 456-5581

FROM: Julie Green

PHONE NUMBER:

MESSAGE: Enlarged press release & 6 suggested steps to improve math & science

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UNITED STATES
DEPARTMENT OF EDUCATION NEWS

FOR RELEASE:
Embargoed until 11 a.m. EST February 24, 1998

Contact: David Thomas
(202) 401-1579

RILEY URGES STUDENTS TO TAKE TOUGHER COURSES: CHALLENGES SCHOOLS AND STATES TO RAISE ACADEMIC, TESTING AND TEACHING STANDARDS IN MATH AND SCIENCE

Responding to results of an international study, U.S. Secretary of Education Richard W. Riley today said America must dramatically accelerate and fundamentally change its efforts to improve math and science achievement for its students to rank among the top performing students internationally.

According to the Third International Math and Science Study (TIMSS), released today by the Education Department's National Center for Education Statistics (NCES), U.S. 12th graders outperformed only two (Cyprus and South Africa) of the 21 participating countries in math and science. Asian countries chose not to participate in the TIMSS 12th-grade study.

U.S. students' scores in science were not significantly different from those of seven other countries, including Italy, Germany, France and the Russian Federation; in math their scores were similar to those of four other countries, including Italy and the Russian Federation.

"This is unacceptable, and it absolutely confirms what the president and I have been saying, that academic standards must be raised dramatically across America," Riley said. "The standards of many state assessments in math are far lower than national and international standards of excellence; too many science and math teachers are teaching out-of-field; and far too few high school seniors have taken physics, trigonometry, calculus and advanced placement courses."

-MORE-

TIMSS also examined how U.S. advanced 12th-grade students -- in math, those studying precalculus and calculus, in science those studying physics -- performed in relation to advanced students in other nations. On the advanced math assessment, U.S. students were outperformed by those in 11 countries, were similar to those in four countries, and outperformed those in no participating countries.

On the physics assessment, U.S. students were outperformed by those in 14 countries, were the same as those in one country, and outperformed those in no participating countries.

Earlier TIMSS results showed that the achievement of U.S. fourth-grade students is quite high -- above the international average in both math and science, and in science outperformed only by Korea. However, in the middle grades U.S. standing begins to lag and by eighth grade, U.S. students score only slightly above the international average in science and below the international average in math.

"We need to have higher expectations for our students, Riley said. "Many of our students stop taking math and science after 10th or 11th grade. For example in the U.S., even among college bound high school seniors, 51 percent have not even taken four years of science. This research also shows that our high school curriculum and instruction has less rigor and depth than other nations and less focus on building understanding of major concepts.

"In addition, we don't build a firm foundation for our students in the middle school years. Other nations begin to introduce challenging concepts such as algebra, geometry, probability and statistics, but we continue to focus on arithmetic, even though our students are good at arithmetic. So we shouldn't be surprised that by the 12th grade, our students have fallen even further behind their counterparts abroad.

"How can we expect our students to test well in math and science internationally when we do not even ask them to take challenging courses and rigorous tests throughout their middle and high school careers."

Riley pointed out that the TIMSS tests set high standards. For example, a question for advanced physics assessment: *A car moving at a constant speed with a siren sounding comes towards you and then passes by. Describe how the frequency of the sound you hear changes. (See attachment for additional sample questions.)*

The international average was only 37 percent for answering that question correctly. But only 12 percent of U.S. advanced students could answer that question.

"We need to raise our expectations of our students if we want to be internationally competitive," Riley said. "Our 12th graders' low international ranking isn't the only cause for alarm here. If we're to continue to be global competitors in the new knowledge economy, we'll need a steady and competent pool of employees. Right now, the low performance of those in the pipeline for those future jobs has troubling implications for our future.

"This is further evidence of the value of a voluntary national math test at eighth grade. Parents, teachers, and students want to know whether students are meeting rigorous national and international standards. The proposed voluntary national tests will help teachers and parents identify what students know and can do and prepare them to take demanding high school math and science courses.

"It would be highly inconsistent to decry the performance of a sample of U.S. students on this test and then turn around and deny parents the chance to see how their children would perform individually on a rigorous voluntary national test in math."

In addition, Riley said, "We know how important it is to build a strong foundation in math and science in the middle grades. That's why the Department of Education and the National Science Foundation are launching a joint effort to improve middle school math." President Clinton has requested $60 million in the fiscal year 1999 budget to improve the math teaching of elementary and middle school teachers, provide assistance to communities that wish

to select and implement rigorous instructional materials, maximize the effective use of existing federal resources, and promote public understanding of the importance of challenging middle school math.

Riley also challenged local communities to look hard at what math and science they teach and how they teach it. "TIMSS shows that what we teach and how we teach it is what determines our students' achievement. Decisions about curriculum and teaching are local ones. I urge school boards, principals, parents and all those involved in education, as well as employers, to take a hard look at the decisions they are making and consider whether, based on TIMSS results, their schools are likely to boost significantly the achievement of their students.

"I also urge our students to take four years of challenging curriculum, including physics and calculus, by graduation. That's a huge charge, but it's needed to be internationally competitive."

Riley also noted that 28 percent of high-school math teachers and 18 percent of high-school science teachers neither majored nor minored in these subjects, and challenged states and communities to ensure that students are taught by teachers who are prepared to teach advanced math and science. In the physical sciences, where student performance lags the most, almost half of American students are taught by teachers without a major or minor in that field.

"In sheer quantitative terms, TIMSS is the world's largest, most comprehensive, and most rigorous international education comparison ever," said U.S. Commissioner of Education Statistics Pascal D. Forgione Jr.

The TIMSS consists of three parts: initial findings about math and science general knowledge for 21 participating countries; initial findings of advanced math and physics assessments for 16 countries; and initial findings about the relationships between school systems and students' lives and achievement.

Among the findings in *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context:*

- In all three areas of advanced math and in all five content areas of physics, U.S. advanced math and physics students' performance was among the lowest of the TIMSS nations;

- On the assessment of math general knowledge, the U.S. score was 461. Hungary, Germany, Slovenia, Austria, Canada, Australia, New Zealand, France, Norway, Iceland, Switzerland, Denmark, Sweden, and the Netherlands had scores significantly higher average scores than the U.S. The highest score was 560 in the Netherlands;

- On the assessment of science general knowledge, the U.S. average score average was 480. Denmark, Slovenia, Austria, Switzerland, Australia, New Zealand, Canada, Norway, Iceland, Netherlands, and Sweden, had significantly higher average scores than the U.S. The highest score was 559 in Sweden.

- The U.S. was one of three countries which did not have a significant gender gap in math general knowledge among students at the end of secondary schooling. While there was a gender gap in science general knowledge in the U.S. as in every other TIMSS nation, the U.S. gender gap was one of the smallest;

This TIMSS report is the last of a series of three Pursuing Excellence reports. The first presented findings on student achievement at eighth grade. The second presented findings on fourth graders. The fourth- and eighth-grade reports are available on the department's web site at www.nces.ed.gov/timss. Next month printed copies of the new report will be available while they last from the National Library of Education, (202) 219-1692. The report also will be available from the U.S. Government Printing Office.

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UNITED STATES DEPARTMENT OF EDUCATION

PUBLIC AFFAIRS

How to Fundamentally Improve Mathematics and Science Education

1) Build a firm foundation by having more students study algebra and geometry by 8th and 9th grade

2) Raise state and local standards of academic performance in mathematics and science

3) Measure student performance against rigorous standards, like the voluntary national test in 8th grade mathematics

4) Offer a challenging curriculum and encourage students to take demanding mathematics and science courses, such as calculus and physics by 12th grade

5) Improve the teaching of mathematics and science through teacher training and reduce the large number of teachers teaching out-of-field

6) Destroy the myth that advanced mathematics and science are only for a few students

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UNITED STATES DEPARTMENT OF EDUCATION

WASHINGTON, D.C. 20202

TIMSS 12TH GRADE RESULTS SHOW NEED TO BUILD A STRONG FOUNDATION, SET HIGHER STANDARDS, REQUIRE TOUGHER COURSES, AND ENSURE WELL-PREPARED AND EFFECTIVE TEACHERS

TIMSS RESULTS SHOW UNACCEPTABLY POOR U.S. PERFORMANCE. The Third International Mathematics and Science Study (TIMSS) compared the mathematics and science achievement of a half-million students from 41 countries at 4th, 8th and 12th grade. Prior TIMSS reports showed that U.S. students performed relatively well at 4th grade -- above the international average in both mathematics and science, and in science outperformed only by Korea. U.S. students' relative standing declined by 8th grade, to only slightly above the international average in science and below the international average in mathematics. One reason is that while most students in grades 4-8 in other nations are studying the beginning concepts of algebra, geometry and other topics, U.S. students continue to be taught primarily arithmetic.

Today's release of 12th grade results shows that U.S. students' standing relative to other TIMSS countries continues to decline in the high school years. A comparison of U.S. 12th graders' general mathematics and science knowledge to students in 20 other nations shows that our students scored below the international average in both topics and exceeded the performance of only two nations. A separate examination of advanced mathematics and physics comparing our students taking pre-calculus or calculus and our students taking physics with advanced mathematics and physics students in other nations shows that the performance of our advanced students is among the lowest of countries participating in TIMSS. The bottom line is that it appears that U.S. standards of achievement, testing and teaching in mathematics and science are far too low in middle and high schools.

BUILD A STRONG FOUNDATION IN THE MIDDLE GRADES: $60 MILLION TO IMPROVE MATHEMATICS ACHIEVEMENT IN THE MIDDLE GRADES. The President's budget requests approximately $60 million for the U.S. Department of Education (ED) and the National Science Foundation (NSF) to implement an Action Strategy to support local efforts to put in place the rigorous courses and effective teaching that will build a strong foundation in the middle school years. This joint initiative will provide high quality information and technical assistance to communities wishing to select and implement rigorous instructional materials based on challenging standards. It will promote improved mathematics teaching of elementary and middle school teachers by supporting teacher networks and effective teacher training models and materials that help teachers upgrade their content knowledge and learn how to teach for conceptual understanding while still ensuring mastery of the basics of computation. It will maximize existing federal resources via joint Education and NSF capacity-building grants to jumpstart efforts in 200-300 school districts to significantly improve the quality of mathematics instruction in the middle school years. And, it will promote public understanding of the importance of challenging middle school mathematics through a national effort to engage parents and communities.

RAISE STANDARDS AND MEASURE STUDENT PERFORMANCE WITH A VOLUNTARY NATIONAL TEST IN MATHEMATICS AT 8TH GRADE. The TIMSS results demonstrate the need for a rigorous national benchmark that will reflect not only how a student's performance compares across states but also

around the world. The standards of state assessments in 8th grade mathematics vary widely, and many of these 8th grade assessments are not as rigorous as the standards of the National Assessment of Educational Progress (NAEP) according to a recent study by the Southern Regional Education Board. Moreover, recent international comparisons of science and mathematical examinations for college-bound students show that our SAT, ACT, and AP exams are much less rigorous than similar exams from other nations. This is why President Clinton has proposed a voluntary national test in mathematics at the eighth grade. The voluntary national test will be based on the rigorous content and performance standards in NAEP and linked to TIMSS. While TIMSS and NAEP provide a snapshot of the nation's performance, they assess only a sample of students: neither individual student nor school performance can be ascertained. The voluntary national test in mathematics, however, would let parents and teachers know how individual students and schools can improve in relation to rigorous national and international standards and whether students are adequately prepared to take demanding high school mathematics and science.

OFFER A CHALLENGING CURRICULUM AND ENCOURAGE STUDENTS TO TAKE TOUGHER COURSES. TIMSS shows that what we teach and how we teach is what determines our students' achievement. Because decisions about curriculum and teaching are local ones, it rests primarily with local communities and states to ensure that students are getting a rigorous mathematics and science program taught by effective and well-trained teachers. Today, most students -- even most college-bound students -- do not take four years of high school mathematics and science. Ninety percent of all high school students stop taking mathematics before getting to calculus. Students should take demanding mathematics and science courses through high school such as physics and calculus -- and these courses must be rigorous.

IMPROVE THE TEACHING OF MATHEMATICS AND SCIENCE. How we teach is as important as what we teach. The TIMSS 8th grade study found that we teach mathematics differently than other nations: U.S. mathematics classes require students to engage in less high-level mathematical thought and solve fewer multistep problems than classes in Germany and Japan. In the nation's high schools, this is compounded by the fact that 28% of high school mathematics teachers and 55% of high school physics teachers neither majored nor minored in these subjects. States, districts, colleges and universities must get serious about teacher preparation, teacher certification, and ongoing professional development to ensure that students are taught by teachers who are prepared to teach challenging mathematics and science.

ADDITIONAL ADMINISTRATION INITIATIVES THAT WILL IMPROVE MATHEMATICS AND SCIENCE ACHIEVEMENT. Many of the President's education proposals in the FY99 budget will raise standards and achievement in mathematics and science. The budget requests $50 million for the Department of Education and $25 million for NSF to support a joint research program to learn how brain research, cognitive science and learning technology can lead to improved achievement in reading and mathematics. The President's $140 million High Hopes for College proposal would promote partnerships between colleges and middle or junior high schools in low-income communities to get and keep students on the track to college, including ensuring that students have access to the rigorous mathematics and science courses that prepare them for college. The President's proposal for Recruiting, Preparing, and Supporting Teachers includes $30 million for improving the preparation of future teachers, with emphasis on teachers of mathematics and reading. Furthermore, the President's $22 billion school modernization proposal will help upgrade mathematics and science classrooms and laboratories in many overcrowded and outdated schools.

UNITED STATES DEPARTMENT OF EDUCATION
WASHINGTON, D.C. 20202-

TIMSS 12th Grade Report
Questions and Answers

THE CONTEXT OF STUDENT ACHIEVEMENT

1. How has the performance of U.S. students in mathematics and science changed over time?

U.S. performance has improved over time on the National Assessment of Educational Progress (NAEP). Since the 1980s, the mathematics and science performance of our nation's students has improved for 9-, 13-, and 17-year-olds. Moreover, there has been significant improvement in students scoring at the proficient or above levels in mathematics at 4th, 8th, and 12th grades since 1990. For example, on the 12th grade mathematics NAEP, 12 percent of students in 1990, 15 percent of students in 1992, and 16 percent of students in 1996 scored at or above the proficient level. In addition, the average score of 12th grade students at the 90th percentile on NAEP has increased significantly since 1990. There has also been significant improvement on the Scholastic Aptitude Test (SAT) over time. Between 1982 and 1996, SAT mathematics scores increased by 15 points. [Mathematics NAEP 1990, 1992, 1996; NAEP 1996 Trends in Academic Progress; The College Board, Scholastic Aptitude Test Data, 1982-1996]

However, TIMSS and other international assessments show that the bar is being raised and we are not keeping up. While international comparisons over time are difficult, it appears that our relative standing to other nations has not improved despite our students' increasing achievement in mathematics and science as measured by NAEP. The first international studies of mathematics and science achievement were conducted in the 1960s, and there have been three assessments since that time. However, each assessment has been done differently (nations participating, content area topics, types of students sampled in each nation, the improvement of assessment, the addition of specialist exams, and even the changing borders of some countries). Despite these factors, the pattern of U.S. performance has been relatively consistent. Our relative ranking at the 12th grade was below the international average in the First and Second International Mathematics and Science Studies conducted in the 1960s and 1980s. Improving our relative standing requires us to improve more rapidly over time than other nations.

2. How rigorous are U.S. state assessment standards in mathematics?

Many state assessments are much less rigorous than nationally set standards like those used in NAEP. A recent Southern Regional Education Board study revealed that in some states, more than 80 percent of the students are proficient on state 8th grade mathematics assessments, but only 20 percent or less were proficient based on the NAEP 8th grade mathematics standards.

(See accompanying chart with state-by-state comparisons of 8th grade NAEP mathematics scores with states' own assessment scores.) Similarly, the recent Quality Counts study by Education Week rated the rigor of state standards in mathematics at 8th grade and gave only one state a grade of "A."

3. To what extent do our students take high level mathematics and science?

Despite some progress, many students are still getting limited exposure to challenging mathematics and science content in middle and high school. Many high school students do not make it from algebra and geometry to advanced mathematics and science courses. Fully 90 percent of all U.S. high school students stop taking rigorous mathematics before getting to calculus. Even among college bound seniors, 52 percent have not taken physics, 48 percent have not taken trigonometry, and 77 percent have not taken calculus. Unlike most other countries where algebra and geometry are introduced in the middle grades..in the U.S. only 25 percent of students take algebra before high school. The most common mathematics course taking path for high school students is 9th grade algebra I, geometry, and algebra II, and then no further mathematics. [Mathtech, Analysis of NELS: 88 data. September 1997; U.S. Department of Education, National Center for Education Statistics, The 1994 High School Transcript Study Tabulations: Comparative Data on Credits Earned and Demographics for 1994, 1990, 1987, and 1982 High School Graduates, 1996]

State requirements for and numbers of students enrolled in challenging mathematics and science courses has increased in the last decade, but there is still a great need for improvement. In the 1980s, over 40 states raised the number of credits in mathematics and science necessary for graduation. In 1996, 43 states required at least two years of mathematics and science compared to 9 nine states in 1980. As a result, since 1990, all states show an increase in the proportion of high school students taking higher level mathematics and most states show an increase in higher level science. Among 1994 high school graduates, 9 percent had taken calculus and 24 percent had taken physics, as compared to 5 percent and 14 percent respectively in 1982. Additionally, AP participation has increased dramatically since 1982, while the percentage of examinations with passing scores and the mean score have not declined significantly. The percent of students taking the AP calculus examination more than tripled, and the percent of students taking and passing the AP physics exam also grew dramatically. [Council of Chief State School Officers, State Indicators of Science and Mathematics Education 1997, State-by-State Trends and New Indicators from the 1995-96 School Year; The College Board, Advanced Placement Data, 1982-1996; U.S. Department of Education, National Center for Education Statistics, The 1994 High School Transcript Study Tabulations: Comparative Data on Credits Earned and Demographics for 1994, 1990, 1987, and 1982 High School Graduates, 1996]

4. How do our SAT, ACT, and Advanced Placement (AP) exams compare with end of school exams in other nations?

Recent international comparisons of science and mathematics examinations for college-bound students show that our SAT, ACT, and AP exams are much less rigorous than similar exams from other nations. The SAT exam only covers beginning to intermediate algebra and geometry, and the ACT exam tests those subjects and also touches on trigonometry.

The AP mathematics and science exams are much closer in content to the end of school exams in other nations, but often still not as rigorous. For example, the content of the AP calculus exam is not as advanced as the comparable exams in France, Germany, and Japan, and does not ask students to demonstrate as deep an understanding of the material. Moreover, many more international students take and pass these exams than U.S. students take and pass AP exams. For example, approximately one-quarter to one-half of the students leaving high school in England and Wales, France, Germany, Israel, and Japan take these demanding exams, and a majority of those students pass them. In the U.S. in 1995, only 8 percent of students took AP exams in any subject, and only 5 percent passed an exam. (See accompanying chart.) [Examining the Examinations, NCISE, 1996; What Students Abroad Are Expected To Know About Mathematics, AFT, 1997; What College-Bound Students Abroad Are Expected To Know About Chemistry and Physics, AFT, 1996]

5. How do the TIMSS 12th grade general knowledge assessments match the mathematics and science curriculum for 12th graders in the U.S.?

The content of the mathematics general knowledge assessment most closely matched the content covered up through 7th grade in most TIMSS nations and the 9th grade in the U.S. The science general knowledge assessment was at a 9th grade level for other nations and an 11th grade level in the U.S. The assessment was a test of the mathematics and science needed to function effectively in society as adults rather than a test of advanced mathematics or science content.

6. How do the TIMSS assessments in physics and advanced mathematics match the mathematics and science curriculum for 12th graders in the U.S.?

The TIMSS physics and advanced mathematics assessments are most comparable in rigor and content to our AP exams. However, there are major differences between the AP exams and TIMSS.

The TIMSS advanced mathematics assessment included "calculus," "geometry" and "numbers, equations and functions," plus a few items on "probability and statistics" and on "validation and structure." Only about one-quarter of the assessment focused on calculus. The two AP calculus exams U.S. (AB/BC versions) focus almost entirely on calculus to the exclusion of other topic areas, especially geometry. While 14 percent of the age cohort in the U.S. were eligible to take the TIMSS advanced mathematics assessment because they had taken precalculus, calculus, or AP calculus, only 5 percent had taken or were taking AP calculus.

The TIMSS physics assessment included items in the content areas of "modern physics," "heat," "wave phenomena," "mechanics," and "electricity and magnetism." The Physics B AP exam includes a "modern physics" content area (nuclear physics, relativity theory, etc), while the Physics C AP exam focuses only on classical physics and includes no items on modern physics. While 14 percent of the age cohort in the U.S. were eligible to take the TIMSS physics assessment because they had taken physics or AP physics, only 1 percent had taken or were taking an AP physics course.

7. How do the 12th grade TIMSS scores relate to the 4th and 8th grade scores? How do U.S. students perform in mathematics and science over time?

Although U.S. students' achievement increases as they progress through school, our relative standing compared to other TIMSS countries drops from 4th to 8th to 12th grade. One reason is that the rate of increase in U.S. student achievement slows in high school. Data from NAEP show that there is less change in average scores in mathematics between 8th and 12th grades than between 4th and 8th grades. Part of the explanation for this may be that many U.S. high school students do not take 4 years of mathematics. For example, even among college bound high school seniors (those taking the SAT), 31 percent did not take 4 years of mathematics. [Mathematics Course-Taking and Gains in Mathematics Achievement,@ 1995. NCES 95-714]

8. How well prepared are our high school mathematics and science teachers?

An extremely high percentage of high school mathematics and science teachers lack adequate preparation in the content area they teach. Twenty-eight percent of U.S. public high school (grades 9-12) mathematics teachers were teaching out-of-field (without a major or minor) in 1993-94. In that same year, 55 percent of public high school physical science teachers (physics, chemistry, or geology) were teaching out-of-field. These percentages increase with poverty status of the schools, and for schools with high percentages of minority students. [Schools and Staffing Surveys, 1993-94]

DISPELLING COMMON MYTHS ABOUT U.S. STUDENT PERFORMANCE

9. Isn't TIMSS an unfair comparison of other nations' best students against all our young people?

No. A similar proportion of students complete secondary schooling in most other TIMSS countries and in the U.S. and TIMSS measured the performance of all students completing secondary school regardless of the type of secondary program they completed. While in the past a much higher proportion of students completed secondary schooling in the U.S. than in many European countries, today enrollment rates in secondary education (as a percentage of the appropriate age cohort) for most of the countries participating in TIMSS are as high as or higher than the U.S. Moreover, the design of the study required countries to include students in the last year of secondary education in all "tracks," so countries did not include only those students in the highest academic tracks. Thus, countries with highly differentiated systems with some programs extending through grade 13 and 14 and others, usually vocationally-oriented programs, ending as early as grade 10, tested students in the last year of all of those programs.

10. Isn't it true that the range of scores for U.S. students is greater than in many countries and we have a concentration of very poor performing students who drag down the overall average of our students?

No. The range of scores in the U.S. is not greater than in most of the other countries on the general knowledge assessments. The difference in scores between the 5th and 95th percentile is very similar in most of the countries (about 300 points), including the U.S. The lower "tail" of the distribution is not larger or longer in the U.S. than in the other countries. The difference between the scores of students at the 5th percentile and the median score (the 50th percentile) is also similar in the U.S. to the other countries. What is true is that the entire U.S. distribution of scores, throughout the distribution, is shifted downward compared to the higher achieving countries – the scores of our students are generally lower than those in the other countries at the 95th, 75th, 50th, 25th and 5th percentiles.

11. Don't private school students perform better than our public school students?

In general, the courses students take in high school determine their achievement more than the type of school they attend. When course-taking patterns are accounted for, the mathematics and science achievement of public and private school students is very similar. For example, a recent analysis shows that public and private school students who took the same mathematics courses were almost equally likely to score at the highest level on the 12th grade mathematics achievement test of the National Educational Longitudinal Study. (See accompanying chart on mathematics achievement.) [U.S. Department of Education, Mathematics Equals Opportunity; Madigan. *Science Proficiency and Course Taking in High School*, 1997, NCES 97-838].

12. Aren't our very best students are as good as those in other countries.

This is true neither in the general knowledge assessments nor in the advanced assessments. In the general knowledge assessments, the students scoring at the 95th percentile in the U.S. consistently have scores that are below those at the 95th percentile in most of the other countries. Furthermore, in the mathematics general knowledge assessment, the scores of U.S. students at the 95th percentile are comparable to students at the 75th percentile in some of the high scoring countries. In other words, the 5 percent of our students score about as well as the best 25 percent of students in those other countries.

In the physics and advanced mathematics assessments, a comparison of the fourteen percent of U.S. students taking advanced courses to comparable proportions of advanced students in the other countries shows that our students perform poorly. Our most advanced students, defined as the 5 percent taking AP calculus and the 1 percent taking AP physics, score about as well as 10-20 percent of the most advanced students in the other countries.

13. Isn't there a "gender gap" in mathematics and science achievement?

On our measures of all students in the U.S., there was not a significant gender gap in mathematics in TIMSS at 4th, 8th or 12th grade. This contrasts with most other nations participating in TIMSS which demonstrated a significant gender gap in mathematics at 12th grade (but not at the earlier grades). While there was a gender gap in science in the U.S. at the 12th grade as in all the other countries except one, the U.S. gender gap was one of the smallest. However, on the

advanced mathematics and on the physics assessments, males outperformed females in the U.S. and most of the other TIMSS countries even though females take these courses at about the same rate as males.

14. Did U.S. students do poorly because there were items on the assessment that involved the metric system, with which they were unfamiliar?

U.S. students did no more poorly on items involving the metric system than they did on other types of items. Many of the items in which the metric system was an element did not require students to know anything about the metric system (other than it is a system of measurement) in order to answer the item. For example, in a geometry item where the students were asked to calculate the area of a figure, a student would calculate the area the same way whether the dimensions of the figure are given in centimeters or inches.

BACKGROUND ON TIMSS AND ITS DESIGN

15. What is TIMSS?

The Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive international study of mathematics and science achievement ever. More than 500,000 students from 41 countries participated in the assessments, administered in 30 languages to pupils at three grade levels.

16. Who sponsored TIMSS?

The tests were coordinated by the International Association for the Evaluation of Educational Achievement (IEA), an independent international cooperative of research centers and departments of education in more than 50 countries. Dr. Albert E. Beaton is directing the international activities of the study with his staff at the International Study Center at Boston College.

The international costs of TIMSS were provided by the National Center for Education Statistics (NCES) of the U.S. Department of Education, the National Science Foundation, and the Canadian Government. NCES had oversight of the collection, analysis and reporting of the U.S. data with direction from Eugene Owen. Dr. William Schmidt of Michigan State University is the TIMSS national research coordinator.

17. How does TIMSS assess student performance?

TIMSS is using data collection methodologies that go beyond those used in two previous international studies of mathematics and science achievement. Student achievement was measured through written tests that included multiple-choice questions and a substantial number of open-ended questions. In many of the countries. samples of students also were selected to engage in performance assessments (i.e., to design experiments. test hypotheses and record

findings through a variety of hands-on activities).

In addition, students, teachers and administrators filled out questionnaires that solicited information on 1,500 topics such as student background, teacher instructional methods and a country's commitment of staff and materials to science and mathematics instruction. TIMSS also analyzed the curricula in participating countries through a review of textbooks, curriculum guides and other curricular materials.

Beyond these approaches, NCES designed two new methodologies that were carried out in the U.S., Germany and Japan. In the classroom videotape study, teachers in grade eight mathematics classes were taped to study classroom interactions. The tapes offer insights into the organization of lessons and instructional methods. In the ethnographic case study, researchers conducted in-depth interviews and observations with teachers, students, administrators and parents in these countries. The case studies focus on the implementation of national standards, teacher training and teachers' lives, the learning environment for adolescents, and methods for dealing with student ability differences.

18. Which students were included in the TIMSS assessment?

Schools were encouraged to have all students take the assessment. Students with limited English proficiency generally could be excluded if they had not been in an English speaking classroom for at least two years. Attempts were made to accommodate all learning disabled students depending on specific test taking provisions in their Individual Education Plans. The sample assessed in the United States was representative of all ethnic groups and all residence categories.

19. How many U.S. students took the TIMSS assessment?

Approximately 5,400 U.S. 12th grade students in 210 public and private schools nationwide took the general knowledge assessments in mathematics and science. Approximately 2,500 students took the advanced mathematics assessment and another 2,500 students took the physics assessment.

20. When will TIMSS be offered again?

A TIMSS follow-up assessment will be given to 8th graders in the U.S. and other countries in 1999. The study will examine the performance of the same cohort of students who participated in TIMSS at the 4th grade level in 1995 four years later when they are in 8th grade. Trends in performance between 4th and 8th grade will be analyzed, and the 1999 scores will be compared to the performance of 8th graders in 1995. More than 20 countries (including Japan, Korea, and Singapore) have tentatively agreed to participate in the study, and preliminary discussions for another videotape study of teaching are underway.

21. What do the parentheses enclosing country names in the 12th grade *Pursuing Excellence* report mean?

Parentheses indicate that the country named had difficulty meeting the very high standards for conducting TIMSS. The nature of such difficulties are documented in the appendix of the report. The U.S. is in parentheses because its combined school and student participation rate was 64 percent, below the standard of 75 percent. These kinds of problems are typical for most assessments at this level in the U.S. It is most likely that as a group, schools and students who were selected for TIMSS but did not participate in the assessments in the U.S. would have had below average scores, thus lowering the U.S. average. This was probably the case in other countries as well. A full documentation of the data collection methodologies and statistical analyses used in all the participating countries is available in technical and quality control reports published by the TIMSS International Study Center at Boston College.

22. What general reports analyzing TIMSS data have been released to date?

There are over 30 different publications, videos, and CD-ROMS that have been released as part of the TIMSS study thus far. For a complete listing, see the web site at http://nces.ed.gov/timss. The following provide a good starting point for research into the TIMSS project, and can all be downloaded from the NCES web site:

Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context

Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context

Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context

If you desire a comprehensive look at TIMSS and the tools to make its data meaningful in local reform efforts, you may be interested in the:

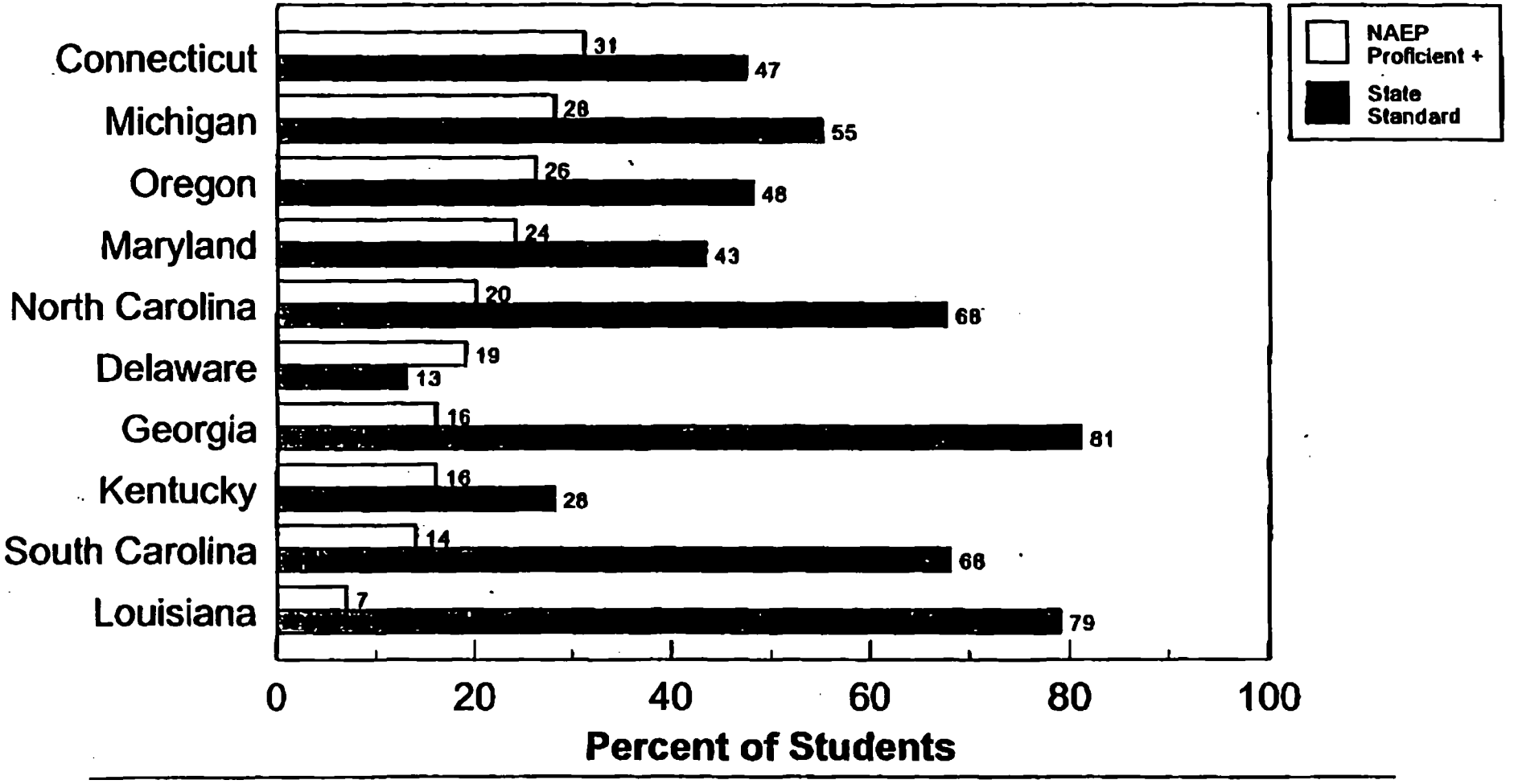
Attaining Excellence: A TIMSS Resource Kit - a package of 12 publications and 2 videos that helps educators, practitioners, policymakers, and concerned citizens reflect upon their own local practices in light of TIMSS findings.

23. Where can I get additional information on TIMSS?

Look at the web site at http://nces.ed.gov/timss or contact the Customer Service Line: Telephone: (202) 219-1333; E-mail: timss@ed.gov

February 23, 1998

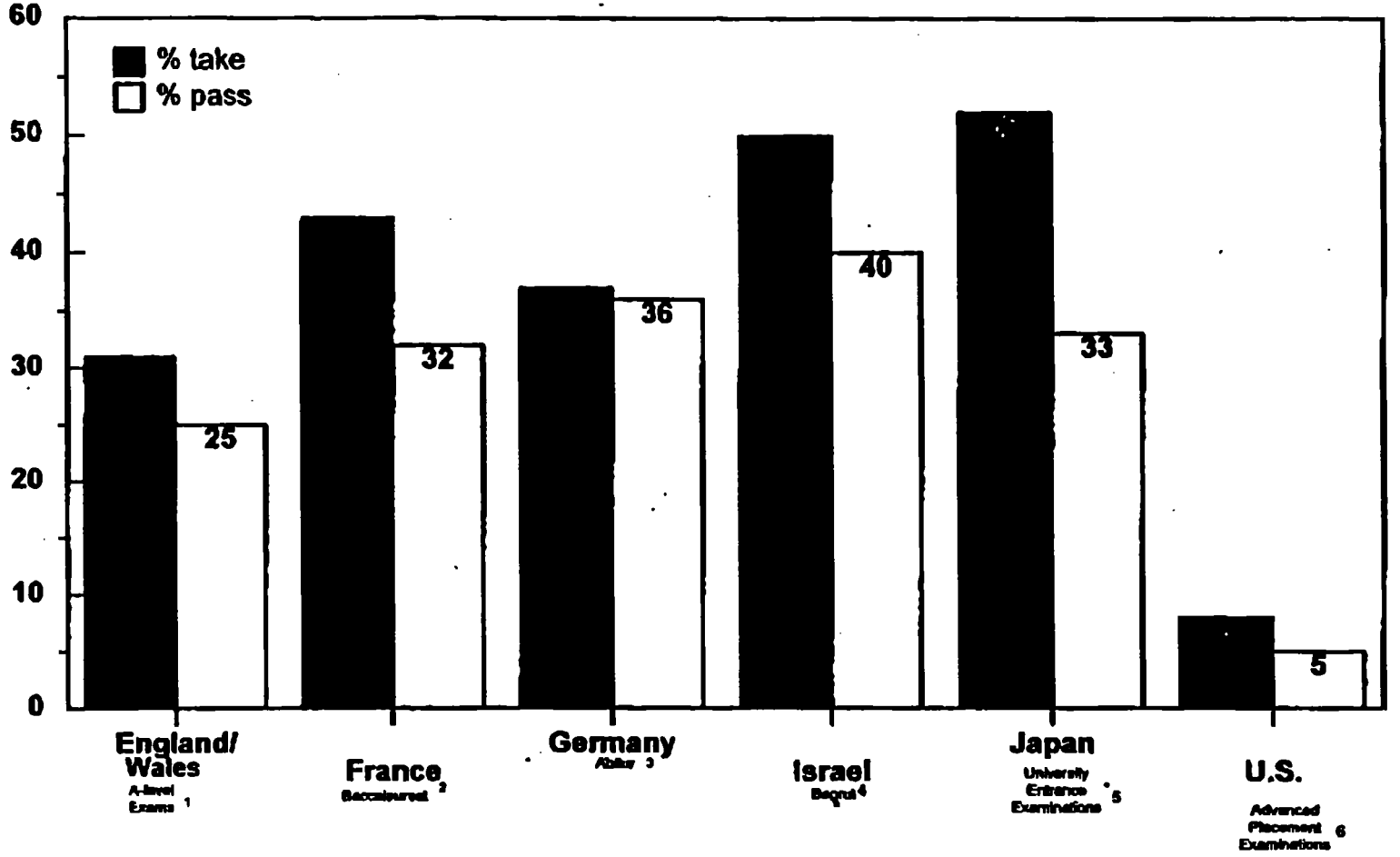
State 1996 NAEP Scores for 8th Grade Math Compared to States' Own Assessments*



★ State assessment results are for the 1995-96 school year. All are for grade 8 except for Michigan which is for grade 7. NAEP results are percentages of students scoring at the proficient or advanced level, state results reflect the state's standards.

Source: U.S. Department of Education and State Departments of Education: Individual State Reports.

Percentage of Students in Last Year of High School Who Take and Pass at Least One Advanced Exam in any Subject



A-level candidates generally take three examinations. Although 25% of the age cohort passes at least one examination, only 15% of the cohort passes three examinations.

These data represent only those students who received a general (academic) baccalaureat, which includes a set of at least six examinations in different subjects. Students in non-academic courses of study also take baccalaureat examinations.

These data represent students who received the Abitur, which includes a set of four examinations in different subjects.

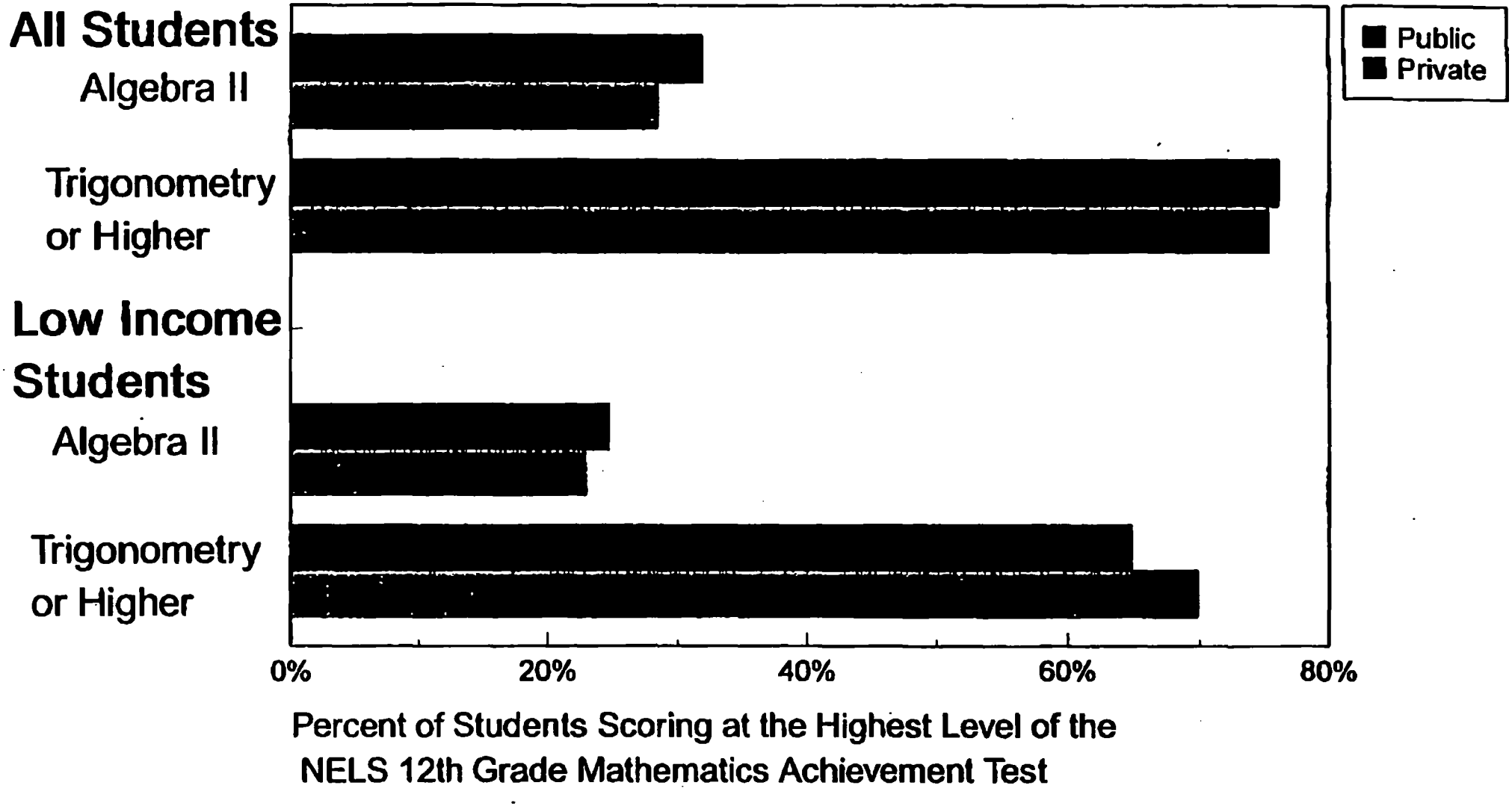
These data represent students who received the Bagrut, which includes a set of from five to ten examinations in different subjects.

These data represent the number of students who apply to university (and thus take the university entrance examinations) and are eventually accepted.

Most students take one or two examinations. AP examinations are available only in about 50% of US high schools.

eprinted with permission of the AFT and National Center for Improving Science Education. [Examining the Examinations, NCISE, 1996; hat Students Are Expected to Know About Mathematics, AFT, 1997]

Public vs. Private School Achievement in Mathematics



Note: When course-taking patterns are accounted for, the mathematics and science achievement of public and private schools is very similar. For example, a recent analysis shows that public and private school students who took the same mathematics courses were almost equally likely to score at the highest level on the 12th grade mathematics achievement test of the National Educational Longitudinal Study (NELS).

UNITED STATES DEPARTMENT OF EDUCATION

WASHINGTON, D.C. 20202

TIMSS RESULTS:
IMPACT FOR OUR ECONOMIC FUTURE AND INDIVIDUAL OPPORTUNITIES

In our knowledge-based economy, demands for skills in mathematics, science, and technology are continually increasing. Many jobs that once called for little background in mathematics, science, and technology in manufacturing, the service industry, and other areas now require higher-level skills -- people who can read technical manuals, handle a spreadsheet, and solve complex problems. Already, businesses are facing worker shortages that are affecting their growth in key sectors like information technology. Clearly, mastering challenging mathematics and science, applying both disciplines to solve real-world problems, and the ability to use technology as a tool, are more important than ever before for the economic future of our nation and individuals' personal opportunities. Yet, often in America, taking four years of high school mathematics and science and enrolling in tougher courses are perceived to be only for elite students. This is out of step with the times and the rest of the world: now most students need substantial and rigorous mathematics and science.

THE ENGINES OF GROWTH IN OUR ECONOMY ARE INDUSTRIES THAT DEMAND MATHEMATICS AND SCIENCE SKILLS. Two of the fastest growing job areas, according to the Bureau of Labor Statistics, are computer technology and health services, fields which require a strong background in mathematics and science. The high-tech explosion in our economy is evident in the fact that about half of America's fastest growing businesses are high-tech firms. The CEO's of these firms and the other fastest-growing product and service companies say that nearly one in four of their entry-level workers needs to be competent in college-level math, according to a new Coopers & Lybrand survey.

JOBS ARE CHANGING. Thousands of applicants are being turned down for factory jobs because they lack the advanced mathematics, communications, and computer proficiencies required to support today's manufacturing. A wide range of industries now call for advanced skills in mathematics and science when traditionally this was not the case. General Motors Corporation recommends that high school students interested in skilled trade occupations -- carpenters, pipefitters, and machinists-- take a rigorous mathematics and science course sequence: algebra, geometry, and physics. Diamond-Star Motors, a joint venture of Chrysler and Mitsubishi, tests all applicants for production and maintenance positions on their ability to do high school-level mathematics. An entry-level automobile worker, according to an industry-wide standard, needs to be able to apply formulas from algebra and physics to properly wire the electrical circuits of a car.

All employees from front-line to professional to management are expected to demonstrate excellence in higher-level skills such as critical thinking, teamwork, communication, and problem-solving.

THE U.S. IS NOT MEETING ITS ECONOMIC NEEDS: BUSINESSES ALREADY FACE WORKER SHORTAGES, LIMITED GROWTH, AND COSTS OF REMEDIAL TRAINING. One third of corporate economists surveyed in 1995 said their firms were encountering problems in finding a skilled workforce. Half of company executives in information technology report a problem in finding skilled workers which they deem the most significant barrier to their company's growth within the next year. One in ten positions in information technology is currently unfilled according to the Information Technology Association of America.

In America's fastest growing businesses, 88 percent of workers need to be retrained in computer technology and 15 percent need to be retrained in mathematics. CEO's of these businesses say that 31 percent of entry-level workers lack the necessary problem solving skills.

Manufacturers surveyed believe that 40 percent of all 17-year-olds lack the mathematics skills to hold down a production job in manufacturing according to the National Association of Manufacturers. One in three job applicants tested by U.S. companies lacks the reading or mathematics skills required for the job as reported by the American Management Association.

STRONG MATHEMATICS AND SCIENCE SKILLS ENHANCE INDIVIDUAL OPPORTUNITY, LEADING TO COLLEGE ENTRY AND SUCCESS. Students who take rigorous mathematics and science courses are much more likely to go on to college than those who do not. Data from the National Educational Longitudinal Study reveal that 83 percent of students who took algebra I and geometry, and nearly 89 percent of students who took chemistry, went on to college, compared to only 36 percent of students who did not take algebra and geometry and 43 percent of students who did not take chemistry. Yet 31 percent of our college bound high school seniors did not take four years or more of mathematics, and 51 percent of college bound high school seniors did not take four years or more of science. Students who took four years or more of mathematics and science scored nearly 100 points higher on the SAT than those who took only one year of mathematics and science.

Taking a challenging college preparatory mathematics sequence and attending and completing college is a sound strategy for securing a promising career. The Bureau of Labor Statistics' (BLS) long-range forecast to the year 2005 predicts that jobs requiring the most education and training will be the fastest growing and highest paying. According to BLS, occupations requiring a bachelor's degree or higher will average 23 percent growth, almost double the 12 percent growth rate projected for occupations requiring less education and training. Even for high school graduates who do not attend college, having strong mathematics skills will make a significant difference in annual salaries, according to authors Murnane and Levy in *The New Basic Skills*.

EXAMPLES OF MATHEMATICS AT WORK

Building Things

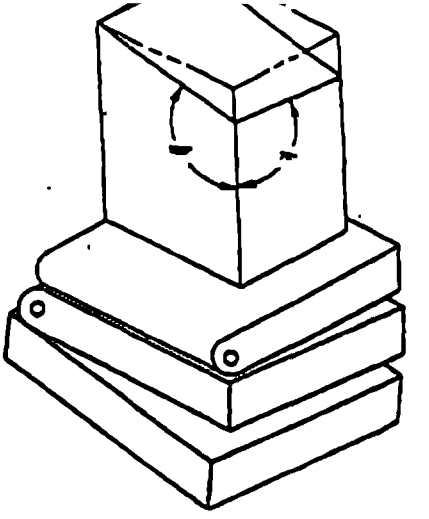


Figure 1

One in three American workers builds products ranging from containers to automobiles and airplanes. The design work of engineers and architects leads to the casting, cutting, fastening, and molding of carpenters, machinists, and others. Each step in the process involves feats of visual imagination, three-dimensional geometry, and measurement.

The calculations that machinists are expected to perform routinely would tax the skills of most mathematics teachers. Figure 1 shows the kind of complicated task confronting a machinist when working in three dimensions: planning how to drill holes at specified angles in a block of aluminum whose base is not square and whose sides are tilted in odd directions. To complete this task, a machinist would use a device called a "sine plate," whose surface can tilt in two different dimensions to compensate for odd angles of a part that is to be drilled.

A good command of geometry and trigonometry is essential for anyone building things in today's manufacturing industries. Both designers and builders use computer-assisted design and computer-assisted manufacturing to support high-performance manufacturing. To use these tools effectively, workers need to have mastered drawing geometric objects, calculating distances, angles, areas and volumes, and using advanced concepts of light. One of the skill standards for computer-aided drafting and design specifies that workers should be able to "describe and explain light including angle of incidence and reflection, critical angle -- fiber optics, diffraction, electromagnetic radiation, electromagnetic spectrum...."

Ensuring Quality

Anyone who drove a car in the 1970's can attest to recent improvements in the auto industry: today's cars have fewer defects, need fewer repairs and last longer. Like the auto industry, other industries ranging from telecommunications to aerospace strictly monitor the manufacturing process so that the end product is free of defects.

Skilled workers are one key to the success of advanced high performance manufacturing. And these workers have a new tool at their command: statistical control manufacturing. Rather than make costly repairs to products after manufacturing, firms like General Motors, Boeing, Siemens, and Kodak now insist that at every step in the manufacturing process, materials, parts, and assembly meet strict specifications. Assembly line workers are responsible for maintaining this consistent level of quality.

To monitor quality, today's assembly line worker uses statistical process control during the manufacture process. This involves collecting data on key indicators -- the temperature of a mixture or pitch of a grinding tool -- and charting data on a graph. If the process strays outside predetermined limits for quality, the worker may decide to make adjustments or shut down the assembly line. Statistical quality control is similar but takes place after the manufacturing process is complete. Workers sample finished products, charting their performance characteristics, and identify potential problems in quality before defective items are shipped for sale. In the past, companies employed specialists for quality control, but today's assembly line workers are expected to fill this role in addition to their other responsibilities.

Speech by
Richard W. Riley
U.S. Secretary of Education

Press Conference on TIMSS Results
Tuesday, February 24, 1998
Washington, D.C.

Thank you Pat [*Forgione*]. Good morning. These are very important results from the Third International Math and Science Study concerning our nation's 12th graders. These results are entirely unacceptable, and absolutely confirm our need to raise our standards of achievement, testing, and teaching, especially in our middle and high schools -- and to get more serious about taking math and science courses.

Let me outline five basic steps we need to take. First, we need to build a firm foundation for our students during the middle school years; second, state assessments and standards must be raised; third, we must expect more high school students to take four years of math and science, including physics, chemistry, trigonometry, and calculus; fourth, more teachers must be prepared to teach these subjects; and fifth, as a nation we must make sure that all students -- not just the elite or the brightest -- understand the importance of math and science in their lives.

I am confident that Americans -- and American students -- have the ability to be competitive with the best students in the world. Consider, for example, the most recent TIMSS measurement of U.S. 4th graders. It showed that our students are well *above* the international average in mathematics and very near the top in achievement in science. This and other assessments show that we are making progress. Unfortunately, we are not gaining fast enough -- and the rest of the world is not standing still.

We give our children a good foundation in the basics. Unfortunately, math and science education gets "stuck in a rut" in the middle grades. We run in place and then allow the majority of our students to "check out" of rigorous math and science courses in high school.

The U.S. was the only country in TIMSS whose students dropped in ranking from above average performance in mathematics at the fourth grade to slightly below average performance at the eighth grade.

By the 12th grade, our students' standing has fallen even further. We must recognize why the drop-off occurred and act aggressively to fix it.

The first reason, and the real core of the problem, is the low expectations and low standards we have for what our students can

and should learn in math and science from 4th to 12th grade. At the 8th grade, for example, many state standards and tests are far less rigorous than national and international standards of excellence. (I hope you will take the opportunity to examine the chart in your materials which makes this clear.)

That is why President Clinton, Vice President Gore, and I have encouraged the development of a voluntary national test in eighth grade mathematics. It would be highly inconsistent to condemn the performance of a sample of U.S. students on this test and then turn around and deny parents and teachers the chance to see how their children would perform individually on a rigorous voluntary national test in math that is linked to TIMSS and NAEP, the National Assessment of Education Progress.

Second, taking the tough courses, including challenging mathematics and science, makes a powerful difference. All students must master the traditional basics of arithmetic early on -- and then move on to more challenging courses.

Unfortunately, too many students -- particularly during the middle school and high school years -- are not taking the rigorous or advanced courses in mathematics and science. By the 8th grade, less than one quarter of American students have taken algebra, while almost all students in the rest of the developed world by that time have studied the fundamentals of algebra and some geometry. Among our high school students only 25% take physics and 10 % take calculus.

What classes students take is so vitally important because it affects *all* students -- those in public and private schools; across all economic levels; from the highest achieving down to the lowest. A large scale study by the Department confirms that it is the courses students take – not whether they are taken in public or private schools that makes a difference. (All of you have a chart that demonstrates this.)

The third major reason our success in the early years hasn't continued is that too many math and science teachers are teaching out of field. In 1993-94, 28% of public high school math teachers in the US were teaching without a major or a minor and 55 % in physics. It's time we overhaul the recruitment, preparation and ongoing professional development of our science and math teachers.

Fourth, we must purge the view that it is ok to be illiterate in math or science -- that these are subjects only for the elite among us. Across our society, demands for specialized skills requiring mathematics, science and technology are growing. Almost 90 percent of new jobs require *more* than a high school level of literacy and math skills. We have all heard about the tremendous shortage of Information Technology workers in America.

The major burden in addressing these issues and overcoming the challenge is on local schools, communities, and states. I've seen communities -- a group of 20 school districts near Chicago called the First in the World Consortium, for instance -- that have taken comprehensive and successful steps toward achieving significantly better results.

Their students recently took the TIMSS test and their students placed among the best in the world in 12th grade in both math and science. They did it by involving parents, teachers, students, and entire communities in developing a rigorous curriculum and high quality teaching and testing. Over 70 % of their high school seniors have taken advanced math and physics courses. Half took algebra by the eighth grade.

We want to support local communities in these kinds of efforts. That is why President Clinton has developed a number of proposals to raise standards and achievement in math and science. His most recent budget proposal includes a $60 million request to Congress to fund an Action Strategy -- coordinated by my Department and the National Science Foundation -- to strengthen the teaching of mathematics in middle schools.

The President also has proposed $350 million over five years to help local communities get qualified teachers into every classroom, with a special emphasis on math and reading. And his $22 billion school modernization proposal will help upgrade math and science classrooms and laboratories in many overcrowded and outdated schools.

I would add one final thought. Let's put an end to the shortsighted, politicized, and harmful bickering over the teaching and learning of mathematics going on in California and elsewhere across this country. We need less ideology and more geometry; less dogmatism and more trigonometry and physics. Failing to focus on what really helps kids learn is an enormous waste of time and a misdirection of our energies.

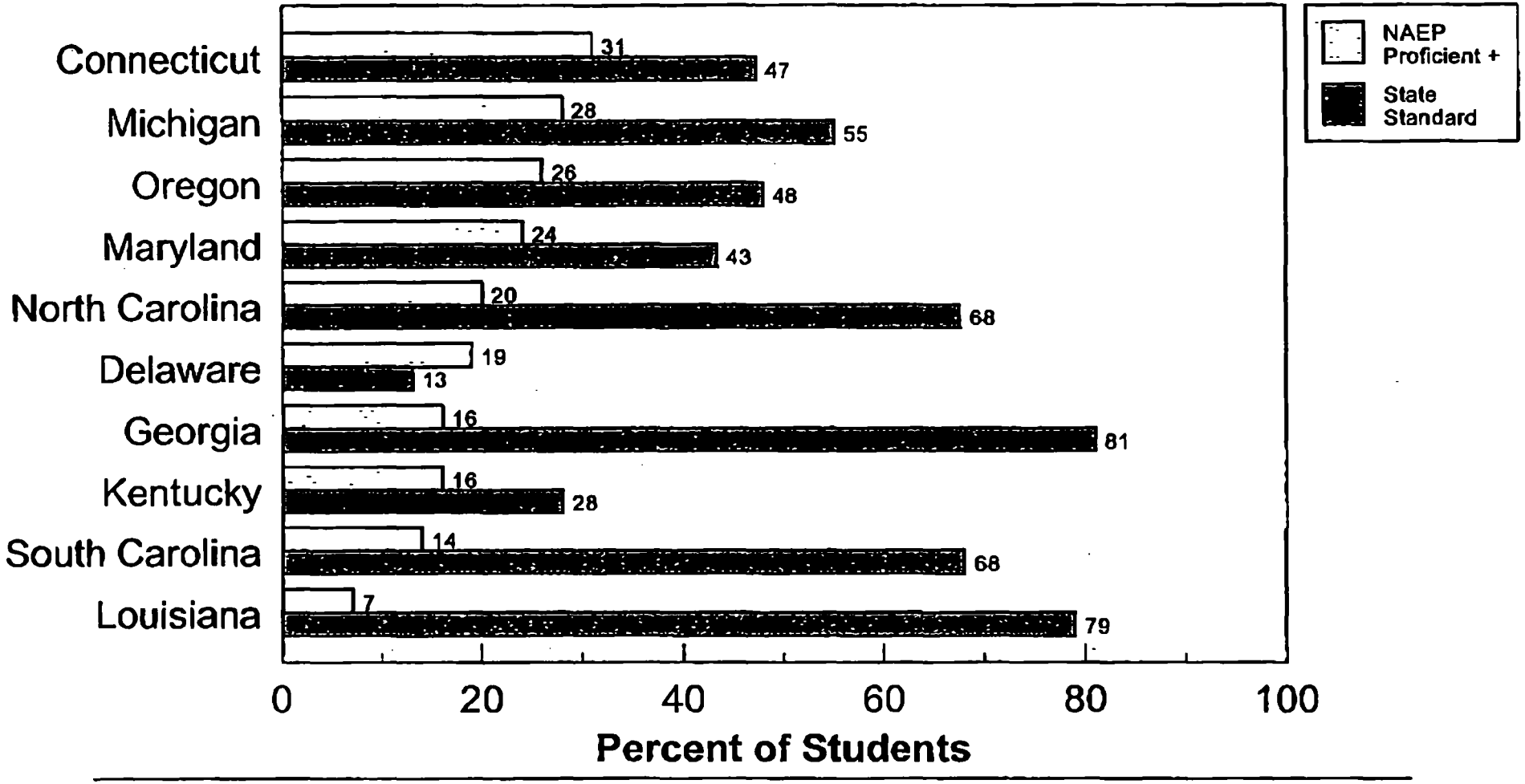
I am confident that if all students and schools were immersed in rigorous teaching and learning environments we would be in the top tier at all levels.

I challenge local schools, school boards, and communities to take a close, hard look at what your students are learning. I urge you to meet and discuss these results. Take a look at the TIMSS questions and answers, which are readily available for your review on the Internet and elsewhere. They are challenging questions. (*Note samples for the press).*

I hope local communities will compare their tests against national and international standards. Determine what is needed in their districts and schools. And then institute more challenging classes and more rigorous teaching.

This is indeed a great challenge -- but one that befits a great nation. Thank you so much.

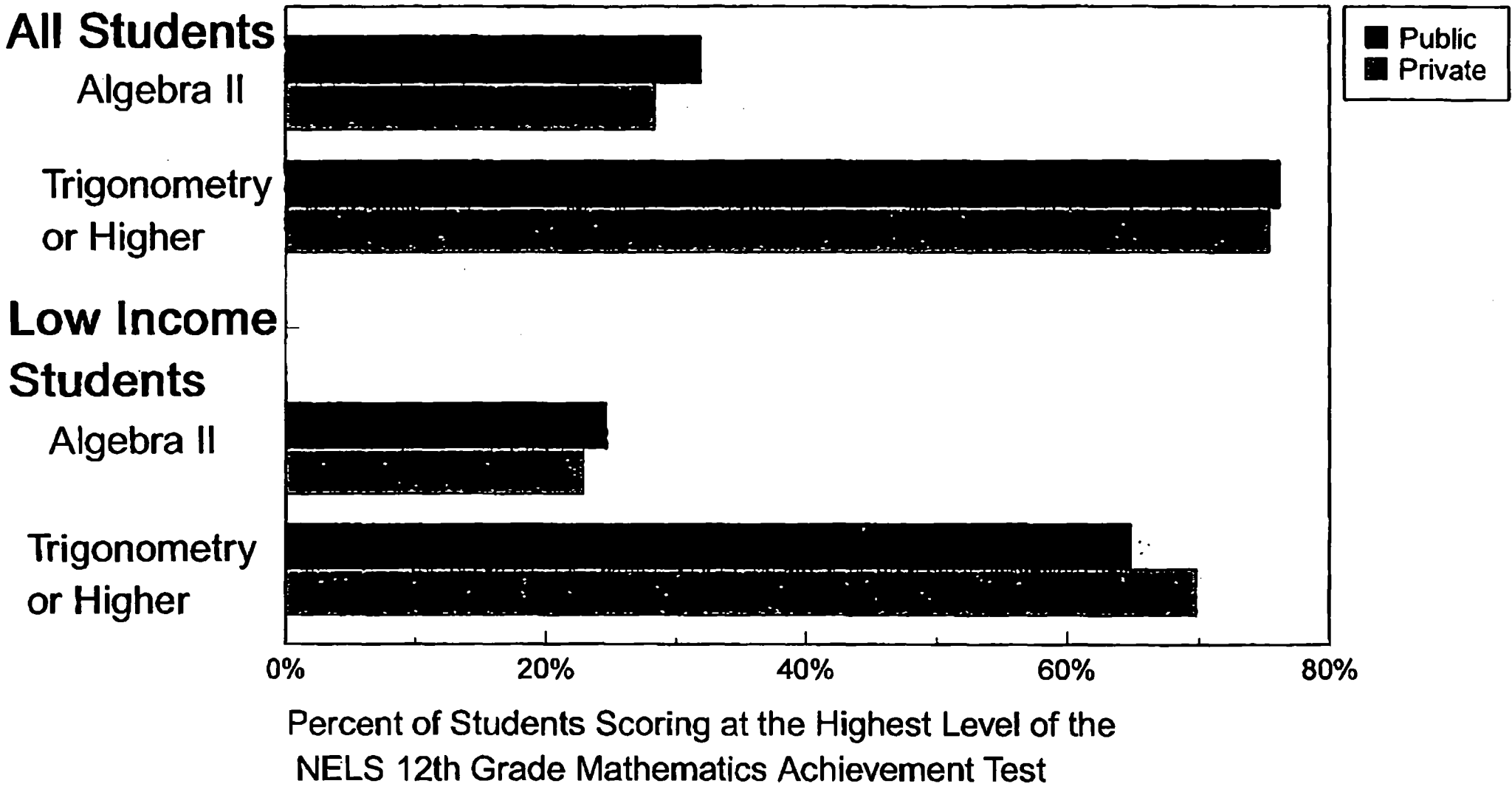
State 1996 NAEP Scores for 8th Grade Math Compared to States' Own Assessments*



★ State assessment results are for the 1995-96 school year. All are for grade 8 except for Michigan which is for grade 7. NAEP results are percentages of students scoring at the proficient or advanced level, state results reflect the state's standards.

Source: U.S. Department of Education and State Departments of Education: Individual State Reports.

Public vs. Private School Achievement in Mathematics



Note: When course-taking patterns are accounted for, the mathematics and science achievement of public and private schools is very similar. For example, a recent analysis shows that public and private school students who took the same mathematics courses were almost equally likely to score at the highest level on the 12th grade mathematics achievement test of the National Educational Longitudinal Study (NELS).

Judy_Wurtzel @ ed.gov
02/17/98 05:48:00 PM

Record Type: Record

To: Michael Cohen, William R. Kincaid

cc:
Subject: TIMSS RELEASE

Based on our conversations, it seems as though the probably outline of an announcement would be:

1. Calling for high standards -- the test

2. Building a stronger middle school foundation -- $50 million in FY99 budget

3. Challenges to the nation:

A. Challenge to states and districts that employee teachers and the colleges and universities that prepare them to get tough on teacher preparation and certification. 28% of high school math teachers and 18% of high school science teachers are teaching out of field.

B. Challenge to students to take and schools to offer more advanced mathematics courses. A high percentage of students never take Algebra II, much less trigonometry, precalculus or calculus. 40% of students who actually plan to go to college and take the SAT or ACT don't get beyond Algebra II.

4. Calling for a commission. Here the message would be that we know some of the things that are wrong (e.g. low standards, out of field teachers, kids not taking courses), but that we need a thoughtful examination of other critical issues (e.g. what are implications of the fact that our curriculum patterns are so different than those of other nations, how does the structure of our high schools impact on achievement, how can we improve teaching for conceptual understanding).

Terry Peterson has talked to Riley briefly and he is interested in the Commission idea. We will talk again tomorrow at more length. I will also try to reach Ray on this.

David Stevenson will send over a 2 pager describing the rationale for a commission and what it would look like.

Judy

UNITED STATES DEPARTMENT OF EDUCATION

OFFICE OF THE DEPUTY SECRETARY

FOB-10 Rm 6251

Telephone Number: (202) 401-3281 **Fax Number: (202) 401-3095**

FAX COVER SHEET

TO: Mike Cohen

FROM: JUDY WURTZEL

FAX: 301-622-4044

NUMBER OF PAGES TO FOLLOW, INCLUDING COVER SHEET: _____

IF YOU DID NOT RECEIVE THE COMPLETE TRANSMISSION, PLEASE CALL (202) 401-3281 or (202) 401-1000.

MESSAGE:

UNITED STATES DEPARTMENT OF EDUCATION

OFFICE OF THE SECRETARY

February 13, 1998

MEMORANDUM

TO: Thurgood Marshall, Jr.
Assistant to the President and
Secretary to the Cabinet

FROM: Leslie T. Thornton
Chief of Staff

SUBJECT: Request for the President to meet with experts

Attached is a scheduling request for the President to meet with a small group of experts to discuss the state of the American high school and appropriate responses to the release of the 12th grade results of the Third International Math and Science Study. The meeting should take place sometime the week of February 16.

I appreciate your review of this request and thank you for your assistance. If you have any questions, please contact me at 401-3001.

Attachment

Schedule Proposal Date_____

_____ACCEPT _____REGRET _____PENDING

TO: Stephanie Streett
Assistant to the President and
Director of Scheduling and Advance

Jennifer Palmieri
Deputy Assistant to the President and
Director of Scheduling and Advance

FROM: Thurgood Marshall, Jr.
Assistant to the President and
Secretary to the Cabinet

REQUEST: The President to meet with a small group of experts to discuss the state of the American high school and appropriate responses to the release of the 12th grade results of the Third International Math and Science Study (TIMSS).

PURPOSE/
BACKGROUND: The President is currently scheduled to release the 12th grade results of the Third International Math and Science Study (TIMSS) on February 24, 1998. These results will show that our 12th grade students perform well below the international average in mathematics and science general knowledge compared to students in 21 other nations. It will also show that our advanced students, those studying pre-calculus and calculus and those studying physics, compare poorly to advanced math and science students in other nations.

The poor TIMSS results merit a strong Presidential and national response. Our poor performance in mathematics and science can be considered comparable to Sputnik in the gravity of the message it sends to the American people. A conversation with experts would inform the President's thinking on how to respond.

A response to the results would have several components. It is an opportunity to reiterate the importance of national standards and the need for a national test in mathematics. It is also an opportunity to announce that responding to U.S. students' poor performance in TIMSS at the 8th

grade, the Administration has proposed a $50 million joint initiative of the National Science Foundation and the Department of Education targeted at improving middle school mathematics.

In addition, a national response should include actions directly focused on high school achievement. One possible response would be calling for a National Commission on America's High Schools for the 21st Century. Forty years after James Conant's report The American High School Today, and 15 years after A Nation At Risk, it is time to reexamine American high schools. While the American high school has improved in the past decades, the international competitiveness of our high school students has not. The rest of the world is moving forward at a faster rate than we. Moreover, in the next decade, the challenges facing American high schools are going to increase. There are going to be increasing numbers of students attending high school as high school enrollments reach an all time high. The high schools also will have increasing numbers of students from racial and language minority backgrounds.

This Commission would be charged to report in one year its recommendations on how to change high schools to improve the academic performance of all high school students in math, science, reading and other content areas. The Commission might be funded and administered by one or more prominent foundations.

A small discussion with a number of experts on the American High School and student achievement in math and science, would allow the President to discuss the major issues facing American high schools today, the implications of TIMSS for high school reform, and explore how a National Commission might build a national consensus for improving American high schools.

PREVIOUS PARTICIPATION: In June 1997, the President announced the 4th grade TIMSS results which showed that our students were above the international average in mathematics and second only to Korea in science.

DATE AND TIME: The week of February 16, 1998

DURATION: 90 minutes

LOCATION: The White House

PARTICIPANTS: A list of potential invitees for such a conversation is attached.

REMARKS REQUIRED:	No
ATTENDANCE REQUESTED:	The President
MEDIA:	No
RECOMMENDED BY:	Richard W. Riley, Secretary of Education
CONTACT:	Leslie T. Thornton, Chief of Staff U.S. Department of Education Telephone: 401-3001

Potential participants for meeting with the President on the American High School and Student Achievement in Mathematics and Science

Bruce Alberts -- President of the National Academy of Sciences

Richard Atkinson -- President of the University of California, former director of the National Science Foundation

Deborah Ball -- Professor of Education at University of Michigan, mathematics education expert

David Cohen -- John Dewey Professor of Education at University of Michigan, expert on high schools and policy

Rudy Crew -- Chancellor of New York City Schools

Patricia Graham -- President of the Spencer Foundation, Professor at Harvard University, historian of education

Carl Kaestle -- Professor of Education and History, Brown University, President of the National Academy of Education, expert in educational policy and history

Robert Moses -- Director of the Algebra Project, national project to help disadvantaged students prepare for taking rigorous mathematics in high school

Tom Payzant, Superintendent of Boston Public Schools

William Schmidt -- Professor at Michigan State University, National Coordinator for TIMSS, expert in science and mathematics education

Urie Triesman -- Professor of Mathematics and Education, University of Texas, developer of programs for high school mathematics

Goodly

Timss mg 2/11

12th Grade Timss – response

Big picture
End a priority
Consequences for the economy

Not just see schools – Foundation
Agenda will help
class size
middle school math ⊕

National Test will help – tied w/ Intl benchmark
No social promotion
Not Fed but national problem
states, et al must respond

Sec – links w/

Eisenhower Eval – +
Fed effectiveness practices
Tweak Title V

Teachers out of field

Title V –
Could add priority in teacher recruiting

DOE – NAEP gain some Q2

Transcripts – only the same day

~~[illegible]~~ Go back to ~~[illegible]~~ test (TIMSS) in 99

suburban/middle class -

DS - Decision made by state/local boards determ
what kids learn —

accountab for local bowds / state for
their perform

Do it yourself TIMSS
technical problem

Ongoing commission | Could get major foundation
multiple orgs
NLCS

1. Commission / Foundation
2. Models / Foundation
3. Chair

Not just one - day

HS reform
improving content ; achieve over 4 years

Carnegie | look at what to do
Gregorian | New dd
Spencer
Lvl [illegible]

40 years after Conant did American High School

Blue print for notice agenda

For Admin
For Rest of the Nation

NCAA

Cocks in Room
Mtg tue 3:30/4:00 PST in Sac
Drive to SF
SF Fri

Red Eye back - 6 am.

Judy_Wurtzel @ ed.gov
02/10/98 02:42:00 PM

Record Type: Record

To: William R. Kincaid

cc:
Subject: Re: TIMSS 12th Grade Briefings

Following our last meeting, I offered to write up a synopsis of where we are in describing the TIMSS story: the results in context and why we perform as we do. This can be a part of our conversation Wednesday.

Framing the "story" around the TIMSS 12th grade release

I. US 12th grade math and science achievement is improving, but compared to other nations our performance is unacceptably low for all our students and for those who take advanced math and science

--NAEP long-term trend data
--NELS growth in achievement data
--SIMSS and SISS comparisons (change in relative performance?)

II. Showing what we mean by low performance

-- examples of items from general knowledge and advanced tests with our scores compared to other nations and international average

III. Low performance for generalists and for those in the "pipeline" to math and science careers has dire implications for our economy

-- growth in economy is in sectors which require math and science skills; are significant job shortages in key areas (IT)

-- skills needed in the workplace by the "average" worker include significant math and science general knowledge and are continually increasing

-- skills needed by those in math/science/technology fields are high (vignettes from employers from STW?)

-- high percent of foreign students in top math/science/engineering departments

IV. Our performance is low because of low expectations, what we teach and how we teach

A. Fail to build foundation in middle school

-- students don't get a strong working knowledge of essential math skills and concepts prior to high school

-- fragemented grades 4-8 curriculum produces little gains in achievement

B. In high school we continue to fall behind

-- 1 year behind in 8th grade/2 years behind in 12th grade

-- in high school, we are one of few nations with a layer cake as opposed to a marble cake approach, thus students may learn less deeply and be less likely to remember content in a 12th grade test

-- our high school curriculum and instruction has less rigor and depth than most other nations and less focus on building understanding of major concepts

C. Low Expectations for our Students

-- our culture thinks advanced math and science is only for elite students

-- because few states require students to take a full course of math and science, many U.S. students, particularly low income students, stop taking math and science after 9th or 10th grade so have no exposure to chemistry, physics, advanced algebra

-- State standards at 12th grade in math and science are not rigorous compared to the NAEP or TIMSS (SREB data?)

-- compared to the exit exams of other nations, the SAT and AP lack rigor (AFT/NCISE)

D. How we teach it

-- teaching for skills not understanding; teachers emphasize rote learning

-- high number of teachers out of field in high school math and science

-- preparation and professional development for teachers here and abroad is less structured and intensive (if can get good comparative data)