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ABSTRACT

The 1995-1996 Third International Mathematics and Science Study (TIMSS) is the largest and most comprehensive international study ever conducted. Students from 41 nations were tested in 30 languages at three educational levels to compare their achievement in mathematics and science. Over 33,000 students and 500 schools were included in this study in the United States. This overview helps educators and others in states, communities, and schools use TIMSS as a starting point. It provides an overview of the TIMSS study, key findings and conclusions from the eighth and fourth grade reports, and supporting materials to help states and communities use TIMSS to examine their own practices from an international perspective. This booklet contains: (1) a summary of what TIMSS is and how it was conducted; (2) key TIMSS results for fourth and eighth grade achievement in mathematics and science from an international perspective; (3) TIMSS presentation overheads; (4) presentation talking points which coordinate with the overheads; (5) a sample meeting announcement; (6) information on the CD-ROM version of Attaining Excellence: A TIMSS Resource Kit; (7) sources of other TIMSS reports; and (8) a TIMSS resource kit questionnaire. (AIM)

ATTAINING EXCELLENCE

TIMSS AS A STARTING POINT TO EXAMINE U.S. EDUCATION

INTRODUCTION TO TIMSS: THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

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

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INTRODUCTION TO TIMSS: THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

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Contents

TIMSS AS A STARTING POINT TO EXAMINE U.S. EDUCATION

In 1989, President Bush and the governors of all 50 states adopted the National Goals for Education, one of which was that the United States will be "first in the world in mathematics and science achievement by the year 2000." The Third International Mathematics and Science Study (TIMSS) shows that our nation has not yet reached this mark.

Attaining Excellence: A TIMSS Resource Kit is designed to provide educators, parents, business leaders, government officials, and community leaders with information and tools they can use to help students, teachers, and school officials examine their own performance in an international perspective. It brings the main findings of the TIMSS study directly to the states, districts, schools, and classrooms. Through this information, local teaching, achievement, and curricula can be compared to those of other countries. Such a review can help schools find ways to help all students—including children with disabilities, limited English proficiency, and traditionally disadvantaged backgrounds—reach higher levels and achieve greater success.

The first step in any journey is to determine the starting point. TIMSS is such a beginning. It helps us scrutinize the quality and effectiveness of U.S. education by holding up a mirror to how well our students perform, comparing our results with those of other countries, and thereby providing us with a solid basis for judging our performance.

But TIMSS goes further. It also provides deep insights into our own methods of teaching and learning. It affords an unprecedented opportunity to view our education system through the prism of other countries' techniques and achievements.

Such a comparison helps us understand our own practices better and also suggests possible alternatives. The goal of this Resource Kit is not to prescribe practices to be adopted, but rather to provide insights from TIMSS to make our own unique processes of education more effective.

This overview, *Introduction to TIMSS: The Third International Mathematics and Science Study*, helps educators and others in states, communities, and schools to use TIMSS as a starting point. It provides a succinct overview of the TIMSS study, key findings and conclusions from the eighth- and fourth-

grade reports, and supporting materials to help communities and states use TIMSS to examine their own practices from an international perspective. This booklet includes the following major sections:

- Overview of TIMSS—A basic summary of what TIMSS is and how it was conducted.
- Key TIMSS Results: Eighth Grade—What TIMSS tells us about U.S. eighth-grade achievement in international perspective.
- Key TIMSS Results: Fourth Grade—What TIMSS tells us about U.S. fourth-grade achievement in international perspective.
- TIMSS Presentation Overheads—A set of black-line masters that can be duplicated onto overhead transparencies for introducing TIMSS to various audiences. These overheads highlight key facts that audiences should learn about the study and its findings.
- Presentation Talking Points—Accompanying remarks for the presentation overheads to help the presenter highlight or elaborate upon major points.
- Sample Meeting Announcement—A black-line prototype meeting announcement to aid in developing flyers and posters for TIMSS community meetings.
- Information on the CD-ROM version of *Attaining Excellence: A TIMSS Resource Kit*—A version of these documents on disc for use by schools and school districts.
- Sources of Other TIMSS Reports—A list of sources for ordering a variety of TIMSS-related analyses and reports.
- TIMSS Resource Kit Questionnaire—We believe that customers are the best judges of what works in making TIMSS products useful to a variety of audiences, and we urge you to fill out the questionnaire and send it to the U.S. Department of Education, Office of Educational Research and Improvement (OERI).

Attaining Excellence: A TIMSS Resource Kit is only one of the many ways to learn about TIMSS. In the coming years, new reports and resources will be published by the Office of Educational Research and Improvement, including modules on assessment and twelfth-grade TIMSS results. TIMSS material also can be found at the National Center for Education Statistics' TIMSS site on the World Wide Web at http://www.ed.gov/NCES/timss.

Overview of TIMSS—An Unprecedented International Study

With data from a half-million students, the 1995-1996 Third International Mathematics and Science Study (TIMSS) is the largest, most comprehensive, and most rigorous international study ever conducted. Students from 41 nations were tested in 30 different languages at three different education levels to compare their mathematics and science achievement. Intensive studies of students, teachers, schools, curricula, instruction, and policy issues were also carried out to understand the educational context in which teaching and learning take place. In the United States, over 33,000 students and more than 500 schools were included.

Policymakers recognize that a nation's mathematical and scientific literacy affect economic productivity. World-class competence in mathematics and science is essential to compete successfully in today's interdependent global marketplace. TIMSS provides a comparative international assessment of educational achievement in these two subjects and the factors that contribute to it.

TIMSS Countries

Australia
Austria
Belgium (Flemish)
Belgium (French)
Bulgaria
Canada
Colombia
Cyprus
Czech Republic
Denmark
England
France
Germany
Greece
Hong Kong
Hungary
Iceland
Iran, Islamic Republic
Ireland
Israel
Japan
Korea
Kuwait
Latvia
Lithuania
Netherlands
New Zealand
Norway
Portugal
Romania
Russian Federation
Scotland
Singapore
Slovak Republic
Slovenia
South Africa
Spain
Sweden
Switzerland
Thailand
United States of America

TIMSS—More Than a Report Card

TIMSS is an important study for those interested in U.S. education. In 1983, the National Commission on Excellence in Education pointed to our nation's low performance in international studies as evidence that we were *A Nation at Risk.* In 1989, President Bush and the governors of all 50 states adopted the National Goals for Education, one of which was that "by the year 2000, the United States will be the first in the world in mathematics and science achievement."

Mathematics and science experts have issued major calls for reform in the teaching of their subjects. The National Council of Teachers of Mathematics published *Curriculum and Evaluation Standards* in 1989, and *Professional Standards for Teaching Mathematics* in 1991.

In 1993 the American Association for the Advancement of Science followed suit with *Benchmarks for Science Literacy,* and in 1996, the National Academy of Sciences published *National Science Education Standards.*

TIMSS helps us measure progress toward our national goal of improving our children's academic performance in mathematics and science. But TIMSS is much more than a scorecard for the mathematics and science events in the "education Olympics." It is a diagnostic tool to help us examine our nation's progress toward improvement of mathematics and science education. It was designed to look beyond the scorecard to illuminate how our education policies and practices compare to those of the world community.

TIMSS helps us answer several critical questions about our nation's mathematics and science learning:

- **Achievement**—Do U.S. students know as much mathematics and science as students in other countries?
- **Curriculum**—Are U.S. curricula and expectations for student learning as demanding as those of other nations?
- **Teaching**—How does U.S. classroom instruction compare with that of other countries?
- **Teachers' Lives**—Do U.S. teachers receive as much support in their efforts to teach students as do their colleagues in other nations?
- **Students' Lives**—Are U.S. students as focused on their studies as their international counterparts?

The National Center for Education Statistics of the U.S. Department of Education already has and will continue to publish numerous reports that summarize findings of the study. Publications include the *Pursuing Excellence* series, which comprises three separate reports on mathematics and science achievement at the fourth, eighth, and twelfth grades. Over the next several years, additional reports on selected topics will be published.

Rigorous Quality Control

TIMSS is a fair and accurate comparison of mathematics and science achievement in the participating nations. It is not a comparison of "all our students with other nations' best"—a charge that some critics have leveled at previous international comparisons. The students who participated in TIMSS were selected randomly to represent all students in their respective nations.

The entire assessment process was scrutinized by international technical review committees to ensure its adherence to established standards. Those nations in which irregularities in the assessment process arose, such as differences in ages of students, are clearly noted in the reports. At each step of its development, TIMSS researchers followed careful quality-control procedures. An international curriculum analysis was carried out prior to the development of the assessments to ensure that the tests reflected the mathematics and science curricula of the variety of TIMSS countries and did not overemphasize what is taught in only a few.

International monitors carefully checked the test translations and visited many classrooms while the tests were being administered in each of the 41 countries to make sure that the instructions were properly followed. The raw data from each country were scrutinized to be sure that no anomalies existed, and all analyses were double-checked. Finally, the TIMSS reports and related materials published by the National Center for Education Statistics were written and carefully reviewed to avoid overgeneralization and inaccuracy.

Focus on Fourth, Eighth, and Twelfth Grades

TIMSS was designed to focus on students at three stages of schooling: midway through elementary school, midway through lower secondary school, and at the end of upper secondary school. Because various countries set different ages at which children should begin school, decisions about which students to test needed to consider both age and grade level.

Who was Tested

Population 1	**Students in the pair of adjacent grades containing the most nine-year-olds**	**Grades three - four in the United States**
Population 2	**Students in the pair of adjacent grades containing the most 13-year-olds**	**Grades seven - eight in the United States**
Population 3	**Students in their final year of secondary school, regardless of age**	**Grade 12 in the United States**

In all countries, students in both public and private schools received the TIMSS test. In all but a few of the 41 TIMSS countries, virtually all children in Populations 1 and 2 are enrolled in school and are therefore eligible to take the test. Testing occurred two to three months before the end of the 1995-1996 school year. Students with special needs and disabilities that would make it difficult for them to take the test were excused from the assessment. In each country, the test was translated into the primary language or languages of instruction. All testing in the United States was done in the English language.

Data Collection Methods

TIMSS brought a variety of different and complementary research methods to bear on the important education questions posed in the study by the International Association for the Evaluation of Educational Achievement (IEA). Five different approaches were used: assessments, questionnaires, curriculum analyses, videotapes of classroom instruction, and case studies of policy topics. Each of these five approaches used in TIMSS represents an important advancement in its field. Taken together, they create an unprecedented opportunity to understand U.S. mathematics and science education from a new and richer perspective.

All TIMSS countries participated in the following three IEA-sponsored parts of the study:

- **Mathematics and science assessments**—One and one-half hours in length, the assessments included both multiple-choice and free-response items. A smaller number of students also completed "hands-on" performance assessments.
- **School, teacher, and student questionnaires**—Students answered questions about their mathematics and science studies and beliefs. Teachers answered questions on their beliefs about mathematics and science and on teaching practices. School administrators answered questions about school policies and practices.
- **Curriculum analysis**—This exploratory study compared mathematics and science curriculum guides and textbooks. It studied subject-matter content, sequencing of topics, and expectations for student performance.

In-Depth Studies of the United States, Japan, and Germany

In conjunction with the three activities above, the National Center for Education Statistics sponsored two additional TIMSS-related studies, which were carried out in the United States, Japan, and Germany. These three countries are all economic superpowers with close economic and political ties. They also are nations whose educators have learned a great deal from each other in the past and whose school systems are both similar to and different from each other in important ways. TIMSS researchers in the United States, Japan, and Germany collaborated in sharing their assessment and questionnaire data and in carrying out the following two parts of the study:

- **Videotapes of mathematics instruction**—In the United States and Germany, half of the eighth-grade mathematics classrooms that participated in the main TIMSS study were randomly chosen to be videotaped. In Japan, eighth-grade classrooms in a random sample of 50 of the TIMSS schools were chosen. In all three countries teachers were filmed teaching a typical lesson, and these tapes were analyzed to compare teaching techniques and the quality of instruction.
- **Ethnographic case studies of key policy topics**—Teams of bilingual researchers spent three months in the United States, Japan, and Germany, observing classrooms and interviewing education authorities, principals, teachers, students, and parents. Topics of study were education standards, methods of dealing with individual differences, the lives and working conditions of teachers, and the role of school in adolescents' lives.

The TIMSS Research Team

TIMSS was conducted by the IEA, a Netherlands-based organization of ministries of education and research institutions in its member countries. The IEA delegated responsibility for overall coordination and management of the study to Professor Albert Beaton at the TIMSS International Study Center, located at Boston College. Each of the 41 IEA member-nations that made the decision to participate in TIMSS paid for and carried out the data collection in its own country according to the international guidelines. The costs of the international coordination were paid for by the National Center for Education Statistics (NCES) of the U.S. Department of Education, the National Science Foundation (NSF), and the Canadian Government.

In the United States, TIMSS was funded by NCES and NSF. Professor William Schmidt of Michigan State University was the U.S. National Research Coordinator. Lois Peak of NCES monitored the international and U.S. data collections.

The U.S. data collection was carried out by Westat, a private survey research firm. Trevor Williams and Nancy Caldwell were Westat project co-directors. Professor James Stigler at the University of California at Los Angeles managed the TIMSS videotape study of mathematics instruction, and Professor Harold Stevenson at the University of Michigan managed the TIMSS ethnographic case studies. Experts from many fields served as advisors to the study. The U.S. TIMSS team also included the students, teachers, and principals who participated in the data collection. Their cooperation made the TIMSS project possible.

Key TIMSS Results: Eighth Grade

Student Achievement

One of our national goals is to be "first in the world in mathematics and science achievement by the year 2000," as President Bush and 50 governors declared in 1989. Although at the eighth-grade level we are far from this mark, we are on par with other major industrialized nations, such as Canada, England, and Germany.

In mathematics, our eighth graders score...

- Below the international average of 41 TIMSS countries. Our students' scores are not significantly different from those of England and Germany.
- At about the international average in Algebra; Fractions; and Data Representation, Analysis, and Probability. We do less well in Geometry, Measurement, and Proportionality.

In science, our eighth graders score...

- Above the international average of 41 TIMSS countries. Our students' scores are not significantly different from those of Canada, England, and Germany.
- Above the international average in Earth Science, Life Science, and Environmental Issues and the Nature of Science. Our students score about average in Chemistry and Physics.

If an international talent scout selected the top 10 percent of all eighth graders in the 41 TIMSS countries...

- In mathematics, 5 percent of U.S. students would be included.
- In science, 13 percent would be included.

Curriculum

U.S. policymakers are concerned about whether expectations for our students are high enough and, in particular, whether they are as challenging as those of our foreign economic partners. In all countries, the relationships among standards, teaching, and learning are complex. This is even more true in the United States, which is atypical among TIMSS countries in that curriculum is defined at the local, rather than national, level.

- The mathematics content of U.S. eighth-grade classes is at a seventh-grade level in comparison to other countries.
- The U.S. eighth-grade mathematics curricula include more topics than those of other countries.
- The number of topics in the U.S. eighth-grade science curricula may be similar to that of other countries.
- U.S. eighth graders spend more hours per year in mathematics and science classes than German and Japanese students.

Teaching

In recent years, concern about the quality of instruction in U.S. classrooms has led professional organizations to issue calls for reform. TIMSS data cannot tell us about the success of these reform efforts for several reasons. This assessment occurred too soon after the beginning of the movement for states and districts to have designed their own programs, retrained teachers, and nurtured a generation of students according to the new approach. Also, we do not have comparable earlier baseline information against which to compare findings from TIMSS.

However, TIMSS includes the first large-scale observational study of U.S. mathematics teaching ever undertaken. Therefore, it forms a historical baseline against which future progress may be measured.

- The content of U.S. mathematics classes requires less high-level mathematical thought than classes in Germany and Japan.
- U.S. mathematics teachers' typical goal is to teach students how to do something, while Japanese teachers' goal is to help them understand mathematical concepts.
- Japanese teachers widely practice what the U.S. mathematics reform recommends, while U.S. teachers do so less frequently.
- Although most U.S. mathematics teachers report familiarity with reform recommendations, only a few apply the key points in their classrooms.

Lives of Teachers

The training that teachers receive before they enter the profession, and the regular opportunities that they have for on-the-job learning and improvement, affect the quality of classroom teaching. The collegial support that teachers receive and the characteristics of their daily lives also affect the type of teaching they provide.

- Unlike new U.S. teachers, new Japanese and German teachers undergo long-term structured apprenticeships in their profession.
- U.S. teachers have more college education than their colleagues in all but a few TIMSS countries.
- Japanese teachers have more opportunities to discuss teaching-related issues than do U.S. teachers.
- Student diversity and poor discipline are challenges not only for U.S. teachers, but for German teachers as well.

Lives of Students

The manner in which societies structure the schooling process gives rise to different opportunities and expectations for young people. The motivators, supports, and obstacles to study in each country are outgrowths of the choices provided by society and schools.

- Eighth-grade students of different abilities are typically divided into different classrooms in the United States and into different schools in Germany. In Japan, no ability grouping is practiced until entrance to high school at the tenth grade.
- In mathematics, U.S. students in classes of higher ability levels study different material than students in lower level classes. In Germany and Japan, all students study basically the same material, although in Germany the depth and rigor of study depends on whether the school is for students of higher or lower ability levels.
- Japanese eighth graders are preparing for a high-stakes examination to enter high school at the end of ninth grade.
- Teachers assign more homework and spend more class time discussing it than teachers in Germany and Japan. U.S. students report about the same amount of out-of-school mathematics and science study as their Japanese and German counterparts.
- Heavy TV watching is as common among U.S. eighth graders as it is among their Japanese counterparts.

Conclusions from Eighth-Grade TIMSS

The report, *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context*, presents initial findings from TIMSS for eighth-grade mathematics and science. A fuller understanding of the health of education in our nation must await the integration of these and the fourth-grade data with information gathered at the twelfth-grade level.

The search for factors associated with student performance is complicated, because student achievement after eight years of schooling is the product of many different factors. Furthermore, the U.S. education system is large and decentralized with many interrelated parts. With these cautions in mind, the eighth-grade report in the *Pursuing Excellence* series offers the following insights into factors that may be associated with our students' performance.

- No single factor in isolation from others should be regarded as the solution to improving the performance of U.S. eighth-grade students.
- The content of U.S. eighth-grade mathematics classes is not as challenging as that of other countries, and topic coverage is not as focused.
- Although most U.S. mathematics teachers report familiarity with reform recommendations, only a few apply the key points in their classrooms.
- Evidence suggests that U.S. teachers do not receive as much support when they enter the teaching profession as their German and Japanese colleagues do.

Key TIMSS Results: Fourth Grade

Student Achievement

President Clinton praised U.S. fourth graders for their performance on the TIMSS test, saying that the results showed that "we can be the best in the world if we simply believe it and then organize ourselves to achieve it." Education Secretary Richard W. Riley said that TIMSS shows that U.S. children "can compete with those anywhere in the world."

In mathematics, U.S. fourth graders score...

- Above the international average of the 26 TIMSS countries. Our students' scores are not significantly different from those of Canada and exceed those of England.
- Above the international average in Whole Numbers; Fractions and Proportionality; Data Representation, Analysis, and Probability; Geometry; and Patterns, Relations, and Functions. We perform below the international average in Measurement, Estimation, and Number Sense.

In science, U.S. fourth graders score...

- Above the international average of the 26 TIMSS countries. Our students are outperformed by students in only one country, Korea, and our scores are not significantly different from those of Japanese students. We outperform England and Canada.
- Above the international average in Earth Science, Life Science, Physical Science, and Environmental Issues and the Nature of Science.

If an international talent scout selected the top 10 percent of all fourth graders in the 26 countries...

- In mathematics, 9 percent of U.S. students would be included.
- In science, 16 percent would be included.

Compared to their international peers...

- Our fourth graders' international standing is stronger than that of our eighth graders.
- Our students perform better in science than in mathematics at both grade levels.

Conclusions from Fourth-Grade TIMSS

- It is too early in the process of data analysis to provide strong evidence for factors that may be related to the patterns of achievement described here. No single factor or combination of factors emerges as overwhelmingly important.
- Differences between the U.S. and international averages for most factors that might influence achievement are relatively small. Many factors in which the U.S. average exceeds the international average at the fourth grade are not shared by the countries that outperform us.
- Many factors in the United States are similar at both fourth- and eighth-grade levels. Because many of the differences between the grades in the United States also characterize many other TIMSS countries, they cannot account for differences in our students' relative performance at these grade levels. Further analyses are needed to provide more information on these subjects.

Resources

TIMSS offers an objective picture of how our students compare to their international counterparts. We are not yet where we aim to be in terms of our national goal for excellence among nations in mathematics and science, particularly at the eighth-grade level.

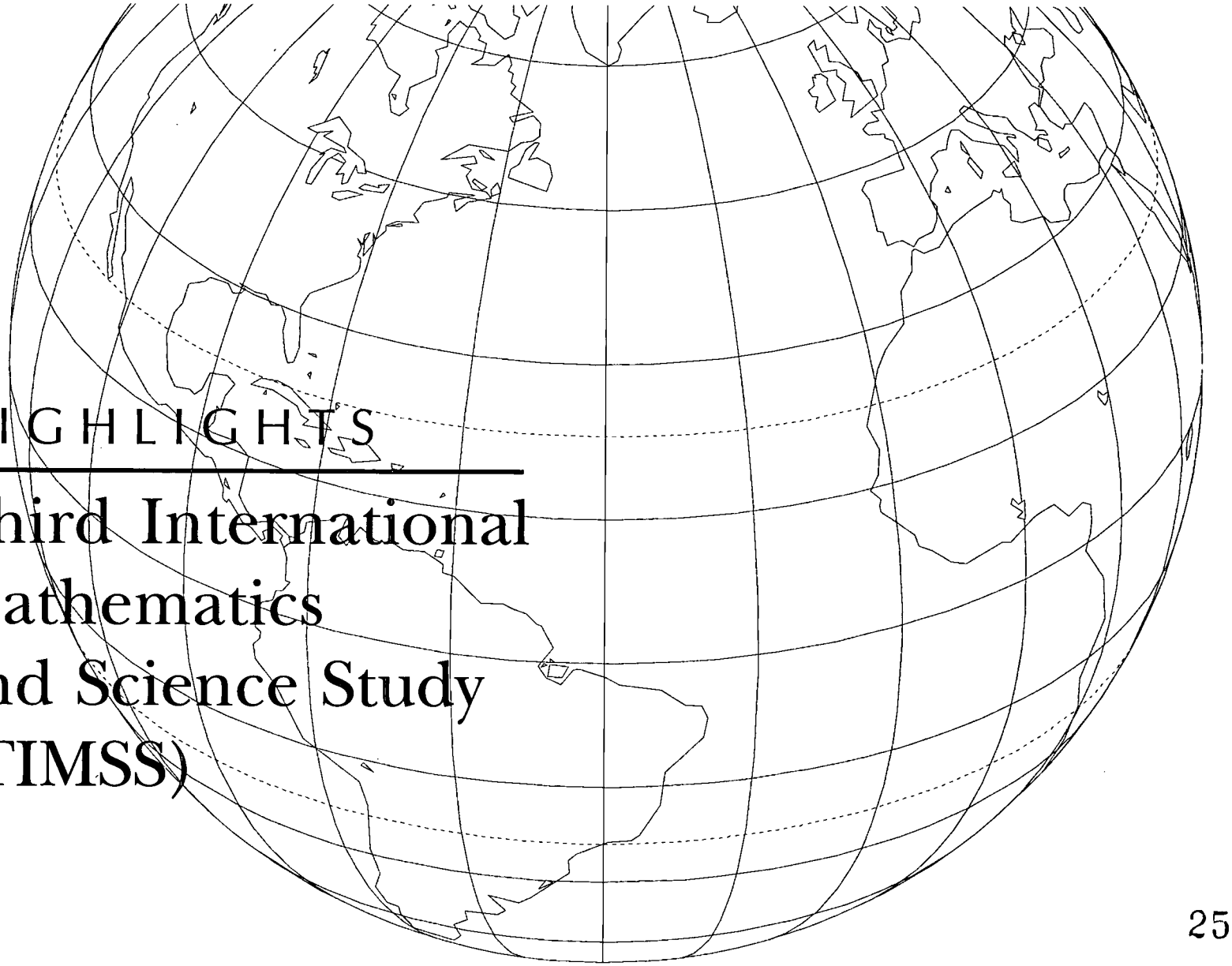
Improving local schools is the responsibility of every citizen. *Attaining Excellence: A TIMSS Resource Kit* is a tool that can help communities to reflect on their own schools and determine the best ways to improve them.

TIMSS is not an answer book. It is a mirror with which we can see ourselves in comparison to other countries. The purpose of this Resource Kit is to help U.S. citizens view with new eyes everyday practices in our schools and classrooms. It helps those concerned about education in their communities to compare their achievement, teaching, and curricula to what TIMSS has learned about the world. This can help us to reexamine assumptions we have taken for granted and to suggest new alternatives. The following pages present additional materials to improve access to, and use of, TIMSS data and resources in this kit.

Overheads for TIMSS Presentations

The following black-line masters were designed to assist you in introducing TIMSS to various audiences and in speaking at community meetings, faculty seminars, and assemblies.

They contain the key findings and implications of TIMSS in an easy-to-digest format and sequence and can be adapted or augmented as necessary for your particular audience. Talking points are contained in the section that follows. There are no copyright restrictions on these overheads or on any of the materials in this Resource Kit. If desired, these black-line masters may be reproduced onto transparencies for use with an overhead projector.



HIGHLIGHTS

Third International Mathematics and Science Study (TIMSS)

- TIMSS is the world's largest, most comprehensive, and most rigorous international comparison.
- TIMSS tested more than a half-million students in three age groups in 41 countries.
- TIMSS focuses on mathematics and science in the fourth, eighth, and twelfth grades.
- TIMSS compares achievement, teaching, curricula, and the lives of students and teachers.
- TIMSS includes a videotape study of mathematics teaching in the United States, Japan, and Germany.

FIVE RESEARCH STRATEGIES OF TIMSS

- Assessments
- Questionnaires
- Curriculum analyses
- Videotapes of eighth-grade mathematics teaching
- Case studies of policy topics

These provide an unprecedented opportunity to understand U.S. mathematics and science education from a new and richer perspective.

TIMSS: A Treasure Trove of Data

- Provides a variety of data to create an accurate, complete picture of the United States in comparison to other countries.
- Helps define world-class performance.
- Supplies useful findings to help teachers and schools become more successful.

TIMSS Answers These Questions:

- Are U.S. curricula and expectations as demanding as those of other nations?
- How does U.S. classroom instruction compare with that of other countries?
- Do U.S. teachers receive as much support in their efforts to teach students as their colleagues in other nations?
- Are U.S. students as focused on their studies as their international counterparts?

EIGHTH-GRADE STUDENT ACHIEVEMENT

- U.S. eighth graders score above the international average in science.
- U.S. eighth graders score below the international average in mathematics.
- U.S. eighth graders are outperformed in ***both*** subjects by Austria, Bulgaria, Czech Republic, Hungary, Japan, Korea, Netherlands, Singapore, and Slovenia.

U.S. Eighth Graders Compared to Other G-7 Nations' Students

- In mathematics, U.S. eighth graders are behind Japan, France, and Canada. They are on par with England and Germany.

- In science, U.S. eighth graders are behind Japan; on par with England, Canada, and Germany; and above France.

FOURTH-GRADE STUDENT ACHIEVEMENT

- U.S. fourth graders score above the international average in science and are outperformed only by students in Korea.

- U.S. fourth graders score above the international average in mathematics.

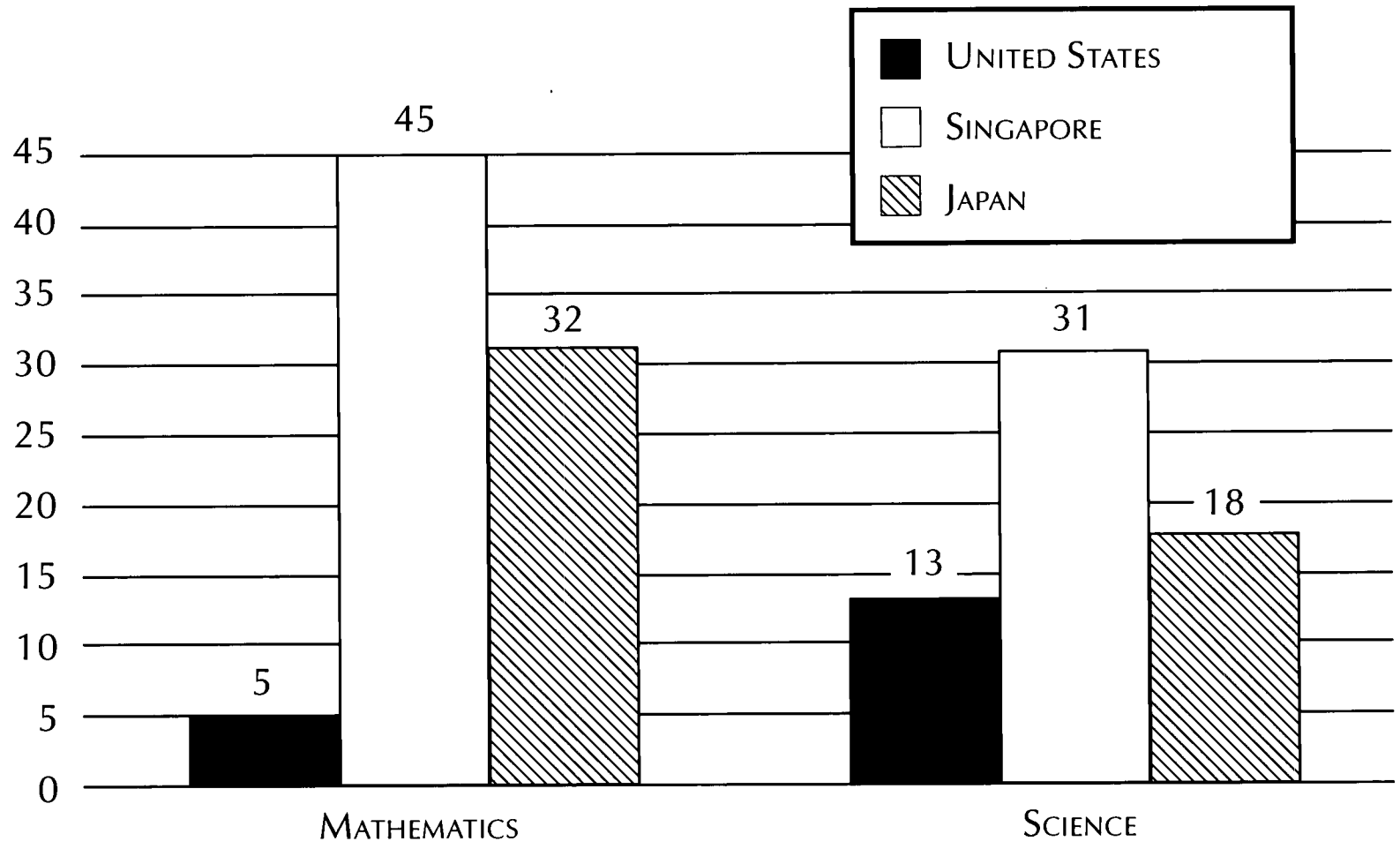
U.S. Fourth Graders Compared to Other G-7 Nations' Students

- In mathematics, U.S. fourth graders are behind Japan, on par with Canada, and ahead of England.

- In science, U.S. fourth graders are on par with Japan and ahead of Canada and England.

How Do Our *Best* Eighth Graders Stack Up?

Percentage of eighth graders in the world's top 10%



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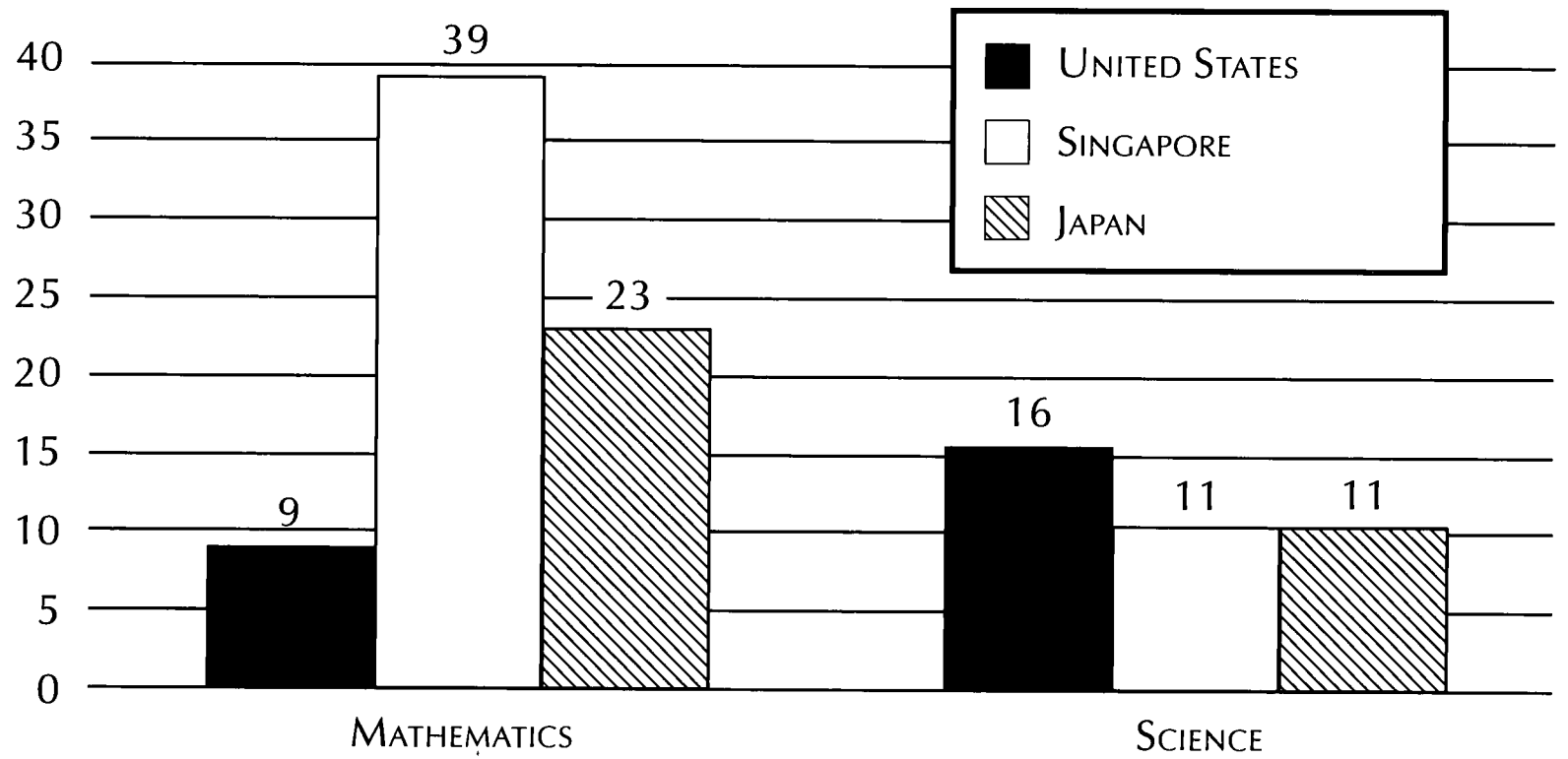


U.S. Strengths and Weaknesses (Eighth Grade)

Strengths:

- Earth Science
- Life Science
- Environmental Issues & the Nature of Science
- Algebra
- Fractions & Number Sense
- Data Representation, Analysis, & Probability

Weaknesses:

- Chemistry
- Physics
- Geometry
- Measurement
- Proportionality

U.S. Strengths and Weaknesses (Fourth Grade)

Strengths:

- Earth Science
- Life Science
- Physical Science
- Environmental Issues & the Nature of Science
- Whole Numbers
- Fractions & Proportionality
- Data Representation, Analysis, & Probability
- Geometry
- Patterns, Relations, & Functions

Weaknesses:

- Measurement, Estimation, & Number Sense

EIGHTH-GRADE MATHEMATICS TEACHING

- What we teach in eighth-grade mathematics, most other countries teach in the seventh.
- The content of U.S. eighth-grade mathematics lessons requires less high-level thought than classes in Germany and Japan.
- The typical goal of a U.S. eighth-grade mathematics teacher is to teach students how to do something. The typical goal of a Japanese teacher is to help students understand mathematical concepts.

EIGHTH-GRADE CURRICULA

- The eighth-grade mathematics curricula in Japan and Germany focus on algebra and geometry, while U.S. curricula still include considerable arithmetic.
- Topic coverage in U.S. eighth-grade mathematics classes is not as focused as in Germany and Japan (although in science, topic coverage may be similar to other countries in degree of focus).
- U.S. curricula are defined locally, whereas the curricula of most other nations are established nationally.

TEACHERS' LIVES

- Unlike U.S. teachers, new Japanese and German teachers receive long-term structured apprenticeships in their profession.
- Japanese teachers have more opportunities to discuss teaching-related issues than do U.S. teachers.
- U.S. teachers have more college education than those in all but a few TIMSS countries.
- Student diversity and poor discipline are challenges not only for U.S. teachers, but for their German colleagues as well.

STUDENTS' LIVES

- Eighth-grade students of different abilities are typically divided into different classrooms in the United States and different schools in Germany. In Japan, no ability grouping is practiced.
- In the United States, students in higher level mathematics classes study different material than do students in lower level classes. In Germany and Japan, all students study the same material, although in Germany, lower level classes study it with less depth and rigor.
- Japanese eighth graders are preparing for a high-stakes examination to enter high school.

Rethinking Common Beliefs—We Know the Problem Is NOT:

- **TIME**—U.S. eighth graders have ***more*** hours of instruction in mathematics and science than students in Japan or Germany.
- **HOMEWORK**—U.S. students ***do as much or more.***
- **TV**—Japanese students watch ***as much TV, yet do better*** in school.

INVESTMENT IN TIMSS

- Provides objective assessment of where we stand in comparison to other countries.
- Shows aspects of U.S. education that deserve attention.
- Helps states and localities reflect on "world-class" education.

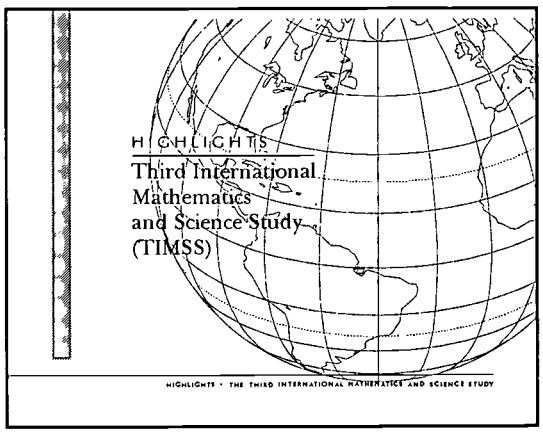
USING TIMSS TO IMPROVE ACHIEVEMENT

- TIMSS begins a national conversation about what we want our schools to accomplish.
- TIMSS provides a lens through which we can view ourselves in an international perspective.
- TIMSS can help expand discussions on what we expect from our students.
- TIMSS can help improve U.S. education.

Presentation Talking Points

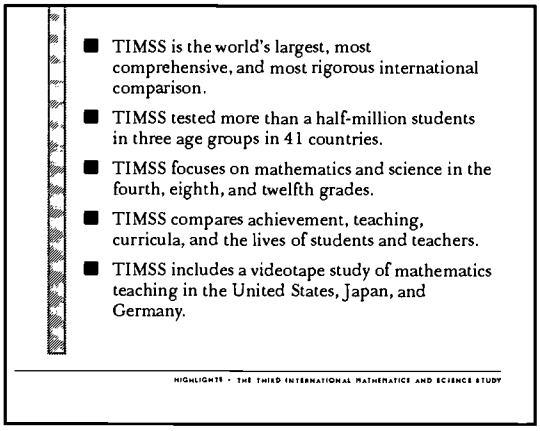
These speaker's notes are designed to accompany the overheads for TIMSS presentations contained in the previous section.

Further information and the findings from the study are contained in the reports in the *Pursuing Excellence* series, which are available in the section of this Resource Kit titled *Attaining Excellence: TIMSS as a Starting Point to Examine U.S. Education.* They can also be obtained directly from the Government Printing Office (see the publications section at the end of this document), or downloaded from the TIMSS Web site at the National Center for Education Statistics' site on the World Wide Web at http://www.ed.gov/NCES/timss.



OVERHEAD 1

TIMSS is an important study for those interested in U.S. education. Through it, we can examine our students' achievement, our schools, and our education practices in comparison to those of other countries.

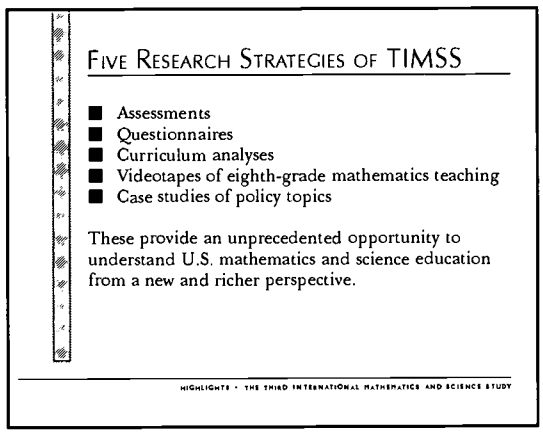


OVERHEAD 2

TIMSS' rich information not only allows us to compare achievement, but also provides insights into how life in U.S. schools differs from that in other nations.

This presentation is based on a series of reports, known as *Pursuing Excellence,* from the National Center for Education Statistics, that describe findings about our fourth- and eighth-grade student achievement and schooling.

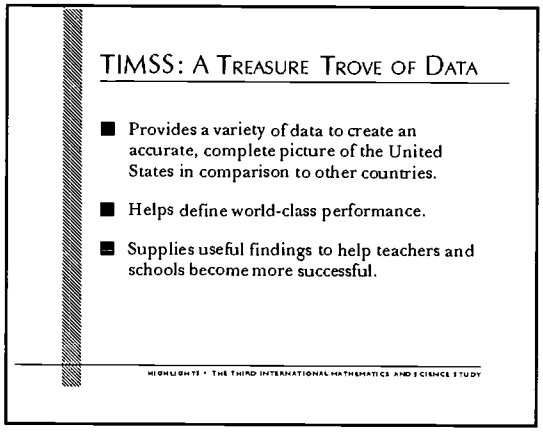
OVERHEAD 3



The study brought a variety of different and complementary research methods to bear on important policy questions. This makes the findings of the study more reliable and provides broader and deeper information.

- Mathematics and science assessments were 90 minutes long. The assessments included both multiple-choice and free-response items. A smaller number of students completed "hands-on" performance assessments in science.
- On questionnaires, students answered questions about their mathematics and science studies and beliefs; teachers answered questions on their beliefs about mathematics, science, and teaching practices; school administrators answered questions about school policies and practices.
- The exploratory curriculum analysis compared eighth-grade mathematics and science curriculum guides and textbooks, subject-matter content, and sequencing of topics.
- Videotapes of mathematics instruction were conducted in half of the U.S. and German participating eighth-grade classrooms. In Japan, eighth-grade classrooms in a random sample of 50 of the TIMSS schools were chosen to be videotaped. In all three countries, teachers were filmed teaching a typical lesson. These tapes were then analyzed to compare teaching techniques and quality of instruction.
- Ethnographic case studies of key policy topics were conducted by a team of 12 bilingual researchers who each spent three months in the United States, Japan, or Germany observing classrooms and interviewing education authorities, principals, teachers, students, and parents. Topics of study were education standards, methods of dealing with individual differences, the lives and working conditions of teachers, and the role of school in adolescents' lives.

Each of the five strategies represents an important advance in its field. Taken together, they provide an unprecedented opportunity to understand U.S. mathematics and science education from a new and richer perspective.



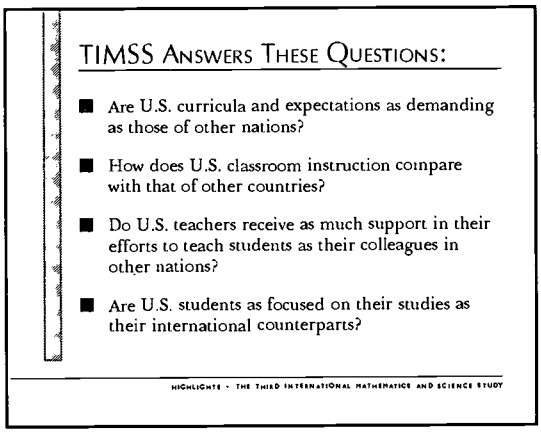
Overhead 4

In 1989, President Bush and the governors of all 50 states adopted the National Goals for Education, one of which was that "by the year 2000, the United States will be first in the world in mathematics and science achievement."

TIMSS helps us think about our own education in comparison to other countries.

TIMSS is a fair and accurate comparison of mathematics and science achievement. It is not a comparison of "all of our students with other nations' best."

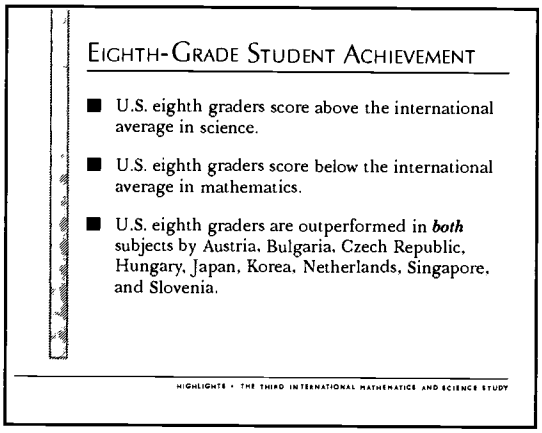
The students who participated in TIMSS were randomly selected to represent all students in each participating nation. Rigorous quality control was followed, and international monitoring was carried out at every step of the study.



OVERHEAD 5

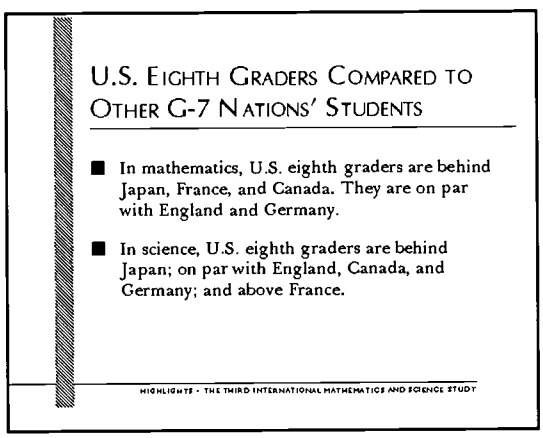
TIMSS helps us measure progress toward our national goal of improving our children's academic performance in mathematics and science.

But, TIMSS is much more than a scorecard for the mathematics and science events in the "education Olympics." It is a diagnostic tool to help us examine our nation's progress toward improvement of mathematics and science education. TIMSS was designed to look beyond the scorecard to illuminate how our education policies and practices compare with those of the world community.



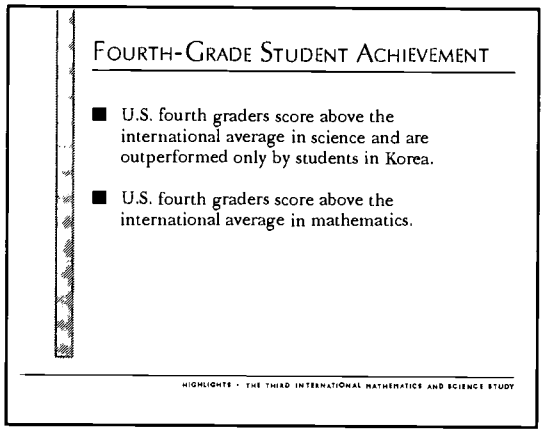
OVERHEAD 6

The United States outperforms seven countries in ***both*** mathematics and science: Colombia, Cyprus, Iran, Kuwait, Lithuania, Portugal, and South Africa.



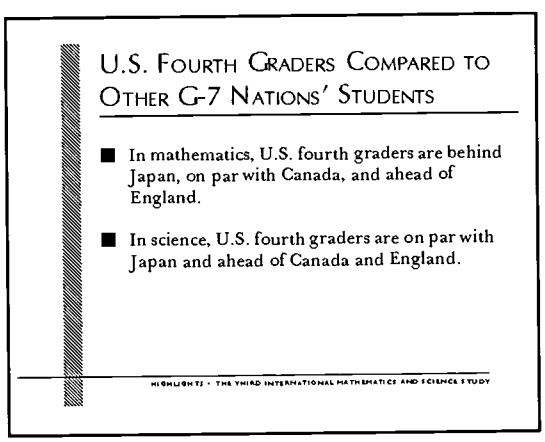
OVERHEAD 7

The Group of Seven includes the nations that are major trading partners with the United States: Canada, England, France, Germany, Italy, and Japan. Italy did not participate in eighth-grade TIMSS.



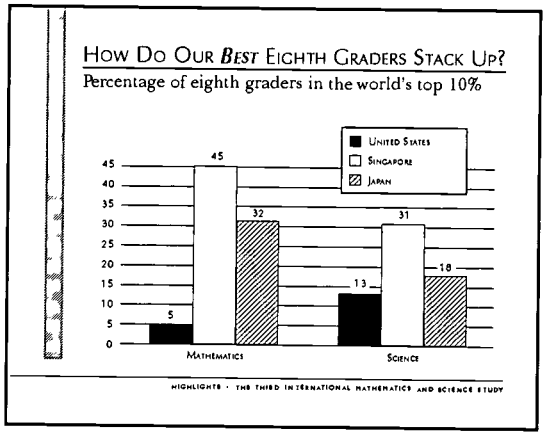
OVERHEAD 8

U.S. fourth-graders performed above the international average in both subjects, and their scores in science were particularly strong.



OVERHEAD 9

Italy, Germany, and France did not participate in fourth-grade TIMSS due to resource constraints in their own countries.



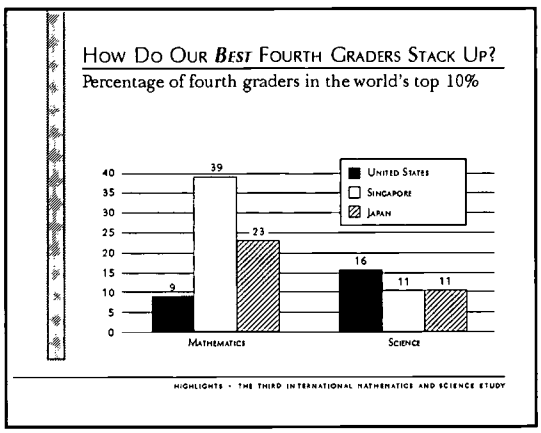
Overhead 10

If an international talent search were to select the top 10 percent of all eighth-grade students in the 41 TIMSS countries combined, then, for mathematics, 5 percent of U.S. eighth graders, 45 percent of Singaporean eighth graders, and 32 percent of Japanese eighth graders would be chosen.

In science, 13 percent of U.S. eighth-grade students would be selected compared to 31 percent of Singaporean eighth-grade students and 18 percent of Japanese eighth-grade students.

If the talent search were to lower its standards to the top half of all students, then, in mathematics, 94 percent of eighth graders in Singapore and 83 percent of eighth graders in Japan would be selected, but only 45 percent of U.S. eighth graders would be selected for the top half.

In science, 82 percent of the eighth-grade students in Singapore and 71 percent of the eighth-grade students in Japan would be selected for the top half, compared to 55 percent of the eighth-grade students in the United States.

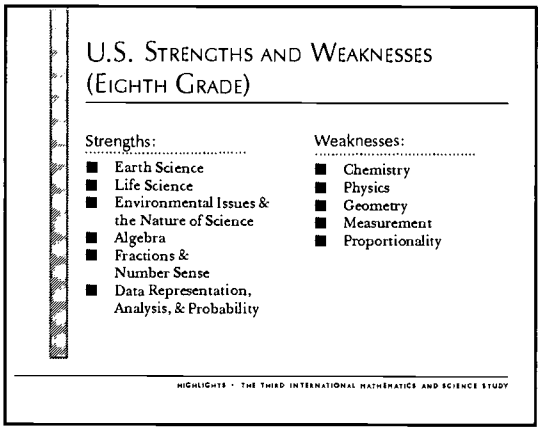


OVERHEAD 11

If an international talent search were to select the top 10 percent of all fourth-grade students in the 26 TIMSS countries combined, 9 percent of U.S. fourth graders would be in the world's top 10 percent. This is well below the 39 percent of Singaporean fourth graders, and 23 percent of Japanese fourth graders who would be chosen in the international mathematics talent search.

In science, 16 percent of U.S. fourth graders would rank among the world's top 10 percent. No country has significantly more of their fourth-grade students in the top 10 percent (Korea has one point more), and 21 nations have a smaller percentage. Only 11 percent of the fourth-grade students in Singapore and Japan would be selected.

If the international talent search were to lower its standards to the top half of all fourth-grade students in the 26 TIMSS countries, in mathematics 56 percent of U.S. fourth graders would be included. This compares with 82 percent of fourth graders in Singapore and 79 percent in Japan. In science, 63 percent of U.S. fourth graders would be in the top half of all fourth-grade students in the TIMSS countries, compared to 68 percent in Japan.

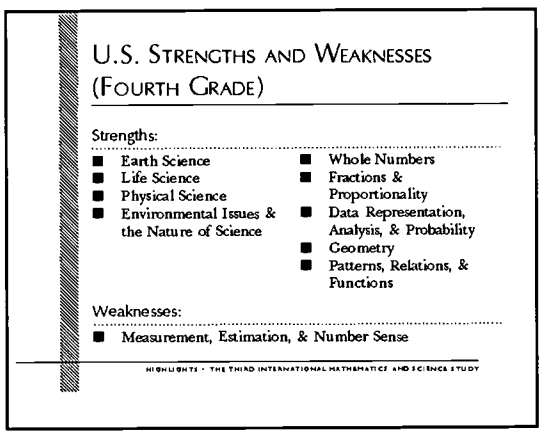


Overhead 12

Representing student achievement in mathematics and science as a total score is a useful way to summarize achievement. However, mathematics and science contain different content areas, which are emphasized and sequenced differently in curricula around the world. Based on these national priorities, in each country, some content areas have been studied more than others at a particular grade level.

The United States is among the top countries in the world in Environmental Issues and the Nature of Science, and we are also above the international average in Earth Science and Life Science. In Chemistry and Physics, our performance is not significantly different from the international average. Our better-than-average scores in Environmental Issues, Earth Science, and Life Science may pull our overall science score up to above average.

U.S. students' performance is at about the international average in Algebra; Data Representation, Analysis, and Probability; and Fractions and Number Sense. Compared to other countries, we do less well in Geometry, Measurement, and Proportionality. Our weaker performance in the latter topics may pull the overall U.S. score down to below average.

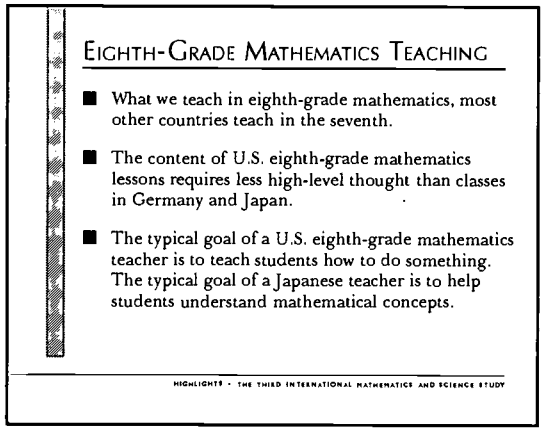


Overhead 13

Mathematics and science contain very different content areas, which are emphasized and sequenced differently in curricula around the world. Based on these national priorities, some content areas are emphasized more than others at a particular grade level.

U.S. fourth graders score above the international average in all four science content areas. In three of these content areas—Earth Science, Life Science, and Environmental Issues and the Nature of Science—U.S. fourth graders are outperformed by only one or two other nations. In Physical Science, U.S. students are outperformed by five other nations.

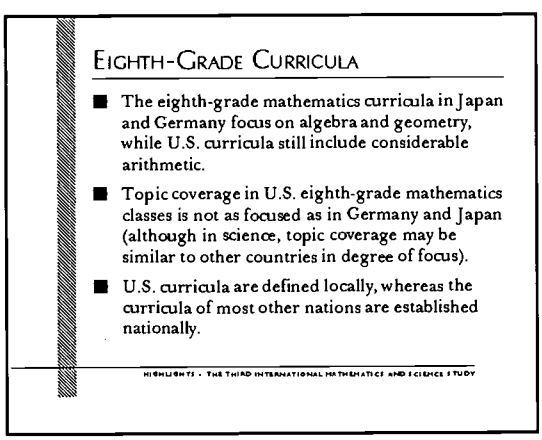
In five out of six TIMSS mathematics content areas, the scores of U.S. fourth graders are above the international averages for those content areas. U.S. fourth graders' performance is above the international average in Whole Numbers; Fractions and Proportionality; Data Representation, Analysis, and Probability; Geometry; and Patterns, Relations, and Functions. In only one content area is the U.S. average below the international average—Measurement, Estimation, and Number Sense.



OVERHEAD 14

The topics taught in U.S. mathematics classrooms were at a seventh-grade level in comparison to other countries, while the topics observed in the German and Japanese classrooms were at a high eighth-grade or even ninth-grade level.

In contrast to expert recommendations that well-taught lessons focus on having students think about and come to understand mathematical concepts, U.S. and German eighth-grade mathematics teachers usually explain that the goal of their lesson is to have students acquire particular skills.

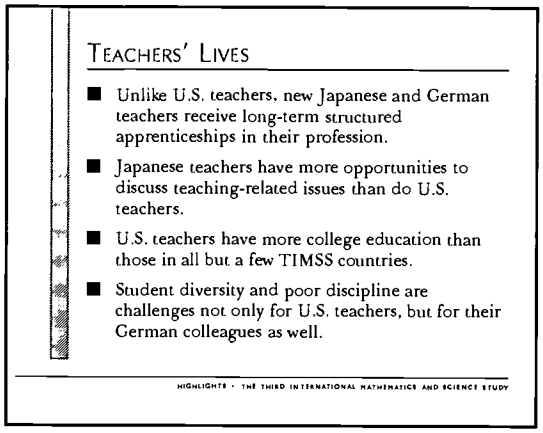


Overhead 15

The curricula in the United States are less advanced than those of Germany and Japan. In the videotapes studied, 40 percent of U.S. eighth-grade mathematics lessons included arithmetic topics such as whole number operations, fractions, and decimals, whereas these topics were much less common in Germany and Japan. In contrast, German and Japanese eighth-grade lessons were more likely to cover algebra and geometry.

Evidence from a variety of sources in TIMSS shows us that U.S. mathematics curricula are less focused than those of other countries. The U.S. science curricula more closely resemble international practices.

In 29 TIMSS countries, including Japan, the curricula are determined by national authorities. In three countries, including Germany, they are determined at the state level. In nine countries, including the United States, curricula are determined at the local level.



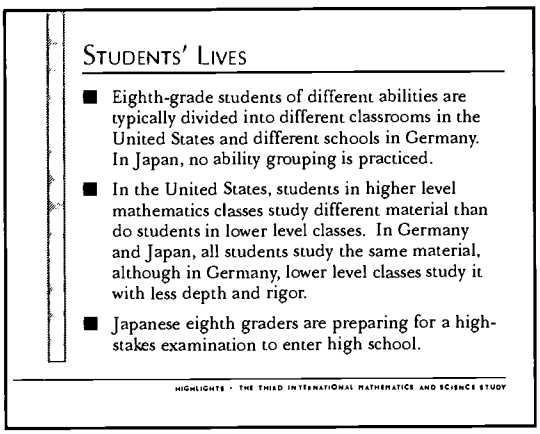
OVERHEAD 16

U.S. teachers lack the long and carefully mentored introduction to teaching that Japanese and German teachers receive. In Germany, after passing a state examination at the end of college, prospective teachers spend two weeks in a student teaching apprenticeship. During this time, they progress from classroom observation, to assisted teaching, to unassisted teaching under a mentor. At the end of the second year, candidates take another state examination and apply for jobs. In Japan, new teachers undergo intensive mentoring and training during their first year on the job, including at least 60 days of closely monitored teaching and 30 days of further training at resource centers.

Prospective U.S. teachers typically spend 12 weeks or less in student teaching near the end of their undergraduate training. After teachers meet the state licensing requirements, the nature of their induction program varies by district.

Nearly half of the U.S. teachers have a master's degree, a proportion exceeded by only four other TIMSS countries.

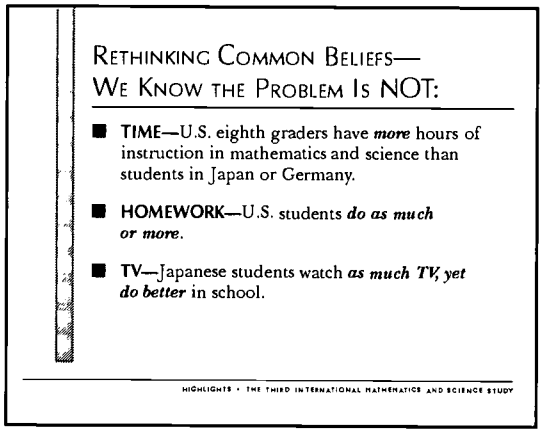
Teachers in all three countries frequently describe student diversity as a challenge. Uninterested students and a wide range of academic abilities challenge teachers in all three countries. Severe discipline problems and threats to student and teacher safety are neither widespread nor unique to the United States.



OVERHEAD 17

Japanese public schools offer a single curriculum for all students through the end of ninth grade, regardless of individual differences in motivation or ability. In mathematics, all eighth-grade Japanese students study a curriculum heavily focused on algebra and geometry. At the end of ninth grade, virtually all Japanese students continue on to high school. The high school entrance exam serves as a gateway, dividing students into high-, medium-, and low-level schools. The slowest students are accepted only by the lesser ranked commercial or vocational high schools. The German school system basically sorts students into one of three types of schools at the end of fourth grade. Within most schools, eighth graders all follow the same course of study in mathematics and science, regardless of their ability level.

In the United States, students are frequently grouped by ability into different mathematics classes. In the eighth grade, lower level classes typically focus on a review of arithmetic and other basic skills, with a small amount of algebra. Higher level classes focus more heavily on algebra, with a small amount of geometry. In contrast, Germany and Japan teach algebra and geometry to all of their eighth-grade students, although the rigor may differ by track.



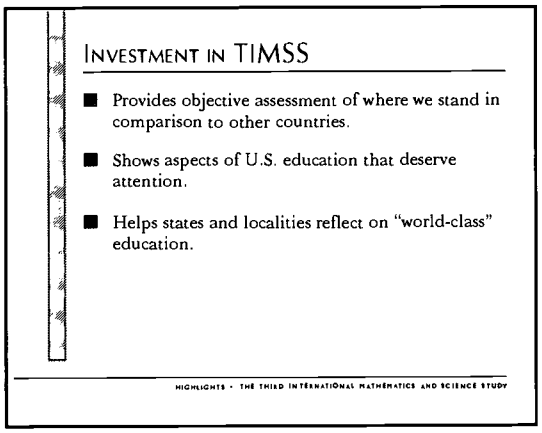
OVERHEAD 18

The report shows that there are no "magic solutions."

The data do not identify any single factor that we can say is present in all countries that succeed and absent in those with lower performance. But, we can say that TIMSS testifies against many simplistic proposals based on myths.

The facts show that:

- **U.S. eighth graders have more hours of instruction**—U.S. students in the eighth grade average 143 hours of mathematics instruction a year, compared to 114 hours in Germany and 117 hours in Japan. U.S. students average 140 hours of science instruction, compared with 136 hours in Germany and only 90 in Japan.
- **U.S. eighth graders do as much homework**—86 percent of U.S. mathematics teachers, 75 percent of German teachers, and only 21 percent of Japanese teachers assign homework 3 to 5 times a week. In science, 48 percent of U.S. teachers, 12 percent of German teachers, and only 4 percent of Japanese teachers assign homework 3 to 5 times per week. U.S. and German teachers also spend more class time working on homework. Only U.S. teachers let students start their homework in school. However, students in all three countries report spending the same amount of time each day studying outside of school.
- **Japanese students do as much TV watching**—Eighth-grade students in Germany, Japan, and the United States all do more TV watching, socializing, and playing sports than studying or reading.
- **Our performance is not due to how much time we spend, but rather how we spend it**—U.S. students spend as much time studying mathematics and science as other students who outperform them. We also cover more topics than most other countries.



OVERHEAD 19

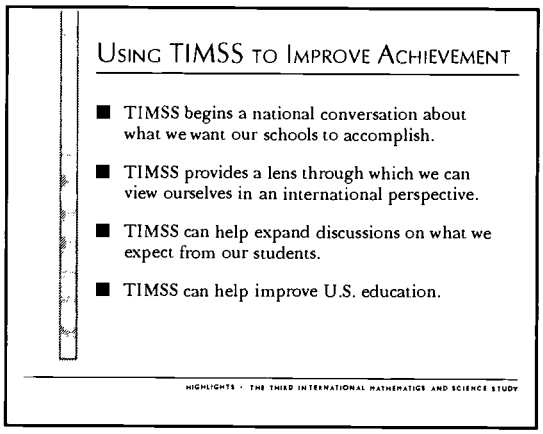
TIMSS is not a set of answers but a new way to see ourselves compared to other countries.

Through TIMSS we can see what students in other countries study, what materials they use, what their teachers do in the classrooms, and what students ultimately achieve.

If we want the United States to improve the mathematics and science education of its students, we must carefully examine not just how other countries rank, but also how their polices and practices help students achieve.

Not only does TIMSS show us where U.S. education stands in terms of test scores, but it also shows us what is included in textbooks, taught in schools, and learned by students.

Examining these data provides a unique opportunity to shed new light on education in the United States through the prism of other countries. At the same time, we should avoid the temptation to zero in on any one finding or leap to a conclusion without carefully considering the data.



OVERHEAD 20

TIMSS is not an answer book, but a mirror in which we can see our own education system at all stages of renewal and with an international perspective.

We can view with new eyes aspects of our education system and progress toward excellence that we may have taken for granted.

We can think more deeply about the assumptions that form the basis for our approaches to schooling and about the reform directions we are taking.

Through TIMSS, we can come to understand our own system better at all stages of education.

Sample Meeting Announcement

The prototype announcement for a meeting about TIMSS provided on the next page can be used as is or adapted as you see fit.

Flyers need to attract the reader's attention immediately and get the point across simply. Here are a few tips:

- Be brief.
- Select an eye-catching headline and drop in a graphic illustration from "clip art" books or software packages.
- Use big, bold print and standard-sized paper for easy reproduction.

URGENT COMMUNITY MEETING!

DO YOU KNOW...

- How Our Students Rate Internationally?
- How We Can Improve Students' Mathematics and Science Achievement?

FINDINGS FROM THE THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY

FOR TEACHERS, ADMINISTRATORS, PARENTS, AND EVERYONE CONCERNED WITH OUR CHILDREN'S EDUCATION

WHERE:

WHEN:

ORDER FORM FOR CD-ROM VERSION OF *ATTAINING EXCELLENCE: A TIMSS RESOURCE KIT*

The Eisenhower National Clearinghouse for Mathematics and Science Education (ENC), located at Ohio State University, is producing a CD-ROM that will contain most of the resources in this kit, previously published TIMSS reports, related papers, and other auxiliary materials. In addition to the TIMSS materials, the disc will include ENC's Resource Finder, an electronic catalog of K-12 mathematics and science curriculum resources.

Schools can receive the ENC CD-ROM free of charge by filling out this form, accompanied by a letter on school letterhead signed by the principal. Call toll free, (800) 621-5785, or send E-mail to cd_request@enc.org

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School _____

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❑ I work at a school and would like to request a free CD-ROM. I am sending a letter on school letterhead signed by the principal.

Send to:
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The Ohio State University
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Telephone: (800) 621-5785
Fax: (614) 292-2066

If you do not work at a school and are still interested in the CD-ROM, contact the Eisenhower National Clearinghouse.

Third International Mathematics and Science Study Publications

WHERE CAN I FIND A GOOD SUMMARY OF TIMSS FINDINGS THAT PUTS U.S. EDUCATION IN COMPARATIVE PERSPECTIVE?

***Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context*, November 1996—This report draws from the assessments, surveys, video, and case studies of TIMSS to summarize the most important findings concerning U.S. achievement and schooling in the eighth grade. Paperback, 80 pp. $9.50.**

To order, contact: U.S. Government Bookstore Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; Telephone: (202) 512-1800; Fax: (202) 512-2250; World Wide Web: http://www.access.gpo.gov/su_docs; GPO #065-000-00959-5. It may also be downloaded from: http://www.ed.gov/NCES/timss

***Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*, June 1997—This report summarizes the most important findings concerning U.S. achievement and schooling in the fourth grade. Paperback, 68 pp. $4.75**

To order, contact: U.S. Government Bookstore Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; Telephone: (202) 512-1800; Fax: (202) 512-2250; World Wide Web: http://www.access.gpo.gov/su_docs; NCES 97-255; GPO #065-000-01018-6. It also may be downloaded from: http://www.ed.gov/NCES/timss

A Video Presentation of Pursuing Excellence: U.S. Eighth-Grade Findings from TIMSS, **July 1997—This video summarizes the TIMSS' key findings concerning U.S. eighth-grade education and includes the views of business leaders, policymakers, educators, and researchers on the study's implications for schools in the United States. 13° minutes. $20.**

To order, contact: U.S. Government Bookstore Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; Telephone: (202) 512-1800; Fax: (202) 512-2250; World Wide Web: http://www.access.gpo.gov/su_docs; GPO #065-000-01003-8.

Web Sites—There are several Web sites devoted to TIMSS. For general information about the study as well as direct access to many TIMSS publications, please see:

http://www.ed.gov/NCES/timss
http://wwwcsteep.bc.edu/timss
http://uttou2.to.utwente.nl/
http://ustimss.msu.edu/

Highlights of Results from TIMSS, **November 1996—Glossy brochure, 8 pp.**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu

WHERE CAN I FIND A DETAILED INTERNATIONAL COMPARISON OF EIGHTH-GRADE STUDENTS?

Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS), **November 1996—This report focuses on mathematics achievement in 41 countries at the two grades with the largest proportion of 13-year-olds, the seventh and eighth grades in most countries. The report includes selected background information about students and teachers. Paperback, 176 pp. + 60 pp. Appendix, $30.**

To order, contact: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy (CSTEEP), Campion Hall Room 323, School of Education, Boston College, Chestnut Hill, MA 02167; Telephone: (617) 552-4521; Fax: (617) 552-8419; E-mail: timss@bc.edu. The report may also be downloaded from: http://wwwcsteep.bc.edu/TIMSS1/TIMSSPublications.html#International

Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS), **November 1996—This report focuses on science achievement in 41 countries at the two grades with the largest proportion of 13-year-olds, the seventh and eighth grades in most countries. The report includes selected background information about students and teachers. Paperback, 168 pp. + 62 pp. Appendix, $30.**

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***TIMSS Monograph Series No. 3 Mathematics Textbooks: A Comparative Study of Grade 8 Texts*, 1995—Geoffrey Howson, Emeritus Professor of Mathematical Curriculum Studies at the University of Southhampton, England, examines eight mathematics textbooks for 13-year-olds for their pedagogical and philosophical similarities and differences. Texts are from England, France, Japan, the Netherlands, Norway, Spain, Switzerland, and the United States. Paperback, 96 pp. ISBN: 1-895766-03-6. $16.95.**

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***Third International Mathematics and Science Study: Quality Assurance in Data Collection*, 1996—A report on the quality assurance program that ensured the comparability of results across participating countries. The program emphasized instrument translation and adaptation, sampling response rates, test administration and data collection, the reliability of the coding process, and the integrity of the database. 93 pp. + 91 pp. Appendix.**

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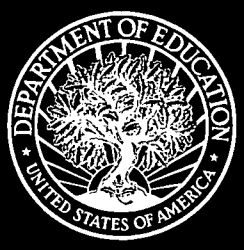

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