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Pursuing Excellence:

Comparisons of International Eighth-Grade Mathematics and Science Achievement from a U.S. Perspective, 1995 and 1999

INITIAL FINDINGS FROM THE
THIRD INTERNATIONAL MATHEMATICS AND SCIENCE STUDY – REPEAT

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

NCES 2001–028

Pursuing Excellence: Comparisons of International Eighth-Grade Mathematics and Science Achievement from a U.S. Perspective, 1995 and 1999

Initial Findings from the Third International Mathematics and Science Study–Repeat

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Commissioner's Statement

The Third International Mathematics and Science Study–Repeat (TIMSS–R) is the latest chapter in one of the most comprehensive and rigorous international studies of schooling and student achievement ever conducted. TIMSS–R, conducted in 1999, comes four years after TIMSS, and was designed to focus on the mathematics and science achievement of eighth-grade students. NCES and the National Science Foundation (NSF) supported the United States' participation in TIMSS–R to provide an update on the mathematics and science performance of U.S. eighth-grade students originally detailed in the 1995 TIMSS study. This report, *Pursuing Excellence: Comparisons of International Mathematics and Science Achievement from a U.S. Perspective, 1995 and 1999*, presents initial findings on how our eighth-grade students fared on TIMSS–R and whether there have been significant changes in achievement in the four years since TIMSS.

TIMSS–R addresses the mission of NCES to gather and publish information on the status and progress of education in the United States and other nations, and continues the tradition of U.S. participation in international comparative studies of mathematics and science education since the 1960s. TIMSS–R represents an advancement in traditional studies because it is the first international study specifically designed to track changes in achievement. The data on mathematics and science achievement collected in TIMSS–R can be compared to the 1995 TIMSS data to identify changes between the eighth-grade students of yesterday and today, and relative changes between fourth-grade students 4 years earlier and their classmates 4 years later. While the same students did not participate in both studies, a scientific sampling of the two groups of students provides the most accurate picture available of their mathematics and science performance from an international comparative perspective. Information from TIMSS–R, in combination with what we have learned from the National Assessment of Educational Progress (NAEP), provides an opportunity to take stock of mathematics and science performance of our students.

One of the most important steps in making good decisions is to have good data. TIMSS–R fills that need and is one of the many surveys and assessments conducted by NCES that can be used by U.S. educators, parents, policymakers, and business leaders to make important decisions that will improve student learning. In addition to data on student performance, TIMSS–R includes a wealth of information on the context within which student learning takes place, such as teaching practices, students' study habits, teacher training and professional development, and school policies. Taken into consideration with other knowledge about the education systems of participating nations, TIMSS and TIMSS–R provide a thoughtful and in-depth look into what our eighth-grade mathematics and science teachers teach and what our eighth-grade students learn in comparison to their counterparts in other nations of the world.

In conclusion, TIMSS–R is a learning experience. The information presented in this report is presented in a straightforward way, and is not intended to determine whether U.S. performance is good or bad. Rather, it is intended to provide you, the reader, with the most accurate and up-to-date information available. The importance of this information, and its impact on American education, will depend on how it is used to improve our mathematics and science education. My colleagues and I invite everyone dedicated to enhancing the quality of our nation's mathematics and science education to make the fullest possible use of this rich resource.

Gary W. Phillips
Acting Commissioner of Education Statistics

December 2000

NSF Director's Statement

It is critical that students in the United States achieve at high levels in mathematics and science. The position of the U.S. in the world economy, the continuing demand for well-trained mathematicians and scientists, and the need for an informed citizenry able to make intelligent public-policy decisions about important economic, medical, and environmental issues all depend upon it.

Studies such as TIMSS–R help us place the achievement of U.S. students into an international context and thus provide important additional sources of information for evaluation of student abilities. The National Science Foundation (NSF) has co-funded the TIMSS–R study and has actively participated in its management for this reason.

The careful design of the TIMSS–R study provides an opportunity to analyze trends in the achievement of eighth-grade students in the 23 countries that participated in both 1995 and 1999. The results show that U.S. eighth-grade students continue to perform at the international average in science and just below the international average in mathematics, with no statistically significant changes in their level of achievement from 1995 to 1999. Indeed, this is true for most of the countries participating in both years, although some countries (e.g., Canada) did make significant gains. A thorough analysis of the reasons for these exceptional gains may provide insight into possible strategies for improving education in the United States.

The timing of TIMSS–R allows us to compare results across grades in the 17 nations that participated in both the fourth-grade TIMSS in 1995 and the eighth-grade TIMSS–R in 1999. It is disturbing that the international ranking across these 17 nations of the U.S. eighth-grade students is relatively poor in both mathematics and science when compared with that of U.S. fourth-graders in 1995. This confirms the disappointing showing of our eighth-grade students in international comparisons, and demonstrates that the decline in relative performance during the middle school years is a continuing and serious problem.

The initial TIMSS study indicated that student achievement is the result of multiple factors. In schools, curriculum, teacher qualifications, and high expectations for all students are critical. Other factors, such as the educational resources available to the family, also may be key to student success. For example, achievement differences found between student groups or by type of school may be narrowed or eliminated when parent education and home resources are used in the analyses.

This first TIMSS–R report does not analyze the relationships between contextual variables and student achievement. However, it contains a preliminary comparison of the U.S. with other nations on a number of factors. For example, U.S. eighth-grade teachers are less likely to have majors and minors in mathematics and science than their counterparts in most other countries. This finding is consistent with other reports such as *Before It's Too Late: A Report to the Nation from the National Commission of Mathematics and Science Teaching for the 21st Century*.

We look forward to further analysis of the data in this report, the release of data from 27 U.S. benchmarking jurisdictions that engaged in TIMSS–R as if they were separate nations, and the companion classroom video studies. These will enrich our understanding of the factors that contribute to the disappointing achievement levels of U.S. eighth-grade students. Similar detail from the 1995 TIMSS study revealed the importance of rigorous mathematics and science curricula and alerted researchers to the need for teachers to have deep content knowledge in order to use those curricula successfully and achieve high standards for all students.

NSF is pleased to have supported this important study and report. The data contained within the TIMSS–R study will be used for years to understand issues and trends in the teaching of mathematics and science. Simply said, it is an invaluable resource.

Rita R. Colwell
Director
National Science Foundation

December 2000

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CHAPTER 1

INTRODUCTION

The National Science Foundation (NSF), the U.S. Department of Education's Office of Educational Research and Improvement (OERI), and the National Center for Education Statistics (NCES) joined together to support the participation of the United States in the Third International Mathematics and Science Study–Repeat (TIMSS–R), a successor to the 1995 Third International Mathematics and Science Study (TIMSS).[1] The joint research effort has produced rich information on the mathematics and science performance of U.S. eighth-grade students. This report, *Pursuing Excellence: Comparisons of International Eighth-Grade Mathematics and Science Achievement from a U.S. Perspective, 1995 and 1999* presents initial findings from the TIMSS–R study.

Why are international comparisons of education important?

International comparisons of student achievement and various background factors related to teaching and learning have been conducted for over 30 years. Many observers believe that such comparisons can help policymakers, researchers, teachers, and parents understand what other nations do to further the educational achievement of their populations. Some also believe that if the United States wants to remain internationally competitive, we need to better understand how our students perform in critical areas such as mathematics and science. Moreover, some are of the opinion that international assessments are one way of seeing what our national, state, and local standards mean in a world context. In short, international assessments can expand comparisons of educational achievement to other systems outside the United States; aid in our understanding of the possible reasons for observed differences in achievement; document the many varied education and learning practices around the world; get a sense of resources available to students in different nations; and improve the study of education itself (Board on International Comparative Studies in Education, 1990; Medrich and Griffith 1992).

Why a repeat of TIMSS?

The series of NCES reports on the 1995 TIMSS study described the mathematics and science performance of U.S. students in comparison to their peers at three different grade levels (NCES 1996, 1997c, 1998, 2000a).[2] The 1995 TIMSS assessments revealed that U.S. fourth-graders performed well in both mathematics and science in comparison to students in other nations, U.S. eighth-grade students performed near the international average in both mathematics and science, and U.S. twelfth-graders scored below the international average and among the lowest of the TIMSS nations in mathematics and science general knowledge, as well as in physics and advanced mathematics.

The participation of the United States in TIMSS heightened the nation's interest in improving mathematics and science education. Although work on improving mathematics and science education began years before TIMSS, results from TIMSS have had an impact on the way the United States thinks about mathematics and science education (Welch 2000).

TIMSS–R continues the tradition of international comparative study of mathematics and science education begun in the 1960s. The contribution of TIMSS–R is unique, however, because its design makes it possible to track changes in achievement and certain background factors from the earlier TIMSS study—a first for any international study. Moreover, TIMSS–R is the first international assessment that provides some indication of the pace of educational change across nations, informing expectations as to what can be achieved. TIMSS–R provides valuable information on the state of education in the United States and other nations in 1999.

Thirty-eight nations chose to compare the mathematics and science performance of their students in 1999. However, unlike TIMSS, the 1999 TIMSS–R study focused on eighth-grade students only. TIMSS–R allows the United States to compare the achievement of its eighth-graders in

[1]TIMSS collected data during the 1994–95 school year. TIMSS–R collected data during the 1998–99 school year. For convenience, reference will be made to 1995 and 1999, respectively, throughout this report.

[2]See appendix 1 for a brief list of TIMSS-related publications.

the original TIMSS to the scores of its eighth-graders four years later in TIMSS–R. It also provides an opportunity for the United States to compare the relative performance of a cohort of fourth-graders in 1995 to the relative performance of a cohort of eighth-graders 4 years later in 1999.[3] In short, TIMSS–R should help us understand the overall progress that our schools, teachers, and students are making toward achieving excellence in mathematics and science.

What questions does this report address?

This report highlights initial findings on the performance of U.S. eighth-grade students relative to students in other nations on the TIMSS–R assessment. This report also describes the mathematics and science performance of students in participating nations at two points in time: 1995 and 1999.

In general, this report addresses the following questions:

- How does the mathematics and science knowledge of U.S. eighth-grade students compare to that of students in other nations?
- Has the level of mathematics and science knowledge of eighth-grade students changed since 1995, and has the relative international standing of U.S. eighth-grade students changed in the 4 years since the original TIMSS?
- How does the relative performance of U.S. eighth-grade students in 1999 compare to the relative performance of U.S. fourth-grade students 4 years earlier, in 1995?
- How do nations compare on education-related background factors studied in TIMSS–R?

Performance in the United States is presented relative to that of other nations that participated in each assessment.[4] Comparisons in this report are made among the 38 nations that participated in TIMSS–R in 1999; among 23 nations that participated in both TIMSS and TIMSS–R at the eighth-grade level; and among the 17 nations that participated at the fourth-grade level in TIMSS and at the eighth-grade level in TIMSS–R.[5] This report is based on the comparative data published in the reports *TIMSS 1999 International Mathematics Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade* (Mullis et al. 2000) and *TIMSS 1999 International Science Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade* (Martin et al. 2000).

What issues does this report not address?

Findings from comparisons between the results of TIMSS and TIMSS–R cannot be interpreted to indicate the success or failure of mathematics and science reform efforts in the United States. TIMSS–R was designed to specifications detailed in the TIMSS curriculum frameworks (Robitaille et al. 1993). International experts developed the TIMSS curriculum frameworks to portray the structure of the intended school mathematics and science curricula from many different nations, not specifically the United States. Thus, when interpreting the findings, it is important to take into account the mathematics and science curricula likely encountered by U.S. students in school. TIMSS and TIMSS–R results are most useful when they are considered in light of other knowledge about education systems, including not only curricula, but also factors such as trends in education reform, changes in the school-age populations, and societal demands and expectations.

[3]Comparisons of fourth- and eighth-graders between TIMSS and TIMSS–R are made on the basis of two sets of cross-sectional, nationally representative samples.

[4]Participants in TIMSS and TIMSS–R are referred to as nations throughout the text. However, several of the participants are not independent jurisdictions, as is the case for Hong Kong, Special Administrative Region (SAR), Belgium-Flemish, and Chinese Taipei.

[5]Throughout the text "grade 8" refers to the middle-school grade sampled for TIMSS-R as well as the higher of the two middle-school grades sampled for TIMSS; "grade 4" refers to the higher of the two elementary school grades sampled for TIMSS. This is an accurate characterization of the samples for the United States and many of the other nations. Detailed information on the grades sampled can be found in appendix 2 of this report for TIMSS–R and in Beaton et al. (1996a and 1996b) for TIMSS.

Change efforts in the United States began years before TIMSS and TIMSS–R. These efforts to create change in U.S. schools have been undertaken at the state and local levels, making it difficult to determine by solely examining national-level statistics the extent to which these efforts have been implemented and the degree and depth of the changes made. The 4 years between TIMSS and TIMSS–R is a relatively short amount of time to expect to see significant change. Finally, this report focuses on variability in achievement among nations. It is important to keep in mind that the range of achievement observed among nations could also be expected to be observed within the United States (NCES 1997a and 1997b; Johnson and Siegendorf 1998). Thus, as will be shown later in the report, there are U.S. eighth-grade students who perform among the top-performing students in the world, and there are U.S. eighth-grade students who perform among the lowest performing students in the world.

This report should also not be construed to suggest that specific school policies, professional development techniques, instructional practices, curricula or change strategies, or combinations of these will lead to higher levels of achievement. The factors that may contribute to high achievement can vary from nation to nation. Nonetheless, TIMSS–R provides valuable information that can help the United States reflect on its own performance relative to other nations as we strive to improve educational opportunities for all students.

What is TIMSS–R?

TIMSS–R is the fourth comparison of mathematics and science achievement carried out by the International Association for the Evaluation of Educational Achievement (IEA). IEA conducted studies of mathematics and science as separate subjects at various times during the 1960s, 1970s, and 1980s. The United States participated in each of these studies. The Third International Mathematics and Science Study (TIMSS) collected data during the 1994–95 school year. TIMSS provided an update on the performance of U.S. students in mathematics and science during the mid-1990s and a starting point for a regular cycle of international assessments in mathematics and science. Funded by the U.S. Department of Education, NSF, the Government of Canada, the World Bank, and participating nations, TIMSS was the first IEA study to combine both mathematics and science in the same assessment. TIMSS was also the largest and most comprehensive international study of educational achievement ever undertaken.

TIMSS–R follows the earlier TIMSS study by 4 years and focused on the mathematics and science achievement of eighth-grade students. Most importantly perhaps, TIMSS–R provides a second data point in a regular cycle of international assessments of mathematics and science that are planned to chart trends in achievement over time, much like the regular cycle of national assessments in this nation, such as the National Assessment of Educational Progress (NAEP), or longitudinal studies such as the National Educational Longitudinal Study (NELS:88).

The United States sponsored three additional components of TIMSS–R that will enrich our knowledge of education in an international context:

- TIMSS–R Benchmarking Project—Twenty-seven states, districts, and consortia of districts throughout the United States participated as their own "nations" in this project, following the same guidelines as the participating nations. When the findings from the Benchmarking Project are released in April 2001, these 27 participating jurisdictions will be able to assess their comparative international standing and judge their mathematics and science programs in an international context.
- Videotape Classroom Study—the first TIMSS Videotape Classroom Study examined eighth-grade mathematics teaching in three nations. Building on the work of the first TIMSS videotape study (Stigler et al. 1999), the TIMSS–R Videotape Classroom Study has been expanded in scope to examine national samples of eighth-grade mathematics and science instructional practices in seven nations. The study is designed to present national-level portraits of mathematics and science teaching practices that can provide a more detailed context for understanding

mathematics and science teaching and learning in the classroom. The first set of results from the Videotape Classroom Study is anticipated in late 2001.

- NAEP/TIMSS–R Linking Study—A subsample of students taking the 2000 state NAEP mathematics and science assessment also took the TIMSS–R assessment. This provides an opportunity to compare students' performance on NAEP to their performance on TIMSS–R, and allows for estimates of how states participating in NAEP 2000 would have performed had they participated in TIMSS–R. Results from the TIMSS–R Benchmarking Project will be used to check the results of this linking study. Results will be released in late 2001.

With many states and districts creating content and performance standards targeted at boosting student achievement to "world class" levels in mathematics and science, the Benchmarking Project can provide reliable data on how state and district students compare internationally in these areas. Results from the TIMSS–R Videotape Classroom Study should also add to our understanding of mathematics and science instructional practices in nations with high student achievement levels on assessments such as TIMSS. Findings from the NAEP/TIMSS–R Linking Study will provide states the opportunity to compare their students to their peers in other nations.

Which nations participated in TIMSS–R?

The IEA invited all nations that participated in the 1995 TIMSS as well as other nations to participate in the 1999 TIMSS–R. Interested nations met at international meetings where study plans and guidelines were discussed. Thirty-eight nations collected data for TIMSS–R, including 26 that had participated in TIMSS and 12 that were participating for the first time. Therefore, depending on the analysis, the number of nations being compared between TIMSS and TIMSS–R will change. The 38 nations that participated in TIMSS–R are shown in figure 1. In addition, figure 1 lists the nations that participated in both TIMSS and TIMSS–R.

How was TIMSS–R conducted?

The IEA, a Netherlands-based organization of education and research institutions from its member nations, conducted TIMSS–R. The IEA delegated responsibility for the overall coordination and management of the project to the International Study Center at Boston College. The United States, the World Bank, and participating nations paid for and carried out data collection according to international guidelines.

NCES and NSF funded the collection of data in the United States and also contributed toward support of the international project. OERI has contributed additional funding towards the U.S. portion of the study. Westat, Inc., a private research firm, handled the data collection in the United States under contract to the Department of Education. To help guide the study, NCES and NSF established a TIMSS–R Technical Review Panel (TRP). The members of the TRP are experts in mathematics and science education, assessment, and international comparative studies.

TIMSS–R included two types of data collection instruments: mathematics and science assessment items in multiple-choice (77 percent) and free-response (23 percent) formats; and school, teacher, and student questionnaires that requested information to help provide a context for the performance scores. An international panel of assessment and content experts, following the same assessment framework established for TIMSS, developed the mathematics and science items in TIMSS–R. Like the TIMSS assessment items, the TIMSS–R items represent a range of mathematics and science topics that are included in the curricula of many different nations and, thus, not aligned to any particular curriculum. See appendix 2 for more details on the composition of the TIMSS and TIMSS–R assessments and how the achievement scores were derived.

Figure 1.—Participation in TIMSS and TIMSS–R: 1995 and 1999

	TIMSS-R nations (1999) 8th grade	TIMSS-R nations that participated at 8th grade in TIMSS (1995)	TIMSS-R nations that participated at 4th grade in TIMSS (1995)
	Australia	Australia	Australia
	Belgium-Flemish[1]	Belgium-Flemish[1]	
	Bulgaria	Bulgaria	
	Canada	Canada	Canada
	Chile		
	Chinese Taipei		
	Cyprus	Cyprus	Cyprus
	Czech Republic	Czech Republic	Czech Republic
	England	England	England
	Finland		
	Hong Kong SAR	Hong Kong SAR	Hong Kong SAR
	Hungary	Hungary	Hungary
	Indonesia		
	Iran, Islamic Republic of	Iran, Islamic Republic of	Iran, Islamic Republic of
	Israel	Israel	
	Italy	Italy[2]	Italy[2]
	Japan	Japan	Japan
	Jordan		
	Korea, Republic of	Korea, Republic of	Korea, Republic of
	Latvia-LSS[3]	Latvia-LSS[3]	Latvia-LSS[3]
	Lithuania	Lithuania	
	Macedonia, Republic of		
	Malaysia		
	Moldova		
	Morocco		
	Netherlands	Netherlands	Netherlands
	New Zealand	New Zealand	New Zealand
	Philippines		
	Romania	Romania	
	Russian Federation	Russian Federation	
	Singapore	Singapore	Singapore
	Slovak Republic	Slovak Republic	
	Slovenia	Slovenia	Slovenia
	South Africa	South Africa	
	Thailand	Thailand	
	Tunisia		
	Turkey		
	United States	United States	United States
Total Nations	38	26	17

[1]The Flemish and French educational systems in Belgium participated separately in TIMSS 1995. The Flemish educational system in Belgium participated in TIMSS-R 1999.

[2]Italy was unable to provide the International Study Center at Boston College with its data in time for these data to be included in the international reports for both the fourth and eighth grade in TIMSS 1995. However, its data for TIMSS 1995 are included in this report.

[3]Designated LSS because only Latvian-speaking schools were tested.

NOTE: Only nations that completed the necessary steps for their data to appear in the reports from the International Study Center at Boston College are listed.

SOURCE: Mullis et al. (2000). *TIMSS 1999 International Mathematics Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit A.1. Chestnut Hill, MA: Boston College.

The questionnaires asked for information on topics such as students' attitudes and beliefs about learning, study habits and homework, and their lives both in and outside of school; teachers' attitudes and beliefs about teaching and learning, teaching assignments, class size and organization, instructional practices, and participation in professional development activities; and principals' viewpoints on policy and budget responsibilities, curriculum and instruction issues, student behavior problems, as well as descriptions of the organization of schools and courses.

Both public and nonpublic school students in all participating nations received the TIMSS–R assessments and questionnaires. Most nations, including the United States, conducted the assessment 2 to 3 months before the end of the 1998–99 school year. Students with special needs and disabilities that would make it very difficult for them to take the test were excused from the assessment as accommodations were not offered in TIMSS–R in the United States. Each participating nation documented such exclusions, including the United States. Each nation translated the assessments and questionnaires into the primary language or languages of instruction. In the United States, all materials were in English. The student assessment portion required approximately one and a half hours to complete.

All participating nations drew nationally representative samples of students. In the United States, the sample consisted of 221 schools and 9,072 eighth-grade students, which ensured a representative sample of eighth-grade students in the United States as a whole. Detailed information on sampling is provided in appendix 2.

Are the results from TIMSS and TIMSS–R comparable?

The data collected for TIMSS in 1995 and the data collected for TIMSS–R in 1999 are comparable because comparability was built into the design and implementation. Through a careful process of review, analysis, and refinement, the assessment and questionnaire items were purposefully developed and field tested for similarity and for reliable comparisons between TIMSS and TIMSS–R. After careful review of all available data, including a test for item reliability between old and new items, the TIMSS and TIMSS–R assessments were found to be very similar in format, content, and difficulty level. Moreover, TIMSS and TIMSS–R data are on the same eighth-grade scale to allow for reliable comparisons between the two eighth-grade cohorts over time. Procedures for conducting the assessments were the same. Appendix 2 contains more detailed information on these and other technical aspects of TIMSS–R.

How can we be sure the data are comparable across nations?

TIMSS–R continues the tradition of fair and accurate international comparisons of student achievement and other educational factors. It is not a comparison of other nations' best students to our nation's average students. Moreover, through the refinement of the scaling process that allows comparisons within and across nations, the TIMSS and TIMSS–R achievement scores can be reliably compared. To ensure the comparability of data across nations, the International Study Center at Boston College instituted a series of strict quality-control procedures. National school and student samples were rigorously reviewed for bias and international comparability by the TIMSS–R Sampling Referee. A professional translation agency verified the accuracy of translated materials. Project coordinators in each nation received thorough training in data collection and scoring procedures and their work was monitored for scoring reliability. Quality control staff conducted site visits in each participating nation during the testing period to further ensure that international data collection procedures were followed. Data from each nation were extensively reviewed for internal and cross-country consistency.

Nations collected data from a representative national sample of students, but were permitted to supplement their student samples to allow for the analysis of data by variables of national interest. To obtain reliable comparisons among nations, the data were appropriately weighted to account for sampling designs. Sampling and participation rate irregularities arose in some nations. These irregularities are clearly noted in this and other TIMSS–R reports. The United States met all international sampling and participation guidelines. More detailed information on quality control can be found in appendix 2 and the *TIMSS 1999 Technical Report* from Boston College (Martin and Gregory 2000).

Finally, it should be noted that in addition to the 38 nations that participated in TIMSS–R in 1999, this report separately discusses the 23 that participated in TIMSS at the eighth-grade level,[6] and the 17 TIMSS-R nations that participated in TIMSS at the fourth-grade level (see figure 1).[7] In order to make a fair comparison of how U.S. eighth-grade students in 1999 compared to the eighth-graders of 1995 or the fourth-graders of 1995, analyses were conducted only among those nations that participated in both TIMSS and TIMSS–R.

How does TIMSS–R relate to other large-scale studies of mathematics and science achievement?

TIMSS–R is one of several large-scale studies designed to examine the mathematics and science performance of students. Two other large-scale studies of mathematics and science achievement are the National Assessment of Educational Progress (NAEP) and the Program for International Student Assessment (PISA). NAEP is an ongoing program that has reported on the mathematics and science achievement of U.S. students for some 30 years. PISA is a relatively new international project and will report results for the first time in late 2001. These three assessments were designed with different purposes in mind, and this is evident in the types of assessment items as well as the content areas and topics covered in each assessment.

TIMSS–R and NAEP assess students at the eighth grade. TIMSS–R is based on the curricula that students in participating nations are likely to have encountered by grade 8, while NAEP is based on an expert consensus of what students in the United States should know and be able to do in various academic subjects at that grade. PISA, on the other hand, focuses on 15-year-old students (most often tenth-graders in the United States) and is designed to measure students' mathematics and science literacy—that is, students' ability to respond to "real life" situations both in and outside of school. In contrast, TIMSS–R and NAEP tend to focus on mathematics and science as it is generally presented in classrooms and textbooks.

All three assessments cover a range of mathematics and science content areas and topics, but to different degrees. In mathematics, for example, TIMSS–R appears to place more emphasis on number sense, properties and operations than the other two studies; PISA tends to emphasize data analysis more than the other two studies; and NAEP appears to distribute its focus across the content areas included in its assessment framework more than the other two studies. In science, TIMSS–R appears to emphasize physical sciences more than the other two assessments; PISA seems to have a stronger emphasis on earth science than TIMSS–R and NAEP; and NAEP appears to distribute most science items among three content areas: physical science, earth science, and life science. As findings from these studies are released, it is important to understand the differences and similarities among them to be able to make sense of the findings in relation to each other.

[6]Twenty-six nations participated in the eighth-grade level in TIMSS 1995 and TIMSS–R 1999. Three of the 26 nations—Israel, South Africa, and Thailand—experienced significant difficulties with meeting international sampling or participation guidelines in 1995. Therefore, these 3 nations are not included in analyses comparing achievement at the eighth-grade level between 1995 and 1999, nor are they included in the international averages associated with these comparative analyses.

[7]Of the 42 nations that participated in TIMSS 1995 at the eighth-grade level, 26 also participated in TIMSS–R. Of the 26 nations that participated in TIMSS 1995 at the fourth-grade level, 17 also participated in TIMSS–R. See table A2.6 in appendix 2 for a complete list of nations.

How is the rest of the report organized?

The remainder of the report includes three additional chapters and several appendices:

Chapter 2 describes the relative performance of U.S. eighth-grade students in mathematics and science in comparison to their peers in participating nations. The chapter is divided into three sections. First, achievement results for TIMSS–R are described for the United States and the other 37 participating nations, including overall mathematics and science achievement, achievement in five mathematics content areas and six science content areas, and proportions of students in the top 10 percent and top 25 percent of all students. Sample mathematics and science items are included to acquaint the reader with the TIMSS–R assessment. The second section focuses on the 23 nations that participated in TIMSS and TIMSS–R at the eighth-grade level, describing changes in mathematics and science achievement over the 4 intervening years. The third section compares the 17 nations that participated in fourth-grade TIMSS and eighth-grade TIMSS–R, examining changes in the relative standing of the U.S. 1995 fourth-graders and 1999 eighth-graders.

Chapter 3 focuses on the education-related contextual factors related to teaching and curriculum that were examined in TIMSS–R. The chapter is divided into four sections. The first section describes mathematics and science teacher preparation, qualifications, and ongoing professional development activities. The next section examines the curriculum in the participating nations, including the topics covered and emphasized in mathematics and science lessons. The third section provides information on classroom practices as reported by teachers and students. The chapter ends with a brief discussion of how much time eighth-grade students spend studying mathematics and science outside of school.

Chapter 4 discusses future directions that the analyses of TIMSS and TIMSS–R data could take. Several appendices are included in this report to provide additional information on the technical aspects of the study as well as more detailed information on the analyses presented in the main chapters of the report.

In addition to the text of this report, supplemental information is provided in the five appendices. Appendix 1 contains a selection of publications that have been produced in relation to TIMSS 1995. Appendix 2 discusses several technical aspects of the TIMSS and TIMSS–R studies. The tables in Appendices 3 and 4 provide additional information on the figures in Chapters 2 and 3, respectively. Lastly, Appendix 5 provides a supplemental table containing comparisons of mathematics and science achievement of the 54 nations that participated at the eighth-grade level in either TIMSS, TIMSS–R, or both studies.

CHAPTER 2

MATHEMATICS AND SCIENCE ACHIEVEMENT

KEY POINTS

In 1999, U.S. eighth-graders exceeded the international average in mathematics and science among the 38 participating nations.

Between 1995 and 1999, there was no change in eighth-grade mathematics or science achievement in the United States. Among the 22 other nations, there was no change in mathematics achievement for 18 nations, and no change in science achievement for 17 nations.

There was an increase in mathematics achievement among U.S. eighth-grade black students between 1995 and 1999. There was no change in science achievement for this group of students over the same period. U.S. eighth-grade white and Hispanic students showed no change in their mathematics or science achievement over the 4 years.

No differences in performance were found between U.S. eighth-grade girls and boys in mathematics in 1999, but boys outperformed girls in science.

The relative performance of the United States in mathematics and science was lower for eighth-graders in 1999 than it was for the cohort of fourth-graders 4 years earlier in 1995.

As indicated in the previous chapter, the primary intent of conducting TIMSS in 1995 and TIMSS–R in 1999 was to take the first step in measuring change in both achievement and educational context at the international level. This chapter describes the mathematics and science achievement of students in the participating nations. It is divided into three main sections, in the following order:

- findings for the 38 nations that participated in TIMSS–R;
- findings for the 23 nations that participated at the eighth grade in both TIMSS and TIMSS–R[1]; and
- findings for the 17 nations that participated at the fourth grade in TIMSS and eighth grade in TIMSS–R.

To assist the reader, the number of nations being compared in each analysis will be made explicit. This is important, as the number of nations included in the international average can vary depending on the frame of reference in the analysis.

What do the test scores mean?

TIMSS–R test scores are on a scale of 1 to 1,000, with a standard deviation of 100.[2] TIMSS–R test scores indicate where on the scale a group of students would fall. In general, the higher the score on TIMSS or TIMSS–R, the more items correctly answered by a larger percentage of a nation's students. The lower the score on TIMSS or TIMSS–R, the fewer items correctly answered by a larger percentage of a nation's students. TIMSS and TIMSS–R used item response theory to create the scale scores. The scales used in TIMSS and TIMSS–R account for differences in the difficulty of items and allow students' performance to be summarized on a common metric. The scales are thus a simplified method for making comparisons between nations. The scales measure achievement on mathematics and science items judged by international experts to be appropriate for eighth-grade students in the participating nations. Thus, higher performance indicates that students are more proficient at middle-school mathematics or science.

For all analyses presented in this report, differences between averages or percentages that are statistically significant are discussed using comparative terms such as "higher" and "lower." Differences that are not statistically significantly are discussed as "similar to" or "not different from" each other. To determine whether differences reported are statistically significant, two-tailed t-tests, at the .05 level, were used. Bonferroni adjustments are made when more than two groups are compared simultaneously (e.g., black, white, and Hispanic students).

THE MATHEMATICS AND SCIENCE ACHIEVEMENT OF EIGHTH-GRADERS IN 1999

This section presents results for the 38 nations that participated in TIMSS–R in 1999.

National averages for mathematics and science from the 1999 TIMSS–R assessment are presented, beginning with figure 2. Though tempting, it is not correct to report U.S. scores by rank. This is because the process of estimating each nation's score from the sample of students who took the test produces only an estimate of the range within which the nation's real score lies. To conduct a fair comparison of the United States to other nations, nations are grouped according to whether their performance is higher than, not different from, or lower than the United States, given the margin of error for the survey. Nations with a national average higher than the U.S. average are indicated in the uppermost band of shading. Nations with a national average lower than the U.S. average are

[1]Twenty-six nations participated in TIMSS and TIMSS–R at the eighth grade. Of the 26 nations, 3 nations experienced significant irregularities in their participation in 1995: Israel, South Africa, and Thailand. Findings for the other 23 nations are reported here.

[2]Because the standard deviation is 100, raw differences between scores can be translated into effect sizes by dividing the raw difference by the standard deviation. For example, if the raw difference between the scores of two nations is 75, this translates to an effect size of 0.75 in TIMSS–R. The TIMSS–R scale was developed once a majority of nations had submitted data. At that time, the mean was set to 500, with a standard deviation of 100. Once the remaining data was submitted by nations, it was fitted to the developed scale, resulting in an actual mean slightly different than 500.

indicated in the lowermost band of shading. Nations with a national average not different from the U.S. average are shown unshaded and, for the most part, lie between these shaded areas. Note that the international average—the average of the national average scores for all nations combined—can be compared to the U.S. average in the same way as a national average and is shaded to indicate the significance of the difference.

Figure 2.—Average mathematics and science achievement of eighth-grade students, by nation: 1999

MATHEMATICS	
Nation	Average
Singapore	604
Korea, Republic of	587
Chinese Taipei	585
Hong Kong SAR	582
Japan	579
Belgium-Flemish	558
Netherlands	540
Slovak Republic	534
Hungary	532
Canada	531
Slovenia	530
Russian Federation	526
Australia	525
Finland[1]	520
Czech Republic	520
Malaysia	519
Bulgaria	511
Latvia-LSS[2]	505
United States	502
England	496
New Zealand	491
Lithuania[3]	482
Italy	479
Cyprus	476
Romania	472
Moldova	469
Thailand	467
(Israel)	466
Tunisia	448
Macedonia, Republic of	447
Turkey	429
Jordan	428
Iran, Islamic Republic of	422
Indonesia	403
Chile	392
Philippines	345
Morocco	337
South Africa	275
International average of 38 nations	487

SCIENCE	
Nation	Average
Chinese Taipei	569
Singapore	568
Hungary	552
Japan	550
Korea, Republic of	549
Netherlands	545
Australia	540
Czech Republic	539
England	538
Finland	535
Slovak Republic	535
Belgium-Flemish	535
Slovenia	533
Canada	533
Hong Kong SAR	530
Russian Federation	529
Bulgaria	518
United States	515
New Zealand	510
Latvia-LSS[2]	503
Italy	493
Malaysia	492
Lithuania[3]	488
Thailand	482
Romania	472
(Israel)	468
Cyprus	460
Moldova	459
Macedonia, Republic of	458
Jordan	450
Iran, Islamic Republic of	448
Indonesia	435
Turkey	433
Tunisia	430
Chile	420
Philippines	345
Morocco	323
South Africa	243
International average of 38 nations	488

Average is significantly higher than the U.S. average
Average does not differ significantly from the U.S. average
Average is significantly lower than the U.S. average

[1]The shading of Finland may appear incorrect; however, statistically, its placement is correct.

[2]Designated LSS because only Latvian-speaking schools were tested which represents 61 percent of the population.

[3]Lithuania tested the same cohort of students as other nations, but later in 1999, at the beginning of the next school year.

NOTE: Eighth grade in most nations. See appendix 2 for details.
Parentheses indicate nations not meeting international sampling and/or other guidelines. See appendix 2 for details.
The international average is the average of the national averages of the 38 nations.

SOURCE: Martin et al. (2000). *TIMSS 1999 International Science Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 1.1. Chestnut Hill, MA: Boston College; Mullis et al. (2000). *TIMSS 1999 International Mathematics Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 1.1. Chestnut Hill, MA: Boston College.

How well did U.S. eighth-graders perform in 1999?

In mathematics, U.S. eighth-graders exceeded the international average, outperforming their peers in 17 of the 37 other TIMSS–R nations, performing similarly to students in 6 nations, and performing lower than their peers in 14 nations. In 1999, the U.S. average score was 502, with other nations' average mathematics scores ranging from 604 for Singapore to 275 for South Africa. Among the top performing nations in 1999 were five Asian industrialized nations—Singapore, Korea, Chinese Taipei, Hong Kong SAR, and Japan. Comparisons with five of the Group of Eight (G8) nations are possible as well: in 1999, the United States performed significantly better in mathematics than Italy, performed similarly to England, but was outperformed by Japan, Canada, and the Russian Federation.[3]

In science, U.S. eighth-graders exceeded the international average, outperforming their peers in 18 of the 37 other nations, performing similarly to students in 5 nations, and performing lower than their peers in 14 nations. In 1999, the U.S. average score was 515, with other nations' average science scores ranging from 569 for Chinese Taipei to 243 for South Africa. Among the top performing nations in science were four Asian industrialized nations—Chinese Taipei, Singapore, Korea, and Japan—and Hungary. Comparisons with other participating G8 nations show that the United States performed significantly better than Italy, performed on par with the Russian Federation, but performed lower than Japan, England and Canada.

When looking across mathematics and science achievement in 1999, 12 nations outperformed the United States in both subjects: Australia, Belgium-Flemish, Canada, Chinese Taipei, Finland, Hungary, Japan, Korea, the Netherlands, Singapore, the Slovak Republic, and Slovenia. Likewise, three nations performed similarly to the United States in both subjects: Bulgaria, Latvia-LSS, and New Zealand. Finally, U.S. eighth-graders outperformed their peers in 17 nations across both mathematics and science in 1999.[4]

What percentage of our students scored at or above the international top 10 percent benchmark in 1999?

Average achievement scores indicate how the average student performs, but say little about the performance of the nation's students at different levels. International benchmarks were devised to provide a view of what proportion of a nation's students scored at or near various levels of achievement. These international benchmarks give a general indication of the relative distribution of scores within and across nations. For example, if a nation has a high average score and a large percentage of its students at or above the upper international benchmarks, this indicates that the nation's students are concentrated among the highest achieving students internationally.

TIMSS–R uses four benchmarks: the top 10 percent, the top 25 percent, the upper 50 percent, and the upper 75 percent. Each benchmark is based on all eighth-graders from all 38 nations in 1999. This report discusses two benchmarks in detail: the top 10 percent benchmark, which refers to the cutoff score that separates the top 10 percent of all students in 1999, and the similar top 25 percent benchmark. In 1999, the top 10 percent of all students scored 616 or higher in mathematics and 616 or higher in science (data not shown). The top 25 percent of all students scored 555 or higher in mathematics and 558 or higher in science (data not shown). Detailed information on these two benchmarks, as well as the upper 50 and upper 75 percent benchmarks, is found in tables A3.2 (mathematics) and A3.3 (science) in appendix 3.

[3]The United Kingdom, a member of the G8, is represented here by the score for England. France and Germany, the other two members of the G8, did not participate in TIMSS–R.

[4]An analysis of the overall mathematics and science achievement of the 54 nations that participated in TIMSS or TIMSS–R is provided in appendix 5.

In mathematics, 9 percent of U.S. eighth-graders scored 616 or higher, placing them among the top 10 percent of all eighth-graders in the 38 nations in 1999. This is a lower percentage of students than in 8 nations, a similar percentage as in 13 nations, and a higher percentage than in 16 nations (figure 3). In contrast, 46 percent of Singapore's eighth-grade students scored 616 or higher in mathematics in 1999. Among the five participating G8 nations, only Japan had a significantly higher percentage of students who scored at or above the international top 10 percent benchmark (33 percent) than the United States in mathematics.

Figure 3.—Percentages of eighth-grade students reaching the TIMSS-R 1999 top 10 percent in mathematics and science achievement, by nation: 1999

MATHEMATICS	
Nation	Percent
Singapore	46
Chinese Taipei	41
Korea, Republic of	37
Hong Kong SAR	33
Japan	33
Belgium-Flemish	23
Hungary	16
Slovenia[1]	15
Russian Federation	15
Netherlands	14
Slovak Republic	14
Australia	12
Malaysia	12
Canada	12
Czech Republic	11
Bulgaria	11
United States	9
New Zealand	8
Latvia-LSS[2]	7
England	7
Finland	6
Romania	5
Italy[1]	5
(Israel)[1]	5
Thailand	4
Lithuania[3]	4
Moldova	4
Cyprus	3
Jordan	3
Macedonia, Republic of	3
Indonesia	2
Turkey	1
Iran, Islamic Republic of	1
Chile	1
Tunisia	0
South Africa	0
Philippines	0
Morocco	0

SCIENCE	
Nation	Percent
Singapore	32
Chinese Taipei	31
Hungary	22
Korea, Republic of	22
England	19
Australia	19
Japan	19
Russian Federation	17
Czech Republic	17
Netherlands	16
Slovenia	16
United States	15
Finland	14
Slovak Republic	14
Bulgaria	14
Canada	14
New Zealand	12
Belgium-Flemish	11
Hong Kong SAR	10
Italy	7
Latvia-LSS[2]	7
(Israel)	7
Malaysia	6
Romania	6
Lithuania[3]	6
Jordan	4
Moldova	4
Macedonia, Republic of	4
Thailand	3
Cyprus	2
Iran, Islamic Republic of	2
Indonesia	1
Chile	1
Turkey	1
Philippines	1
South Africa	0
Tunisia	0
Morocco	0

Average is significantly higher than the U.S. average
Average does not differ significantly from the U.S. average
Average is significantly lower than the U.S. average

[1]The shading of Italy, Israel, and Slovenia in mathematics may appear incorrect; however, statistically, their placement is correct.

[2]Designated LSS because only Latvian-speaking schools were tested which represents 61 percent of the population.

[3]Lithuania tested the same cohort of students as other nations, but later in 1999, at the beginning of the next school year.

NOTE: Eighth grade in most nations. See appendix 2 for details.
Parentheses indicate nations not meeting international sampling and/or other guidelines. See appendix 2 for details.

SOURCE: Martin et al. (2000). *TIMSS 1999 International Science Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 1.6. Chestnut Hill, MA: Boston College; Mullis et al. (2000). *TIMSS 1999 International Mathematics Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 1.6. Chestnut Hill, MA: Boston College.

In science, 15 percent of U.S. eighth-graders scored 616 or higher, placing them among the top 10 percent of all students internationally in 1999. This was a lower percentage of students than in 4 nations, a similar percentage as in 13 nations, and a higher percentage than in 20 nations (figure 3). In contrast, 32 percent of Singapore's eighth-grade students scored 616 or higher in science in 1999. Among the five participating G8 nations, none had a significantly higher percentage of students who scored at or above the international top 10 percent benchmark than the United States in science.

What percentage of our students scored at or above the international top 25 percent benchmark in 1999?

An examination of the top 25 percent international benchmark offers yet another opportunity to understand the performance of our eighth-grade students in mathematics and science in 1999. In mathematics, 28 percent of U.S. eighth-grade students scored 555 or higher, placing them among the top 25 percent of all students internationally in 1999. This was a lower percentage than in 11 nations, a similar percentage as in 9 nations, and a higher percentage than in 17 nations. In contrast, 75 percent of eighth-grade students in Singapore scored 555 or higher in mathematics in 1999.

In science, 34 percent of U.S. eighth-graders scored 558 or higher, placing them among the top 25 percent of all students internationally in 1999. This was a lower percentage than in 5 nations, a similar percentage as in 13 nations, and a higher percentage than in 19 nations. In contrast, 58 percent of eighth-grade students in Chinese Taipei scored 558 or higher in science in 1999.

How well did U.S. eighth-graders perform in the different content areas in 1999?

An overall score is a useful summary of general mathematics and science performance. However, mathematics and science comprise a range of content areas that can be conceptually distinct, differ in levels of complexity, enter the curriculum at different times, and be taught by different teachers in separate courses. TIMSS–R assessed five mathematics and six science content areas:

Mathematics[5]

- Fractions and number sense
- Measurement
- Data representation, analysis, and probability
- Geometry
- Algebra

Science

- Earth science
- Life science
- Physics
- Chemistry
- Environmental and resource issues
- Scientific inquiry and the nature of science

U.S. eighth-graders' average score was higher than the international average in three of the five mathematics content areas assessed in 1999: *fractions and number sense*; *data representation*, *analysis*, *and probability*; and *algebra*. They performed at the international average in *measurement* and *geometry*.

Figure 4 displays mathematics content area scores for all 38 nations based on the TIMSS–R assessment. Six nations outperformed the United States across all five mathematics content areas in 1999: Belgium-Flemish, Chinese Taipei, Hong Kong SAR, Japan, Korea, and Singapore. New Zealand is the only nation in TIMSS–R that performed simiarly to the United States in all five content areas. Seven nations performed below the United States in all five mathematics content areas: Chile,

[5]TIMSS 1995 included *proportionality* among the mathematics content areas. After careful consideration, the *proportionality* items were redistributed among several of the other mathematics content areas for the TIMSS and TIMSS–R data.

Figure 4.—Average eighth-grade achievement in mathematics content areas, by nation: 1999

Fractions and number sense		Measurement		Data representation, analysis, and probability		Geometry		Algebra	
Nation	Average	Nation	Average	Nation	Average	Nation	Average	Nation	Average
Singapore	608	Singapore	599	Korea, Republic of	576	Japan	575	Chinese Taipei	586
Hong Kong SAR	579	Korea, Republic of	571	Singapore	562	Korea, Republic of	573	Korea, Republic of	585
Chinese Taipei	576	Hong Kong SAR	567	Chinese Taipei	559	Singapore	560	Singapore	576
Korea, Republic of	570	Chinese Taipei	566	Japan	555	Chinese Taipei	557	Japan	569
Japan	570	Japan	558	Hong Kong SAR	547	Hong Kong SAR	556	Hong Kong SAR	569
Belgium-Flemish	557	Belgium-Flemish	549	Belgium-Flemish	544	Belgium-Flemish	535	Belgium-Flemish	540
Netherlands	545	Hungary	538	Netherlands	538	Slovak Republic	527	Hungary	536
Canada	533	Netherlands	538	Slovenia	530	Bulgaria	524	Russian Federation	529
Malaysia	532	Slovak Republic	537	Finland	525	Latvia-LSS[1]	522	Slovak Republic	525
Finland	531	Czech Republic	535	Australia	522	Russian Federation	522	Slovenia[3]	525
Slovenia	527	Australia	529	Slovak Republic	521	Netherlands	515	Canada[3]	525
Hungary	526	Russian Federation	527	Canada	521	Czech Republic	513	Netherlands	522
Slovak Republic	525	Slovenia	523	Hungary	520	Canada	507	Australia	520
Australia	519	Canada	521	Czech Republic	513	Slovenia	506	Czech Republic	514
Russian Federation	513	Finland	521	England	506	Australia	497	Bulgaria	512
United States	509	Malaysia	514	**United States**	506	Malaysia	497	**United States**	506
Czech Republic	507	England	507	Russian Federation	501	Lithuania[2]	496	Malaysia	505
Bulgaria	503	Latvia-LSS[1]	505	New Zealand	497	Finland	494	Latvia-LSS[1]	499
England	497	Italy	501	Latvia-LSS[1]	495	Hungary	489	England	498
Latvia-LSS[1]	496	Bulgaria	497	Lithuania[2]	493	Romania	487	Finland	498
New Zealand	493	New Zealand	496	Bulgaria	493	Thailand	484	New Zealand	497
Cyprus	481	Romania	491	Malaysia	491	Cyprus	484	Lithuania[2]	487
Lithuania[2]	479	**United States**	482	Italy	484	Tunisia	484	Italy	481
(Israel)	472	Moldova	479	Thailand	476	Italy	482	Romania	481
Thailand	471	Cyprus	471	Cyprus	472	Moldova	481	(Israel)	479
Italy	471	Lithuania[2]	467	(Israel)	468	New Zealand	478	Cyprus	479
Moldova	465	Thailand	463	Romania	453	**United States**	473	Moldova	477
Romania	458	(Israel)	457	Moldova	450	England	471	Macedonia, Republic of	465
Tunisia	443	Macedonia, Republic of	451	Tunisia	446	(Israel)	462	Thailand	456
Iran, Islamic Republic of	437	Tunisia	442	Turkey	446	Macedonia, Republic of	460	Tunisia	455
Macedonia, Republic of	437	Jordan	438	Macedonia, Republic of	442	Jordan	449	Jordan	439
Jordan	432	Turkey	436	Jordan	436	Iran, Islamic Republic of	447	Iran, Islamic Republic of	434
Turkey	430	Chile	412	Iran, Islamic Republic of	430	Indonesia	441	Turkey	432
Indonesia	406	Iran, Islamic Republic of	401	Chile	429	Turkey	428	Indonesia	424
Chile	403	Indonesia	395	Indonesia	423	Chile	412	Chile	399
Philippines	378	Philippines	355	Philippines	406	Morocco	407	Morocco	353
Morocco	335	Morocco	348	Morocco	383	Philippines	383	Philippines	345
South Africa	300	South Africa	329	South Africa	356	South Africa	335	South Africa	293
International average of 38 nations	487	International average of 38 nations	487	International average of 38 nations	487	International average of 38 nations	487	International average of 38 nations	487

Average is significantly higher than the U.S. average
Average does not differ significantly from the U.S. average
Average is significantly lower than the U.S. average

[1]Designated LSS because only Latvian-speaking schools were tested which represents 61 percent of the population.

[2]Lithuania tested the same cohort of students as other nations, but later in 1999, at the beginning of the next school year.

[3]The shading of Slovenia and Canada may appear incorrect; however, statistically, their placement is correct.

NOTE: Eighth grade in most nations. See appendix 2 for details.
Parentheses indicate nations not meeting international sampling and/or other guidelines. See appendix 2 for details.
The international average is the average of the national averages of the 38 nations.

SOURCE: Mullis et al. (2000). *TIMSS 1999 International Mathematics Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 3.1. Chestnut Hill, MA: Boston College.

Indonesia, Iran, Morocco, the Philippines, South Africa, and Turkey. *Geometry* and *measurement* are the content areas in which the United States performed lowest in terms of the number of nations that outperformed the United States, but the U.S. average was similar to the international average in both content areas.

In interpreting these results, it is important to consider the mathematics content areas and topics that students have likely encountered in the years leading up to and including eighth grade. For example, if students in the United States were not provided the opportunity to learn a particular mathematics topic or content area by the time of the assessment, it would be less likely that the students would perform well in comparison to their international peers in that area. Information on the coverage of mathematics content areas, as well as many other aspects of eighth-grade mathematics teaching and learning, is discussed in the next chapter.

U.S. eighth-graders' average score was higher than the international average in five of the six science content areas assessed in 1999: *earth science*; *life science*; *chemistry*; *environmental and resource issues*; and *scientific inquiry and the nature of science*. They performed at the international average of the 38 nations in *physics*.

Figure 5 displays science content area scores for the 38 TIMSS–R nations in 1999. As with mathematics, the international performance of nations differs when examining science by the six science content areas. The international performance of the United States is highest for *life science*; *environmental and resource issues*; and *scientific inquiry and the nature of science*. Only two nations scored higher than the United States in each of these three content areas. Chinese Taipei outperformed the United States in five of the six content areas, however. As in mathematics, New Zealand is the only nation that performed similarly to the United States across all six content areas in science. Finally, 12 nations performed below the United States in all six science content areas: Chile, Cyprus, Iran, Jordan, Macedonia, Moldova, Morocco, the Philippines, Romania, South Africa, Tunisia, and Turkey. *Physics* was the science content area that the United States performed lowest in terms of the number of nations that outperformed the United States, but the U.S. average was similar to the international average.

As with mathematics, it is important to understand the context within which science learning occurs when interpreting these results. This includes the science content areas and topics that students have likely encountered in their science lessons. Information on the coverage of the six science content areas, as well as many other aspects of eighth-grade science teaching and learning, is covered in the following chapter.

Figure 5.—Average eighth-grade achievement in science content areas, by nation: 1999

Earth science		Life science		Physics		Chemistry		Environmental and resource issues		Scientific inquiry and the nature of science	
Nation	Average	Nation	Average	Nation	Average	Nation	Average	Nation	Average	Nation	Average
Hungary	560	Chinese Taipei	550	Singapore	570	Chinese Taipei	563	Singapore	577	Singapore	550
Slovenia	541	Czech Republic	544	Chinese Taipei	552	Hungary	548	Chinese Taipei	567	Korea, Republic of	545
Chinese Taipei	538	Singapore	541	Japan	544	Singapore	545	Australia	530	Japan[3]	543
Slovak Republic	537	Netherlands	536	Korea, Republic of	544	Finland	535	Netherlands	526	Chinese Taipei	540
Netherlands	534	Slovak Republic	535	Hungary	543	Japan	530	Korea, Republic of	523	England	538
Japan	533	Hungary	535	Netherlands	537	Bulgaria	527	Canada	521	Australia	535
Belgium-Flemish	533	Belgium-Flemish	535	Australia	531	Slovak Republic	525	Slovenia	519	Netherlands	534
Czech Republic	533	Japan	534	Belgium-Flemish	530	England	524	Hong Kong SAR	518	Canada	532
Korea, Republic of	532	England	533	Russian Federation	529	Korea, Republic of	523	England	518	Hong Kong SAR	531
Russian Federation	529	Australia	530	England	528	Russian Federation	523	Czech Republic	516	Finland	528
England	525	Korea, Republic of	528	Czech Republic	526	Canada	521	Finland	514	Belgium-Flemish	526
Singapore	521	Canada	523	Slovenia	525	Australia	520	Belgium-Flemish	513	Hungary	526
Finland	520	Slovenia	521	Hong Kong SAR	523	Hong Kong SAR	515	Slovak Republic	512	**United States**	522
Bulgaria	520	Finland	520	Canada	521	Netherlands	515	**United States**	509	Czech Republic	522
Australia	519	**United States**	520	Finland	520	Czech Republic	512	Thailand	507	New Zealand	521
Canada	519	Russian Federation	517	Slovak Republic	518	Slovenia	509	Japan	506	Slovenia	513
Hong Kong SAR	506	Hong Kong SAR	516	Lithuania[2]	510	**United States**	508	New Zealand	503	Slovak Republic	507
New Zealand	504	Bulgaria	514	Bulgaria	505	Belgium-Flemish	508	Malaysia	502	Latvia-LSS[1]	495
United States	504	Latvia-LSS[1]	509	New Zealand	499	New Zealand	503	Hungary	501	Russian Federation	491
Italy	502	Thailand	508	**United States**	498	Italy	493	Russian Federation	495	Italy	489
Latvia-LSS[1]	495	New Zealand	501	Latvia-LSS[1]	495	Latvia-LSS[1]	490	Latvia-LSS[1]	493	Malaysia	488
Malaysia	491	Lithuania[2]	494	Malaysia	494	Iran, Islamic Republic of	487	Italy	491	Lithuania[2]	483
Lithuania[2]	476	Italy	488	(Israel)	484	Lithuania[2]	485	Indonesia	489	Bulgaria	479
Romania	475	Malaysia	479	Italy	480	Malaysia	485	Bulgaria	483	(Israel)	476
(Israel)	472	Moldova	477	Thailand	475	Jordan	483	Jordan	476	Moldova	471
Thailand	470	Romania	475	Romania	465	Romania	481	Cyprus	475	Cyprus	467
Moldova	466	Cyprus	468	Macedonia, Republic of	463	Macedonia, Republic of	481	Romania	473	Macedonia, Republic of	464
Macedonia, Republic of	464	Macedonia, Republic of	468	Cyprus	459	(Israel)	479	Iran, Islamic Republic of	470	Thailand	462
Cyprus	459	(Israel)	463	Jordan	459	Cyprus	470	Tunisia	462	Romania	456
Iran, Islamic Republic of	459	Jordan	448	Moldova	457	Moldova	451	Turkey	461	Tunisia	451
Jordan	446	Indonesia	448	Indonesia	452	Tunisia	439	Lithuania[2]	458	Iran, Islamic Republic of	446
Tunisia	442	Turkey	444	Iran, Islamic Republic of	445	Thailand	439	(Israel)	458	Indonesia	446
Chile	435	Tunisia	441	Turkey	441	Turkey	437	Chile	449	Turkey	445
Turkey	435	Iran, Islamic Republic of	437	Chile	428	Chile	435	Moldova	444	Chile	441
Indonesia	431	Chile	431	Tunisia	425	Indonesia	425	Macedonia, Republic of	432	Jordan	440
Philippines	390	Philippines	378	Philippines	393	Philippines	394	Morocco	396	Philippines	403
Morocco	363	Morocco	347	Morocco	352	Morocco	372	Philippines	391	Morocco	391
South Africa	348	South Africa	289	South Africa	308	South Africa	350	South Africa	350	South Africa	329
International average of 38 nations	488	International average of 38 nations	488	International average of 38 nations	488	International average of 38 nations	488	International average of 38 nations	488	International average of 38 nations	488

- Average is significantly higher than the U.S. average
- Average does not differ significantly from the U.S. average
- Average is significantly lower than the U.S. average

[1]Designated LSS because only Latvian-speaking schools were tested which represents 61 percent of the population.
[2]Lithuania tested the same cohort of students as other nations, but later in 1999, at the beginning of the next school year.
[3]The shading of Japan may appear incorrect; however, statistically, its placement is correct.

NOTE: Eighth grade in most nations. See appendix 2 for details.
Parentheses indicate nations not meeting international sampling and/or other guidelines. See appendix 2 for details.
The international average is the average of the national averages of the 38 nations.

SOURCE: Martin et al. (2000). *TIMSS 1999 International Science Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 3.1. Chestnut Hill, MA: Boston College.

What were students asked to do on the TIMSS–R assessment?

This section contains an example test item from each of the five mathematics and six science content areas assessed in 1999. Included are both multiple-choice and free-response item formats. Each example item is introduced with a brief description, the content area it represents, the correct answer or an example of a written response that was marked as correct, the U.S. percent correct, and the international average percent correct.

Information on the percent correct for each of the 38 TIMSS–R nations is provided in tables A3.6 (mathematics example items) and A3.7 (science example items) in appendix 3.

Figure 6 shows an example of a mathematics item that relates to *fractions and number sense*. This item asked students to choose the expression that best estimated the sum of two three-digit numbers using rounding. Ninety-three percent of U.S. students correctly chose B as the answer. The international average was 80 percent.

Figure 6.—Example mathematics item 1

The sum 691 + 208 is closest to the sum

A. 600 + 200

B. 700 + 200

C. 700 + 300

D. 900 + 200

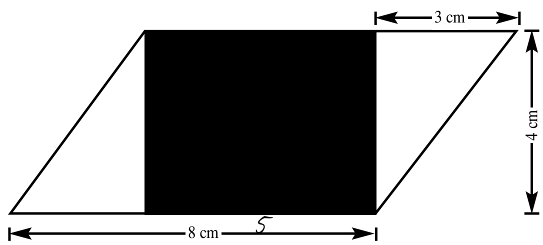
Correct answer: B U.S. percent correct: 93 International average: 80

SOURCE: Mullis et al. (2000). *TIMSS 1999 International Mathematics Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade*. Exhibit 2.18. Chestnut Hill, MA: Boston College.

In this example of a *measurement* item (figure 7), students were asked to find the area of a rectangle contained in a given parallelogram. Thirty-four percent of U.S. students correctly answered this item, while the international average was 43 percent.

Figure 7.—Example mathematics item 2

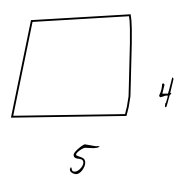
The figure shows a shaded rectangle inside a parallelogram.



What is the area of the shaded rectangle in square centimeters?

8 − 3 = 5

Answer: 20 cm



4 · 5 = 20

Correct answer: 20 cm^2 U.S. percent correct: 34 International average: 43

SOURCE: Mullis et al. (2000). *TIMSS 1999 International Mathematics Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 2.9. Chestnut Hill, MA: Boston College.

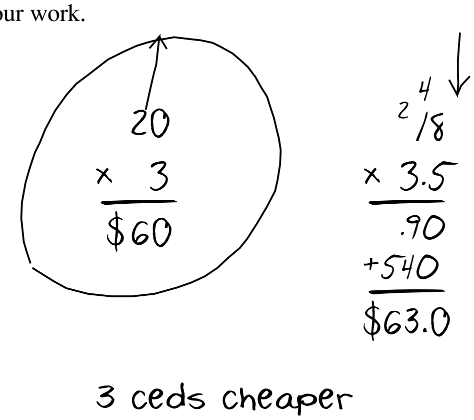
Figure 8 is an example of an item from the *data representation, analysis, and probability* content area. In this item, students were asked to determine which of the two magazines was less expensive, given the number of issues and cost of each issue. In order to receive full credit for this item, students had to calculate the cost of 24 issues for each magazine and arrive at the answer of Teen Life being 3 *ceds* less expensive than Teen News. In the United States, 26 percent of students received full credit for this item; the international average was 24 percent.

Figure 8.—Example mathematics item 3

Chris plans to order 24 issues of a magazine. He reads the following advertisements for two magazines. *Ceds* are the units of currency in Chris' country.

Teen Life Magazine	Teen News Magazine
24 issues First four issues FREE The remaining issues 3 *ceds* each.	24 issues First six issues FREE The remaining issues 3.5 *ceds* each.

Which magazine is the least expensive for 24 issues? How much less expensive? Show your work.



Correct answer: Teen Life, 3 ceds cheaper U.S. percent correct: 26 International average: 24

SOURCE: Mullis et al. (2000). *TIMSS 1999 International Mathematics Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 2.3. Chestnut Hill, MA: Boston College.

Figure 9 is an example of an item from the *geometry* content area. In this item, students were asked to determine the measure of the fourth angle of a quadrilateral, given the measurements of the other three (figure 9). In order to correctly answer this item, students needed the knowledge that the sum of the four angles of a quadrilateral always equals 360 degrees. Twenty percent of U.S. students answered this item correctly. The international average was 40 percent.

Figure 10, an *algebra* item, asked students to determine the number of girls and the number of boys in the fictitious club, given the total number of members and the information that there were 14 more girls than boys. Full credit was given if students gave the correct response of 36 boys and 50 girls and showed their work. Numerical, algebraic, and "guess and check" methods were all accepted for full credit. Twenty-nine percent of U.S. students received full credit on this item. The international average was 33 percent.

Figure 9.—Example mathematics item 4

In a quadrilateral, each of two angles has a measure of 115º. If the measure of a third angle is 70º, what is the measure of the remaining angle?

A. 60º

B. 70º

C. 130º

D. 140º

E. None of the above

Correct answer: A U.S. percent correct: 19 International average: 40

SOURCE: Boston College, International Study Center, Third International Mathematics and Science Study–Repeat (TIMSS–R), unpublished tabulations, 1999.

Figure 10.—Example mathematics item 5

A club has 86 members, and there are 14 more girls than boys. How many boys and how many girls are members of the club?

Show your work.

$$x+(14+x)=86$$
$$2x+14=86$$
$$2x+14-14=86-14$$
$$\frac{2x}{2}=\frac{72}{2}$$
$$x=36$$

$$86-36=50$$

There are 36 boys and 50 girls.

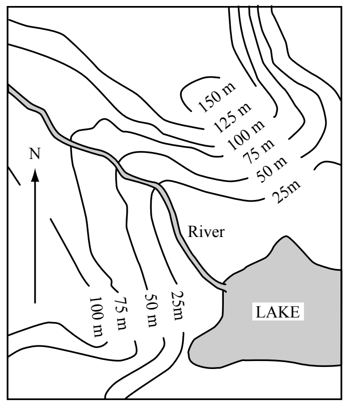
Correct answer: 36 boys and 50 girls U.S. percent correct: 29 International average: 33

SOURCE: Boston College, International Study Center, Third International Mathematics and Science Study–Repeat (TIMSS–R), unpublished tabulations, 1999.

Figure 11 is an example of an *earth science* item. This item asked students to read a contour map and determine which direction a river is flowing. In the U.S., 48 percent of students answered this item correctly; the international average was 37 percent.

Figure 11.—Example science item 1

On the diagram, hills and valleys are shown by means of contour lines. Each contour line indicates that all points on the line have the same elevation above sea level.



In which direction does the river flow?

A. Northeast

B. Southeast

C. Northwest

D. Southwest

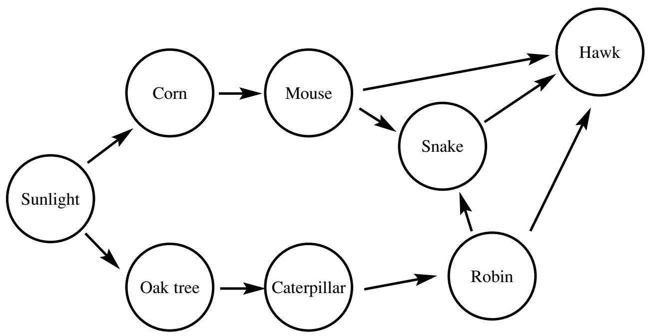
E. It is not possible to tell from the map.

Correct answer: B U.S. percent correct: 48 International average: 37

SOURCE: Boston College, International Study Center, Third International Mathematics and Science Study–Repeat (TIMSS–R), unpublished tabulations, 1999.

In this *life science* item, students were given a food web and asked to explain the effects of one part of the web on another part (figure 12). Specifically, they were asked to describe the consequences of crop failure on the population of robins. Several types of responses were given full credit. For example, students could have answered that the robin population would decrease due to predators eating more robins if mice die. They could have also answered that the robin population would increase based on predators dying due to lack of food (mice). Other feasible explanations, such as the robin population being unaffected because mice would find other sources of grain, were also given full credit.

Figure 12.—Example science item 2



Look at the food web above. If the corn crop failed one year what would most likely happen to the robin population? Explain your answer.

The population would go down because, the mice eat corn and if there is no corn for the mice to eat they will die and if the mice die the snake will have to eat more robins to stay alive.

U.S. percent correct: 35 International average: 26

SOURCE: Boston College, International Study Center, Third International Mathematics and Science Study–Repeat (TIMSS–R), unpublished tabulations, 1999.

Figure 13 shows an example of a science item that relates to *physics*. Given data on fuel consumption and work accomplished, students were asked to determine and explain which of two machines was more efficient by converting the information into common units or measures that could then be compared. Thirty percent of U.S. eighth-grade students answered both parts of this item correctly. The international average was 31 percent.

Figure 13.—Example science item 3

Machine A and Machine B are each used to pump water from a river. The table shows what volume of water each machine removed in one hour and how much gasoline each of them used.

	Volume of Water Removed in 1 Hour (liters)	Gasoline Used in 1 Hour (liters)
Machine A	1000	1.25
Machine B	500	0.5

a) Which machine is more efficient in converting the energy in gasoline to work?

Answer: B

b) Explain your answer:

1000 ÷ 1.25 = 800

500 ÷ .5 = 1000

Machine B is more efficient because for every liter of gasoline used it removed 1000L of water. With 1L of gasoline Machine A only removes 800L of water.

Correct answer: B U.S. percent correct: 30 International average: 31

SOURCE: Martin et al. (2000). *TIMSS 1999 International Science Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 2.3. Chestnut Hill, MA: Boston College.

Figure 14 shows an example of a science item that relates to *chemistry*. This item asked students to recall that when exposed to moisture and oxygen, iron rusts, and that painting the iron could prevent this reaction from happening. Sixty-six percent of U.S. eighth-grade students correctly answered this item. The international average was 67 percent.

In figure 15, an *environmental and resource issues* item, students were asked to choose the best explanation for why insecticides become ineffective over time. Sixty-two percent of U.S. students answered this item correctly; the international average was 48 percent.

Figure 14.—Example science item 4

Paint applied to an iron surface prevents the iron from rusting. Which ONE of the following provides the best reason?

A. It prevents nitrogen from coming in contact with the iron.

B. It reacts chemically with the iron.

C. It prevents carbon dioxide from coming in contact with the iron.

D. It makes the surface of the iron smoother.

E. It prevents oxygen and moisture from coming in contact with the iron.

Correct answer: E U.S. percent correct: 66 International average: 67

SOURCE: Martin et al. (2000). *TIMSS 1999 International Science Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 2.18. Chestnut Hill, MA: Boston College.

Figure 15.—Example science item 5

Insecticides are used to control insect populations so that they do not destroy the crops. Over time, some insecticides become less effective at killing insects, and new insecticidesmust be developed. What is the most likely reason insecticides become less effective over time?

A. Surviving insects have learned to include insecticides as a food source.

B. Surviving insects pass their resistance to insecticides to their offspring.

C. Insecticides build up in the soil.

D. Insecticides are concentrated at the bottom of the food chain.

Correct answer: B U.S. percent correct: 62 International average: 48

SOURCE: Martin et al. (2000). *TIMSS 1999 International Science Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 2.13. Chestnut Hill, MA: Boston College.

Figure 16 is an example of an item that relates to *scientific inquiry and the nature of science*. In this item, students were asked to describe a procedure that could be used to determine the time it takes for a person's heart rate to return to normal after exercising. They were also asked to list the materials needed for their procedure. In order to receive full credit, students needed to include all of the following: somebody (or self) measuring "normal" pulse rate with a timer or watch; having the subject exercise; and measuring the time interval between the completion of exercise and the pulse rate returning to "normal." Twenty-one percent of U.S. students answered this item correctly. The international average was 12 percent.

Figure 16.—Example science item 6

Suppose you want to investigate how long it takes for the heart rate to return to normal after exercising. What materials would you use and what procedures would you follow?

Materials

Stop watch

procedure

1. check heart rate
2. exercise
3. stop exercising, begin timing
4. check heart rate. when heart rate returns to original rate, stop timing.

U.S. percent correct: 21 International average: 12

SOURCE: Boston College, International Study Center, Third International Mathematics and Science Study–Repeat (TIMSS–R), unpublished tabulations, 1999.

How did different groups of students within the United States perform?

Comparisons of U.S. population group performance are common in the literature on student achievement, especially comparisons by sex and race/ethnicity. The *Condition of Education* (NCES 2000b), the *Digest of Education Statistics* (NCES 1999), *Science and Engineering Indicators–2000* (National Science Board 2000), and the various reports associated with each NAEP assessment (e.g., NCES 1997a, 1997b, and 2000c) routinely provide comparisons of the achievement of selected population groups.

Population groups tend to be defined by demographic attributes such as sex, race/ethnicity, language, and the like. Interest in the comparative performance of population groups reflects a concern that all students—regardless of race, ethnicity, sex, or family background, among other things—receive equitable educational opportunities. A national average score cannot describe the range of achievement within a nation and whether patterns of performance are associated with different subgroups.

The analyses that follow focus on five categories of population groups in the United States; these groups are defined by: sex, race/ethnicity, national origin of parents, level of parental education, and type of school attended.[6] These analyses examine the relationship between specific group characteristics and achievement. These are preliminary analyses of the data from TIMSS–R. Future analyses will examine the same relationships while accounting for other factors.

Figure 17 shows the average mathematics and science performance for the population groups noted above. The results of testing the statistical significance of the difference between group averages are described to the right of the group averages.[7]

Was there a difference in the mathematics and science achievement of U.S. eighth-grade boys and girls?

In mathematics, there was no evidence of a difference in achievement between U.S. eighth-grade boys and girls in 1999. The average score for girls was similar to the average score for boys. Of the other nations in 1999, only four—the Czech Republic, Iran, Israel, and Tunisia—showed differences in the achievement of boys and girls in mathematics, all in favor of boys (see table A3.9, appendix 3 for details).

In science, U.S. eighth-grade boys outperformed eighth-grade girls in 1999. In all, the United States and 15 other nations showed differences between the average achievement of boys and girls, and all differences favored boys.[8] Twenty-two nations showed no differences between boys and girls in science. In addition to the United States, Canada, Chile, Chinese Taipei, the Czech Republic, England, Hungary, Iran, Korea, Latvia-LSS, Lithuania, the Netherlands, Russian Federation, Slovak Republic, Slovenia, and Tunisia showed differences in science achievement between boys and girls (see table A3.9, appendix 3).

The TIMSS–R findings in mathematics are consistent with other studies conducted at this grade level, such as NAEP (NCES, 1997a, 2000c). The TIMSS–R findings for the United States in science differ from the most recent results for NAEP and long term trend NAEP (NCES, 1997b, 2000c) where no difference in science achievement was found between eighth-grade boys and girls. Reasons for the different results in TIMSS–R and NAEP may relate to the differences in the science topics and content areas emphasized in the two assessment frameworks and the relationship of the frameworks to U.S. science curricula through the eighth grade. Differences and similarities between

[6]Data are analyzed based on students' reports of sex, race/ethnicity, national origin of parents, and level of parental education. Data on type of school attended based on school sample.

[7]Other factors are not controlled for in these analyses.

[8]Readers may recall that there was no difference found in TIMSS 1995 between the science performance of U.S. eighth-grade boys and girls (NCES 1996). As a result of rescaling the TIMSS data, the data show that U.S. eighth-grade boys outperformed girls in science in 1995.

Figure 17.—U.S. eighth-grade mathematics and science achievement, by selected characteristics: 1999

Characteristics	Mathematics average	Science average	Significance
Sex			
Boys	505	524	Boys and girls performed similarly in mathematics. Boys outperformed girls in science.
Girls	498	505	
Race/ethnicity			
White students	525	547	White students outperformed black and Hispanic students in mathematics and science. Black and Hispanic students performed similarly to each other in mathematics. Hispanic students outperformed black students in science.
Black students	444	438	
Hispanic students	457	462	
Public/nonpublic school			
Public school students	498	510	Nonpublic school students outperformed public school students in mathematics and science.
Nonpublic school students	526	548	
National origin of parents			
Both U.S. born	510	527	In mathematics and science, students whose parents were both U.S. born outperformed students whose parents were both foreign born. In mathematics and science, students whose parents were both U.S. born and students with one U.S. born parent and one foreign born parent performed similarly. In science, students with one U.S. born parent and one foreign born parent outperformed students whose parents were both foreign born.
Both foreign born	477	472	
1 U.S. born, 1 foreign born	496	509	
Mother's education			
High school or less	484	499	In mathematics and science, students whose mothers completed college outperformed students whose mothers completed high school or less. In mathematics and science, students whose mothers completed college outperformed students whose mothers attended some college. In mathematics and science, students whose mothers attended some college outperformed students whose mothers completed high school or less.
Some college	511	525	
Completed college	539	554	
Father's education			
High school or less	482	495	In mathematics and science, students whose fathers completed college outperformed students whose fathers completed high school or less. In mathematics and science, students whose fathers completed college outperformed students whose fathers attended some college. In mathematics and science, students whose fathers attended some college outperformed students whose fathers completed high school or less.
Some college	512	529	
Completed college	543	560	

NOTE: Other factors are not controlled for in these analyses.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Third International Mathematics and Science Study–Repeat (TIMSS–R), unpublished tabluations, 1999.

TIMSS–R and NAEP, as well as PISA, are discussed in chapter 1. A more thorough analysis of TIMSS–R science data for U.S. boys and girls may reveal important insights into the differences noted here.

Did the achievement of U.S. students differ by race and ethnicity?

Studies have regularly shown that white students outperform the two largest minority groups in the United States—namely, black students and Hispanic students—in mathematics and science. TIMSS-R results and other large-scale studies, such as NAEP (NCES 1997a, 1997b, and 2000c), present a similar picture of the achievement of eighth-grade white students, black students, and Hispanic students in the United States. In 1999, the average score for white students was higher than for either black students or Hispanic students in mathematics. Black students and Hispanic students performed similarly (see figure 17).

In science, the average 1999 score for U.S. eighth-grade white students was higher than for either black students or Hispanic students, and Hispanic students outperformed black students (see figure 17). The research literature offers several explanations for differences in the performance of particular populations, generally suggesting that various forms of inequality of opportunity result in differences in achievement (Wilson 1987 and 1996; Jencks and Phillips 1998). These possible explanations are not explored in the analyses presented here.

Did the achievement of students in U.S. public and nonpublic schools differ?

In both mathematics and science in 1999, the average achievement score of U.S. eighth-grade nonpublic school students was higher than the average of their peers in U.S. public schools (figure 17).[9] Competing explanations for differences in the achievement of public and nonpublic students in the United States are found in the research literature. One possible explanation is that the two types of schools differ in the quality of the education offered to students (Coleman, Hoffer, and Kilgore 1981, 1982). The rationale here is that higher quality offerings lead to higher achievement. Another possible explanation offered in the literature is that differences in achievement between public and nonpublic school students are the result of differences in the socioeconomic status of the students recruited into each type of school (Jimenez and Lockheed 1991). The rationale behind this argument is that different opportunities for learning are created or nurtured among students from different socioeconomic backgrounds. The findings for public and nonpublic students from TIMSS–R are consistent with findings from NAEP (NCES 1997a, 1997b, and 2000c). Indeed, in nations with sizable numbers of nonpublic schools (e.g., Australia, the United Kingdom, and the United States), on average, students who attended nonpublic schools did better than those who attended public schools (Coleman, Hoffer, and Kilgore 1982; Williams and Carpenter 1990; Halsey, Heath, and Ridge 1984). The analyses presented here do not offer any possible explanation for the observed differences; rather, the analyses simply document achievement differences between eighth-grade students in these two types of schools. More thorough analysis of the data, taking into account such factors as race/ethnicity or socioeconomic status, may reveal important insights into possible reasons for the observed differences.

Did the achievement of U.S. students of different national origins differ?

TIMSS–R asked students to indicate whether their parents were U.S. or foreign-born. There is an interest in the birthplace of students' parents because a sizeable proportion of students with parents born outside the United States may not speak English as their first language or may not speak English at home with great frequency, if at all. Since English is generally the language of

[9]Forty-four of the 221 schools sampled in the United States were nonpublic schools. Among these 44 nonpublic schools, 26 were Catholic, 13 were Protestant/other religious, 4 were non-religious independent schools, and 1 was unspecified.

instruction in U.S. classrooms, students' facility with language may play a role in their ability to adequately understand school subjects. Moreover, immigrant status is often associated with lower socioeconomic status and more limited educational opportunities. The average 1999 mathematics score of eighth-grade students whose parents were both foreign-born was lower than the score of students whose parents were both U.S. born (figure 17). In science in 1999, the average score of eighth-graders whose parents were both foreign-born was lower than the score of students with at least one parent born in the United States.

Did the achievement of U.S. students differ by the level of their parents' education?

The average mathematics performance of eighth-grade students in 1999 differed by their parents' level of education. Students who reported that their parents had completed college had a higher average score in mathematics than students who reported that their parents completed some college and, in turn, these students had a higher score than students whose parents had no more than a high school education (figure 17).

The pattern in science is similar to mathematics in 1999. As the level of parental education rises, so do the test scores of students. On average, in science, eighth-grade students whose parents had completed college outperformed students whose parents had attended some college and these students, in turn, outperformed students whose parents had no more than a high school education (figure 17).

The TIMSS–R results indicate that as parental education levels increased so did the mathematics and science performance of U.S. eighth-grade students. The relationship between level of parental education and the educational achievement of children is well-documented (Sewell, Hauser, and Wolf 1976; Featherman 1981; Riordan 1997; NCES 1997a and 1997b).

The Mathematics and Science Achievement of Eighth-Graders Between 1995 and 1999

This section presents results for the 23 nations with comparable data that participated at the eighth grade in both TIMSS and TIMSS–R.[10] To compare the performance of eighth-grade students on TIMSS and TIMSS–R, both eighth-grade assessments used the same scale.[11]

Did the performance of U.S. eighth-graders change between 1995 and 1999?

For the 23 nations that participated in both TIMSS and TIMSS–R, there was little change in mathematics average scores over the 4-year period. There was no change in eighth-grade mathematics achievement between 1995 and 1999 in the United States as well as 18 other nations (figure 18).[12] Three nations—Canada, Cyprus, and Latvia-LSS—showed an increase in overall mathematics achievement between 1995 and 1999. One nation, the Czech Republic, experienced a decrease in overall achievement over the

[10]Twenty-six nations participated in TIMSS and TIMSS–R at the eighth grade. Of the 26 nations, 3 nations experienced significant irregularities in their participation in 1995: Israel, South Africa, and Thailand. Findings for the other 23 nations are reported here. Results for the 3 nations that experienced irregularities are provided in appendix 3, tables A3.10 and A3.11.

[11]The national averages presented here for the TIMSS grade 8 assessment differ a little from the averages appearing in previous TIMSS reports published over the past several years. This is a result of rescaling the TIMSS 1995 grade 8 data to allow for reliable comparisons to the TIMSS–R 1999 grade 8 data.

[12]The finding that there has been no change in the overall mathematics score from 1995, when the United States performed at the international average, to 1999, when the United States performed above the international average, may appear to be inconsistent. However, readers are cautioned from drawing conclusions based on the relative position of the United States in comparison to the international average for all 42 nations in 1995 and all 38 nations in 1999. A more accurate analysis of change in achievement over the 4 years is the one presented above: a comparison between only the 23 nations that participated in both 1995 and 1999, and the international average of scores for these nations.

same period.[13] The reader is cautioned against comparing the relative change in one nation to the relative change in another nation.

In the United States and 17 other nations, there was no change in the science achievement score of eighth-graders between 1995 and 1999. Four nations documented an increase in science

Figure 18.—Comparisons of eighth-grade mathematics achievement, by nation: 1995 and 1999

Nation	1995 average	1999 average	1995–1999 difference[3]
(Latvia-LSS)[1]	488	505	17 ▲
Canada	521	531	10 ▲
Cyprus	468	476	9 ▲
Hong Kong SAR	569	582	13 ●
(Netherlands)	529	540	11 ●
(Lithuania)[2]	472	482	10 ●
United States	492	502	9 ●
Belgium-Flemish	550	558	8 ●
Korea, Republic of	581	587	6 ●
(Australia)	519	525	6 ●
Hungary	527	532	5 ●
Iran, Islamic Republic of	418	422	4 ●
Russian Federation	524	526	2 ●
Slovak Republic	534	534	0 ●
(Slovenia)	531	530	-1 ●
(Romania)	474	472	-1 ●
(England)	498	496	-1 ●
Japan	581	579	-2 ●
Singapore	609	604	-4 ●
Italy	491	485	-6 ●
New Zealand	501	491	-10 ●
(Bulgaria)	527	511	-16 ●
Czech Republic	546	520	-26 ▼
International average of 23 nations	519	521	2 ●

▲ The 1999 average is significantly higher than the 1995 average
● The 1999 average does not differ significantly from the 1995 average
▼ The 1999 average is significantly lower than the 1995 average

[1]Designated LSS because only Latvian-speaking schools were tested.

[2]Lithuania tested the same cohort of students as other nations, but later in 1999, at the beginning of the next school year.

[3]Difference is calculated by subtracting the 1995 score from the 1999 score. Detail may not sum to totals due to rounding.

NOTE: Eighth grade in most nations. See appendix 2 for details.
Parentheses indicate nations not meeting international sampling and/or other guidelines in 1995, 1999, or both years. See appendix 2 for details regarding 1999 data. See NCES (1996) for details for 1995 data.
The international average is the average of the national averages of the 23 nations with approved sampling procedures.
The tests for significance take into account the standard error for the reported differences. Thus, a small difference between the 1995 and 1999 averages for one nation may be significant while a large difference for another nation may not be significant.
The 1995 scores are based on re-scaled data.

SOURCE: Mullis et al. (2000). *TIMSS 1999 International Mathematics Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 1.3. Chestnut Hill, MA: Boston College.

[13]In a separate analysis of just those 48 mathematics items (out of 155) in common between TIMSS and TIMSS–R, the same picture of overall eighth-grade mathematics achievement emerges. Results of this separate analysis revealed that 3 nations—Canada, Cyprus, and Latvia-LSS—experienced increases in their mathematics performance over the 4 years on the in-common items. One nation, the Czech Republic, experienced a decrease in its mathematics performance over the same period of time. The remaining 19 nations, including the United States, experienced no change in overall mathematics achievement on the set of 48 in-common items between TIMSS and TIMSS–R.

achievement between 1995 and 1999: Canada, Hungary, Latvia-LSS, and Lithuania (figure 19). One nation, Bulgaria, showed a decline in science over the 4 years.[14] Again, the reader is cautioned against comparing the relative change in one nation to the relative change in another nation.

Figure 19.—Comparisons of eighth-grade science achievement, by nation: 1995 and 1999

Nation	1995 average	1999 average	1995–1999 difference[3]
(Latvia-LSS)[1]	476	503	27 ▲
(Lithuania)[2]	464	488	25 ▲
Canada	514	533	19 ▲
Hungary	537	552	16 ▲
Hong Kong SAR	510	530	20 ●
(Australia)	527	540	14 ●
Cyprus	452	460	8 ●
Russian Federation	523	529	7 ●
(England)	533	538	5 ●
(Netherlands)	541	545	3 ●
Slovak Republic	532	535	3 ●
Korea, Republic of	546	549	3 ●
United States	513	515	2 ●
Belgium-Flemish	533	535	2 ●
(Romania)	471	472	1 ●
Italy	497	498	1 ●
New Zealand	511	510	-1 ●
Japan	554	550	-5 ●
(Slovenia)	541	533	-8 ●
Singapore	580	568	-12 ●
Iran, Islamic Republic of	463	448	-15 ●
Czech Republic	555	539	-16 ●
(Bulgaria)	545	518	-27 ▼
International average of 23 nations	518	521	3 ●

▲ The 1999 average is significantly higher than the 1995 average
● The 1999 average does not differ significantly from the 1995 average
▼ The 1999 average is significantly lower than the 1995 average

[1]Designated LSS because only Latvian-speaking schools were tested.

[2]Lithuania tested the same cohort of students as other nations, but later in 1999, at the beginning of the next school year.

[3]Difference is calculated by subtracting the 1995 score from the 1999 score. Detail may not sum to totals due to rounding.

NOTE: Eighth grade in most nations. See appendix 2 for details.
Parentheses indicate nations not meeting international sampling and/or other guidelines in 1995, 1999, or both years. See appendix 2 for details regarding 1999 data. See NCES (1996) for details for 1995 data.
The international average is the average of the national averages of the 23 nations with approved sampling procedures.

The tests for significance take into account the standard error for the reported differences. Thus, a small difference between the 1995 and 1999 averages for one nation may be significant while a large difference for another nation may not be significant.

The 1995 scores are based on re-scaled data.

SOURCE: Martin et al. (2000). *TIMSS 1999 International Science Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 1.3. Chestnut Hill, MA: Boston College.

[14]In a separate analysis of just those 48 science items (out of 143) in common between TIMSS and TIMSS–R, a similar picture of overall eighth-grade science achievement emerges. Results of this separate analysis revealed that 3 nations—Canada, Hungary, and Latvia-LSS—experienced increases in science performance over the 4 years on the in-common items. The remaining 20 nations—including the United States—experienced no change in overall mathematics achievement on the set of 48 in-common items between TIMSS and TIMSS–R.

In sum, eighth-grade mathematics and science scores in the United States showed no changes between 1995 and 1999. The lack of change in national averages over a relatively short period of 4 years may indicate that longer periods of monitoring achievement may be necessary to detect change. It may also indicate that change efforts implemented at the local level may not yet be impacting achievement measured at the national level. Of course, careful consideration of TIMSS and TIMSS–R data as well as other data on the teaching and learning of mathematics and science in middle school is needed to better address the possible reasons why change was not evident over the 4 years.

Did the percentage of U.S. students at or above the international top 10 percent benchmark change over the 4 years?

As was discussed earlier in this chapter, average achievement scores indicate how the average student performs, but reveal little about the performance of a nation's top students. The following analyses document changes in the percentages of students who scored at or above the international top 10 percent and top 25 percent benchmarks. Detailed information on changes in these two international benchmarks is provided in tables A3.12 (mathematics) and A3.13 (science) in appendix 3.

The percentage of U.S. eighth-graders who scored at or above the international top 10 percent benchmark of students in mathematics showed no change between 1995 and 1999. None of the other 22 nations documented a change either. The 1999 top 10 percent cut-off score was 616 in mathematics. Applied to the 1995 TIMSS data, 6 percent of U.S. eighth-graders scored 616 or higher in mathematics in 1995, placing them among the top 10 percent of all students internationally.[15] In 1999, this percentage was 9 percent (figure 20).

[15] Readers may note that previous reports on TIMSS indicated that 5 percent of U.S. eighth-grade students were included among all students internationally who scored at or above the international top 10 percent benchmark in mathematics, whereas the percentage reported here is 6 percent. This difference is due to the way that the percentage of students in mathematics in 1995 is calculated for comparative purposes. To compare the percentage of students who scored at or above the international top 10 percent benchmark in mathematics in 1995 to those in 1999, the score point used to determine the top 10 percent in 1999 was also applied to the 1995 data. This, of course, was not the case when the data was initially reported for TIMSS. This procedure was applied to the science data as well.

Figure 20.—Comparisons of percentages of eighth-grade mathematics students reaching the TIMSS-R 1999 top 10 percent in mathematics achievement, by nation: 1995 and 1999

Nation	1995 percentage of students	1999 percentage of students	1995–1999 difference[3]
Hong Kong SAR	28	33	5 ●
Belgium-Flemish	19	23	4 ●
Canada	9	12	3 ●
United States	6	9	3 ●
Hungary	13	16	3 ●
(Latvia-LSS)[1]	5	7	3 ●
(Netherlands)	12	14	3 ●
(Slovenia)	13	15	2 ●
Russian Federation	12	15	2 ●
Korea, Republic of	36	37	2 ●
(Australia)	11	12	1 ●
(Lithuania)[2]	3	4	1 ●
Iran, Islamic Republic of	0	1	0 ●
(Romania)	5	5	0 ●
Singapore	46	46	0 ●
(England)	8	7	0 ●
New Zealand	8	8	0 ●
Japan	34	33	0 ●
Cyprus	4	3	-1 ●
Slovak Republic	14	14	-1 ●
Italy	7	6	-1 ●
Czech Republic	19	11	-8 ●
(Bulgaria)	19	11	-8 ●
International average of 23 nations	14	15	1 ●

▲ The 1999 average is significantly higher than the 1995 average
● The 1999 average does not differ significantly from the 1995 average
▼ The 1999 average is significantly lower than the 1995 average

[1]Designated LSS because only Latvian-speaking schools were tested.

[2]Lithuania tested the same cohort of students as other nations, but later in 1999, at the beginning of the next school year.

[3]Difference is calculated by subtracting the 1995 score from the 1999 score. Detail may not sum to totals due to rounding.

NOTE: Eighth grade in most nations. See appendix 2 for details.
Parentheses indicate nations not meeting international sampling and/or other guidelines in 1995, 1999, or both years. See appendix 2 for details regarding 1999 data. See NCES (1996) for details for 1995 data.
The international average is the average of the national averages of the 23 nations with approved sampling procedures.
1995 scores are based on re-scaled data.
1995 percentage of students reaching the top 10 percent is based on 1999 top 10 percent calculations.

SOURCE: Mullis et al. (2000). *TIMSS 1999 International Mathematics Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 1.7. Chestnut Hill, MA: Boston College.

As in mathematics, the percentage of U.S. eighth-graders who scored at or above the international top 10 percent benchmark of students in science showed no change between 1995 and 1999. The 1999 top 10 percent cut-off score was 616 in science. Applied to the 1995 TIMSS data, 13 percent of U.S. eighth-graders scored 616 or higher in science in 1995, placing them among the top 10 percent of all students internationally. In 1999, this percentage was 15 percent (figure 21). Among the 22 other nations that participated in TIMSS and TIMSS-R at the eighth-grade level, only 2 nations showed a change in the proportion of students scoring at or above the international top 10 percent benchmark over the same four-year period: Hungary documented an increase while Bulgaria documented a decrease.

Figure 21.—Comparisons of percentages of eighth-grade science students reaching the TIMSS-R 1999 top 10 percent in science achievement, by nation: 1995 and 1999

Nation	1995 percentage of students	1999 percentage of students	1995–1999 difference[3]
Hungary	14	22	8 ▲
Russian Federation	13	17	4 ●
Canada	11	14	3 ●
(Latvia-LSS)[1]	4	7	3 ●
(Lithuania)[2]	3	6	3 ●
(Australia)	17	19	3 ●
(England)	17	19	2 ●
United States	13	15	2 ●
Korea, Republic of	20	22	2 ●
(Netherlands)	15	16	1 ●
Italy	7	8	1 ●
Hong Kong SAR	9	10	1 ●
Iran, Islamic Republic of	2	2	0 ●
New Zealand	11	12	0 ●
(Romania)	6	6	0 ●
(Slovenia)	16	16	0 ●
Cyprus	3	2	0 ●
Slovak Republic	15	14	0 ●
Belgium-Flemish	12	11	-1 ●
Singapore	33	32	-1 ●
Japan	21	19	-2 ●
Czech Republic	21	17	-4 ●
(Bulgaria)	24	14	-10 ▼
International average of 23 nations	13	14	1 ●

▲ The 1999 average is significantly higher than the 1995 average

● The 1999 average does not differ significantly from the 1995 average

▼ The 1999 average is significantly lower than the 1995 average

[1]Designated LSS because only Latvian-speaking schools were tested.

[2]Lithuania tested the same cohort of students as other nations, but later in 1999, at the beginning of the next school year.

[3]Difference is calculated by subtracting the 1995 score from the 1999 score. Detail may not sum to totals due to rounding.

NOTE: Eighth grade in most nations. See appendix 2 for details.
Parentheses indicate nations not meeting international sampling and/or other guidelines in 1995, 1999, or both years. See appendix 2 for details regarding 1999 data. See NCES (1996) for details for 1995 data.
The international average is the average of the national averages of the 23 nations with approved sampling procedures.
1995 scores are based on re-scaled data.
1995 percentage of students reaching the top 10 percent is based on 1999 top 10 percent calculations.

SOURCE: Martin et al. (2000). *TIMSS 1999 International Science Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 1.7. Chestnut Hill, MA: Boston College.

Did the percentage of U.S. students at or above the international top 25 percent benchmark change over the 4 years?

The percentage of U.S. eighth-graders who scored at or above the international top 25 percent benchmark of students in mathematics showed no change between 1995 and 1999. The 1999 international top 25 percent cut-off score was 555 in mathematics. Applied to the 1995 TIMSS data, 24 percent of U.S. eighth-graders scored 555 or higher in mathematics in 1995, placing them among the top 25 percent of all students internationally.[16] In 1999, this percentage was 28 percent. Only one nation showed a change in the percentage of its students who scored at or above the international top 25 benchmark over this same period of time—the Czech Republic documented a decrease.

The percentage of U.S. eighth-graders who scored at or above the international top 25 percent benchmark of students in science showed no change between 1995 and 1999. The 1999 international top 25 percent cut-off score was 558 in science. Applied to the 1995 TIMSS data, 34 percent of U.S. eighth-graders scored 558 or higher in science in 1995, placing them among the top 25 percent of all students internationally. In 1999, this percentage was also 34 percent. Four nations—Canada, Hungary, Latvia-LSS, and Lithuania—showed an increase in the percentage of students who scored at or above the international top 25 benchmark over this same period of time.

Did the performance of U.S. eighth-graders in the content areas change between 1995 and 1999?

Comparisons of performance on the mathematics and science content areas can be made among the 23 nations that participated in TIMSS and TIMSS–R at the eighth-grade level. Detailed information on changes in performance in the mathematics and science content areas between 1995 and 1999 is provided in tables A3.14 and A3.15 in appendix 3.

In the five mathematics content areas in common between TIMSS and TIMSS–R, there was no change in the performance of U.S. eighth-graders nor of their peers in most of the other 22 nations. However, Canada and Latvia-LSS documented increases in performance in four of the five mathematics content areas over the 4-year period: *fractions and number sense*; *data representation, analysis and probability*; *geometry*; and *algebra*. No nation showed a change in the performance of its students in *measurement*. On the other hand, the Czech Republic showed a decrease in three content areas: *fractions and number sense*; *geometry*; and *algebra*. The only other nation to show a decrease over the four years was Bulgaria in the area of *data representation, analysis, and probability*.

In the four science content areas in common between TIMSS and TIMSS–R,[17] there was no change in the performance of U.S. eighth-graders nor of their peers in most of the other 22 nations. Only one nation, Canada, recorded an increase in the performance of its eighth-graders in all four science content areas over the 4 years. Hungary and Latvia-LSS showed increases in the performance of their students in two of the four science content areas. The Czech Republic and Slovak Republic experienced decreases in *physics* over the same four years, and Slovenia documented a decrease in *earth science*.

[16]To compare the percentage of students who scored at or above the international top 25 percent benchmarks in mathematics and science in 1995 to those in 1999, the score point used to determine the top 25 percent in 1999 was also applied to the 1995 data.

[17]The TIMSS–R science assessment reflects the inclusion of 10 new items in the areas of *environmental and resource issues*, and *scientific inquiry and the nature of science*. In TIMSS, these areas were reported as a single content area. Therefore, there are four science content areas in common between the two studies that can be reported.

Did the performance of U.S. population groups change between 1995 and 1999?

TIMSS and TIMSS–R data for several population groups showed an increase in performance between 1995 and 1999 in mathematics and science.[18] U.S. eighth-grade black students showed an increase in their mathematics achievement over the 4 years. Students whose parents were both U.S. born also showed an increase in mathematics achievement between 1995 and 1999. Students whose mothers or fathers attended some college or completed college also showed an increase in their mathematics performance over the 4 years. Finally, U.S. eighth-grade students whose mothers or fathers completed college showed an increase in science achievement over the 4 years (figure 22). There was no change found for the other groups of students shown in figure 22 over the 4 years in mathematics or science.

Figure 22.—Changes in U.S. eighth-grade mathematics and science achievement, by U.S. selected characteristics: 1995 and 1999

MATHEMATICS	1995 average	1999 average	1995–1999 difference*
Sex			
Boys	495	505	10 ●
Girls	490	498	8 ●
Race/ethnicity			
White students	516	525	9 ●
Black students	419	444	25 ▲
Hispanic students	443	457	14 ●
National origin of parents			
Both U.S. born	496	510	13 ▲
Both foreign born	474	477	2 ●
1 U.S. born, 1 foreign born	482	496	13 ●
Mother's education			
High school or less	479	484	6 ●
Some college	498	511	13 ▲
Completed college	511	539	27 ▲
Father's education			
High school or less	474	482	8 ●
Some college	498	512	14 ▲
Completed college	515	543	28 ▲

SCIENCE	1995 average	1999 average	1995–1999 difference*
Sex			
Boys	520	524	5 ●
Girls	505	505	0 ●
Race/ethnicity			
White students	544	547	3 ●
Black students	422	438	16 ●
Hispanic students	446	462	16 ●
National origin of parents			
Both U.S. born	521	527	6 ●
Both foreign born	465	472	6 ●
1 U.S. born, 1 foreign born	498	509	11 ●
Mother's education			
High school or less	497	499	2 ●
Some college	522	525	3 ●
Completed college	531	554	23 ▲
Father's education			
High school or less	494	495	1 ●
Some college	521	529	8 ●
Completed college	534	560	25 ▲

▲ The 1999 average is significantly higher than the 1995 average
● The 1999 average is not significantly different from the 1995 average
▼ The 1999 average is significantly below the 1995 average

*Difference is calculated by subtracting the 1995 average from the 1999 average. Detail may not sum to totals due to rounding.

NOTE: Other factors are not controlled for in these analyses.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Third International Mathematics and Science Study–Repeat (TIMSS–R), unpublished tabulations, 1999.

[18]The U.S. sample for TIMSS did not include sufficient numbers of nonpublic school students to reliably calculate achievement scores for this group.

THE MATHEMATICS AND SCIENCE ACHIEVEMENT OF THE 1995 FOURTH-GRADE COHORT IN 1999

TIMSS and other studies before it have suggested that the international performance of the United States relative to other nations appears lower at grade 8 in both mathematics and science than at grade 4. TIMSS–R provides data about the cohort of fourth-grade students in 1995 in comparison to the cohort of eighth-grade students four years later in 1999. However, direct comparisons between the 1995 fourth-grade assessment and the 1999 eighth-grade assessment are complicated by several factors: First, the fourth-grade and eighth-grade assessments include different test questions. By necessity, the kind of mathematics and science items that can be asked of an eighth-grader may be inappropriate for a fourth-grader. Second, because mathematics and science differ between the two grades, the content areas assessed also differ. That is, geometry and physics at grade 4 are different from geometry and physics at grade 8, for example. Without a sufficient set of in-common test items between the grade 4 and grade 8 assessments, it can be difficult to construct a reliable and meaningful scale on which to compare the 1995 fourth-graders to 1999 eighth-graders. Thus, for purposes of this report, comparisons between fourth and eighth grade are based on the performance relative to the international average of the 17 nations that participated in fourth-grade TIMSS and eighth-grade TIMSS–R.

Has the relative performance of the United States changed between fourth and eighth grade over the 4 years?

Figures 23 and 24 display a comparison of the average scores of the 17 nations between fourth-grade TIMSS and eighth-grade TIMSS–R to the international averages at both grades for each subject. The numbers shown in the figures are differences from the international average for the 17 nations. Nations are sorted into three groups: above the international average; similar to the international average; and below the international average.

In mathematics, the U.S. fourth-grade score in 1995 was similar to the international average of the 17 nations in common between fourth-grade TIMSS and eighth-grade TIMSS–R. At the eighth grade in 1999, the U.S. average in mathematics was below the international average of the 17 nations. Thus, U.S. fourth-graders performed at the international average in 1995 and U.S. eighth-graders performed below the international average in 1999 in mathematics, suggesting that the relative performance of the cohort of 1995 U.S. fourth-graders in mathematics was lower relative to this group of nations 4 years later. The data also suggest that, in mathematics, the relative performance of the cohort of 1995 fourth-graders in Canada was higher relative to this group of nations in 1999; the relative performance of the cohort of 1995 fourth-graders in the Czech Republic, Italy, and the Netherlands was lower relative to this group of nations 4 years later; and the relative performance of the cohort of 1995 fourth-graders in the 12 other nations was unchanged relative to this group of nations 4 years later.

Figure 23.—Mathematics achievement for TIMSS-R 1999 nations that participated in 1995 at both the fourth and eighth grades relative to the average across these nations

1995 Fourth grade — Difference from average across 17 nations[1]	
Singapore	73
Korea, Republic of	63
Japan	50
Hong Kong SAR	40
(Netherlands)	32
Czech Republic	23
(Slovenia)	8
(Hungary)	4
United States	0
(Australia)	0
(Italy)	-7
Canada	-12
(Latvia-LSS)[2]	-18
(England)	-33
Cyprus	-42
New Zealand	-48
Iran, Islamic Republic of	-130
International average of 17 nations	517

1999 Eighth grade — Difference from average across 17 nations[1]	
Singapore	80
Korea, Republic of	63
Hong Kong SAR	58
Japan	55
Netherlands	16
Hungary	8
Canada	7
Slovenia	6
Australia	1
Czech Republic	-4
Latvia-LSS[2]	-19
United States	-22
England	-28
New Zealand	-33
Italy	-39
Cyprus	-48
Iran, Islamic Republic of	-102
International average of 17 nations	524

Average is significantly higher than the international average
Average does not differ significantly from the international average
Average is significantly lower than the international average

[1]Difference is calculated by subtracting the international average of the 17 nations from the national average of each nation.

[2]Designated LSS because only Latvian-speaking schools were tested.

NOTE: Fourth and eighth grade in most nations. See appendix 2 for details.

Parentheses indicate nations not meeting international sampling and/or other guidelines at fourth grade in 1995. See NCES (1997c) for details.

The international average is the average of the national averages of the 17 nations.

SOURCE: Mullis et al. (2000). *TIMSS 1999 International Mathematics Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 1.4. Chestnut Hill, MA: Boston College.

In science, the U.S. fourth-grade score in 1995 was above the international average of the 17 nations in common between fourth-grade TIMSS and eighth-grade TIMSS–R. At the eighth grade in 1999, the U.S. average in science was similar to the international average of the 17 nations. Thus, U.S. fourth-graders performed above the international average in 1995 and U.S. eighth-graders performed similar to the international average in 1999 in science. As in mathematics, this suggests that the relative performance of the cohort of U.S. fourth-graders in science was lower relative to this group of nations 4 years later. The data also suggest that, in science, the relative performance of the cohort of 1995 fourth-graders in Singapore and Hungary was higher relative to this group of nations in 1999; the relative performance of the cohort of 1995 fourth-graders in Italy and the New Zealand was lower relative to this group of nations 4 years later; and the relative performance of the cohort of 1995 fourth-graders in the 12 other nations was unchanged relative to this group of nations 4 years later.

The available evidence appears to confirm what had been suggested 4 years ago: that the relative performance of U.S. students in mathematics and science is lower at the eighth grade than at the fourth grade among this group of nations.

Figure 24.—Science achievement for TIMSS-R 1999 nations that participated in 1995 at both the fourth and eighth grades relative to the average across these nations

1995 Fourth grade: Difference from average across 17 nations[1]	
Korea, Republic of	62
Japan	39
United States	28
(Australia)	28
Czech Republic	18
(Netherlands)	17
(England)	14
Canada	12
(Italy)	10
Singapore	10
(Slovenia)	8
Hong Kong SAR	-6
(Hungary)	-6
New Zealand	-9
(Latvia-LSS)[2]	-27
Cyprus	-64
Iran, Islamic Republic of	-134
International average of 17 nations	514

1999 Eighth grade: Difference from average across 17 nations[1]	
Singapore	44
Hungary	28
Japan	25
Korea, Republic of	24
Netherlands	21
Australia	16
Czech Republic	15
England	14
Slovenia	9
Canada[3]	9
Hong Kong SAR	5
United States	-9
New Zealand	-15
Latvia-LSS[2]	-21
Italy	-26
Cyprus	-64
Iran, Islamic Republic of	-76
International average of 17 nations	524

Average is significantly higher than the international average
Average does not differ significantly from the international average
Average is significantly lower than the international average

[1]Difference is calculated by subtracting the international average of the 17 nations from the national average of each nation.

[2]Designated LSS because only Latvian-speaking schools were tested.

[3]The shading of Canada in eighth grade may appear incorrect; however, statistically, its placement in correct.

NOTE: Fourth and eighth grade in most nations. See appendix 2 for details.
Parentheses indicate nations not meeting international sampling and/or other guidelines at fourth grade in 1995. See NCES (1997c) for details.
The international average is the average of the national averages of the 17 nations.

SOURCE: Martin et al. (2000). *TIMSS 1999 International Science Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade.* Exhibit 1.4. Chestnut Hill, MA: Boston College.