Highlights From TIMSS and TIMSS Advanced 2015

Mathematics and Science Achievement of U.S. Students in Grades 4 and 8 and in Advanced Courses at the End of High School in an International Context

NCES 2017-002

U.S. DEPARTMENT OF EDUCATION

ies NATIONAL CENTER FOR EDUCATION STATISTICS

Institute of Education Sciences

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Introduction

What is TIMSS?

The Trends in International Mathematics and Science Study (TIMSS) is an international comparative study designed to measure trends in mathematics and science achievement at the fourth and eighth grades, as well as to collect information about educational contexts (such as students' schools, teachers, and homes) that may be related to student achievement. TIMSS has been administered every 4 years since 1995, with the sixth and most recent administration, in 2015, providing a 20-year trendline. The United States has participated in every administration of TIMSS, which includes 1995, 1999, 2003, 2007, 2011, and 2015 for the eighth grade and all but 1999 for the fourth grade (when it was not administered internationally). TIMSS is designed to align broadly with mathematics and science curricula in the participating education systems and, therefore, to reflect students' school-based learning. Because it is an international study, TIMSS provides valuable benchmarking information on how U.S. students compare to students around the world.

What is TIMSS Advanced?

TIMSS Advanced is an international comparative study designed to measure the advanced mathematics and physics achievement of students in their final year of high school who are taking or have taken advanced courses. TIMSS Advanced also collects information about educational contexts (such as schools and teachers) that may be related to advanced students' achievement. TIMSS Advanced was administered previously, in 1995 and in 2008, and most recently in 2015. The United States participated in the 1995 and 2015 administrations. Like TIMSS, TIMSS Advanced is designed to align broadly with curricula in the participating education systems and, therefore, to reflect students' school-based learning of advanced mathematics and physics. TIMSS Advanced can inform policymakers, researchers, educators, and the public about the degree to which students in the United States excel in advanced mathematics and physics and may be prepared to undertake more specialized study in science, technology, engineering, and mathematics compared to their international peers.

TIMSS and TIMSS Advanced are both sponsored by the International Association for the Evaluation of Educational Achievement (IEA) and conducted, in the United States, by the National Center for Education Statistics (NCES) in the Institute of Education Sciences within the U.S. Department of Education. This report focuses on the U.S. results in an international context. For additional results and information, see the accompanying resources available at http://nces.ed.gov/timss/, including more detailed descriptions of the assessments, key findings, data tables of results, and technical notes. An abbreviated version of the technical notes is provided in the appendix to this report.

A New Approach to Reporting

TIMSS results are now easier than ever to access, with tables, figures, reports, and more available on the TIMSS 2015 website, at http://nces.ed.gov/timss/. The results from TIMSS and TIMSS Advanced 2015 that are highlighted in this report can be explored in more detail at the site above, or by using the International Data Explorer at http://nces.ed.gov/surveys/international/ide/ to create customized tables and charts using international data.

To stay up to date with the latest results from TIMSS, TIMSS Advanced, and other international assessments, follow us on Twitter @EdNCES.

What knowledge and skills are assessed?

The TIMSS and TIMSS Advanced assessments are developed through an international collaborative process involving input from U.S. and international experts in mathematics, science, and measurement. These experts develop assessment frameworks that define the knowledge and skills assessed.

TIMSS

The TIMSS assessments measure students' knowledge and skills in mathematics and science and their ability to apply their knowledge in problem-solving situations. At each grade, students respond to multiple-choice and constructed-response items (or questions) designed to measure what they know and can do across specific ***content*** domains in mathematics and science (table 1a).

Table 1a. Content domains in TIMSS

	Mathematics	Science
Grade 4	Number Geometric shapes and measures Data display	Life science Physical science Earth science
Grade 8	Number Algebra Geometry Data and chance	Biology Chemistry Physics Earth science

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2015.

The assessment items across these content domains measure what students in both grades can do across a range of ***cognitive*** skills or processes: *knowing, applying,* and *reasoning.* The TIMSS science framework also describes science inquiry practices to be measured. The complete subject area frameworks for TIMSS 2015 are available on the TIMSS international website at http://timssandpirls.bc.edu/timss2015/frameworks.html.

TIMSS Advanced

The TIMSS Advanced assessments measure students' knowledge and skills in advanced mathematics and physics and their ability to apply their knowledge in problem-solving situations. Students respond to multiple-choice and constructed-response items designed to measure what they know and can do across specific ***content*** domains in each subject (table 1b).

Table 1b. Content domains in TIMSS Advanced

Advanced mathematics	Physics
Algebra	Mechanics and thermodynamics
Calculus	Electricity and magnetism
Geometry	Wave phenomena and atomic/nuclear physics

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS) Advanced, 2015.

The assessment items across these content domains measure what students can do across a range of ***cognitive*** skills or processes: *knowing, applying,* and *reasoning.* Like TIMSS, the TIMSS Advanced physics framework also describes the science inquiry practices to be measured. The complete subject area frameworks for TIMSS Advanced are available on the TIMSS international website at: http://timssandpirls.bc.edu/timss2015-advanced/frameworks.html.

Which countries participated in TIMSS and TIMSS Advanced?

A large and diverse group of education systems, spanning six of the world's continents, participated in TIMSS 2015 (see table 2). These education systems included 49 IEA member countries and six benchmarking participants[1] that participated in the fourth-grade assessment and 38 IEA member countries and six benchmarking participants that participated in the eighth-grade assessment. Nine education systems—all IEA member countries—participated in TIMSS Advanced 2015.

Table 2. Participation in TIMSS and TIMSS Advanced, by education system: 2015

Education system	TIMSS 2015		TIMSS Advanced	Education system	TIMSS 2015		TIMSS Advanced
	Grade 4	Grade 8	2015		Grade 4	Grade 8	2015
Armenia	✓	✓		Lithuania	✓	✓	
Australia	✓	✓		Malaysia		✓	
Bahrain	✓	✓		Malta		✓	
Belgium(Flemish)-BEL	✓			Morocco	✓	✓	
Bulgaria	✓			Netherlands	✓		
Canada	✓	✓		New Zealand	✓	✓	
Chile	✓	✓		Northern Ireland-GBR	✓		
Chinese Taipei-CHN	✓	✓		Norway	✓	✓	✓
Croatia	✓			Oman	✓	✓	
Cyprus	✓			Poland	✓		
Czech Republic	✓			Portugal	✓		✓
Denmark	✓			Qatar	✓	✓	
Egypt		✓		Russian Federation	✓	✓	✓
England-GBR	✓	✓		Saudi Arabia	✓	✓	
Finland	✓			Serbia	✓		
France	✓		✓	Singapore	✓	✓	
Georgia	✓	✓		Slovak Republic	✓		
Germany	✓			Slovenia	✓	✓	✓
Hong Kong-CHN	✓	✓		Spain	✓		
Hungary	✓	✓		Sweden	✓	✓	✓
Indonesia	✓			Thailand		✓	
Iran, Islamic Rep. of	✓	✓		Turkey	✓	✓	
Ireland	✓	✓		United Arab Emirates	✓	✓	
Israel		✓		United States	✓	✓	✓
Italy	✓	✓	✓	**Benchmarking participants**			
Japan	✓	✓		Abu Dhabi-UAE	✓	✓	
Jordan	✓	✓		Buenos Aires-ARG	✓	✓	
Kazakhstan	✓	✓		Dubai-UAE	✓	✓	
Korea, Rep. of	✓	✓		Florida-USA	✓	✓	
Kuwait	✓	✓		Ontario-CAN	✓	✓	
Lebanon		✓	✓	Quebec-CAN	✓	✓	

NOTE: Education systems that administered TIMSS at a grade other than the target grade are not shown in this table. Results for Armenia, which did participate in TIMSS 2015 at grades 4 and 8, are not shown in this report because their data are not comparable for trend analysis.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS) and TIMSS Advanced, 2015.

[1] IEA member countries include both "countries," which are complete, independent political entities, and non-national entities (e.g., England, Hong Kong, or the Flemish community of Belgium). Non-national entities are indicated in the tables and figures with the three-letter international abbreviation for their country following their name. Non-national entities that are not IEA member countries (e.g., Abu Dhabi or Buenos Aires) also may participate in TIMSS in order to assess their comparative international standing, and they are designated as "benchmarking participants." Benchmarking participants are included in figures and indicated by italics. One U.S. state (Florida) administered TIMSS as a benchmarking participant. For convenience, this report uses the generic term "education systems" when summarizing results. For additional background on terminology, see the textbox in the "About TIMSS 2015" description available on the NCES website at http://nces.ed.gov/timss/timss15.asp.

How are results reported in TIMSS and TIMSS Advanced?

TIMSS results are based on nationally representative samples of fourth- and eighth-grade students. TIMSS Advanced results are based on nationally representative samples of students in their final year of secondary school who are taking or have taken either advanced mathematics or physics courses; in the United States, the samples consist of twelfth-grade students. Advanced mathematics and physics courses are defined as those that cover most of the topics outlined in the respective frameworks.

Scale scores and percentiles

Both TIMSS and TIMSS Advanced achievement results are reported on a scale from 0 to 1,000, with a fixed scale centerpoint of 500[2] and a standard deviation of 100.[3] TIMSS and TIMSS Advanced provide average overall scale scores for mathematics and science (in the case of TIMSS) and advanced mathematics and physics (in the case of TIMSS Advanced), as well as subscale scores for the content and cognitive domains. This report focuses on the overall scales. Additionally, the report presents the distribution of student achievement—identifying the threshold (or cut) scores along the scale that correspond to the lowest 10 percent, lowest quarter, highest quarter, and top 10 percent of students (i.e., the 10th, 25th, 75th, and 90th percentiles).

International benchmarks

TIMSS and TIMSS Advanced international benchmarks provide a way to interpret the scale scores and to understand how students' proficiency varies at different points on the scales. Each successive point, or benchmark, is associated with the knowledge and skills that students successfully demonstrate at each level. TIMSS describes four benchmarks of achievement (*Advanced, High, Intermediate,* and *Low*) and TIMSS Advanced describes three benchmarks of achievement (*Advanced, High,* and *Intermediate*). This report presents the percentages of students reaching each benchmark of achievement (and the cutpoints for those benchmarks), along with detailed descriptions of the skills and knowledge demonstrated by students reaching each benchmark.

For additional results, as well as technical notes (such as on TIMSS Advanced frameworks, subscales, and sampling changes), see the resources at the TIMSS 2015 website: http://nces.ed.gov/timss/.

Comparisons across time

TIMSS has been administered five times (every 4 years) since the first assessment in 1995. In each administration, the framework is reviewed and updated to reflect developments in the field and in curricula, while at the same time ensuring comparability in sampling procedures and assessment items so that TIMSS results can be placed on the same scale and compared across time. Additionally, each successive administration of TIMSS since 1995 has been scaled so that the mean of the achievement distribution is 500, as it was originally set in 1995, and thus comparable across years. This report compares the 2015 results with those from all previous TIMSS assessment years, including—for a long-term perspective—the first TIMSS assessment in 1995.

TIMSS Advanced has been administered two times since the first assessment in 1995: in 2008 and 2015. However, the frameworks and sampling procedures changed after the first administration and thus this report focuses mainly on the results from 2015. Some data are provided—with cautions about their interpretation—about differences in performance between 1995 and 2015. (The United States did not participate in TIMSS Advanced 2008.)

[2] The TIMSS scale centerpoint is referred to as the "TIMSS scale average" in previous reports.

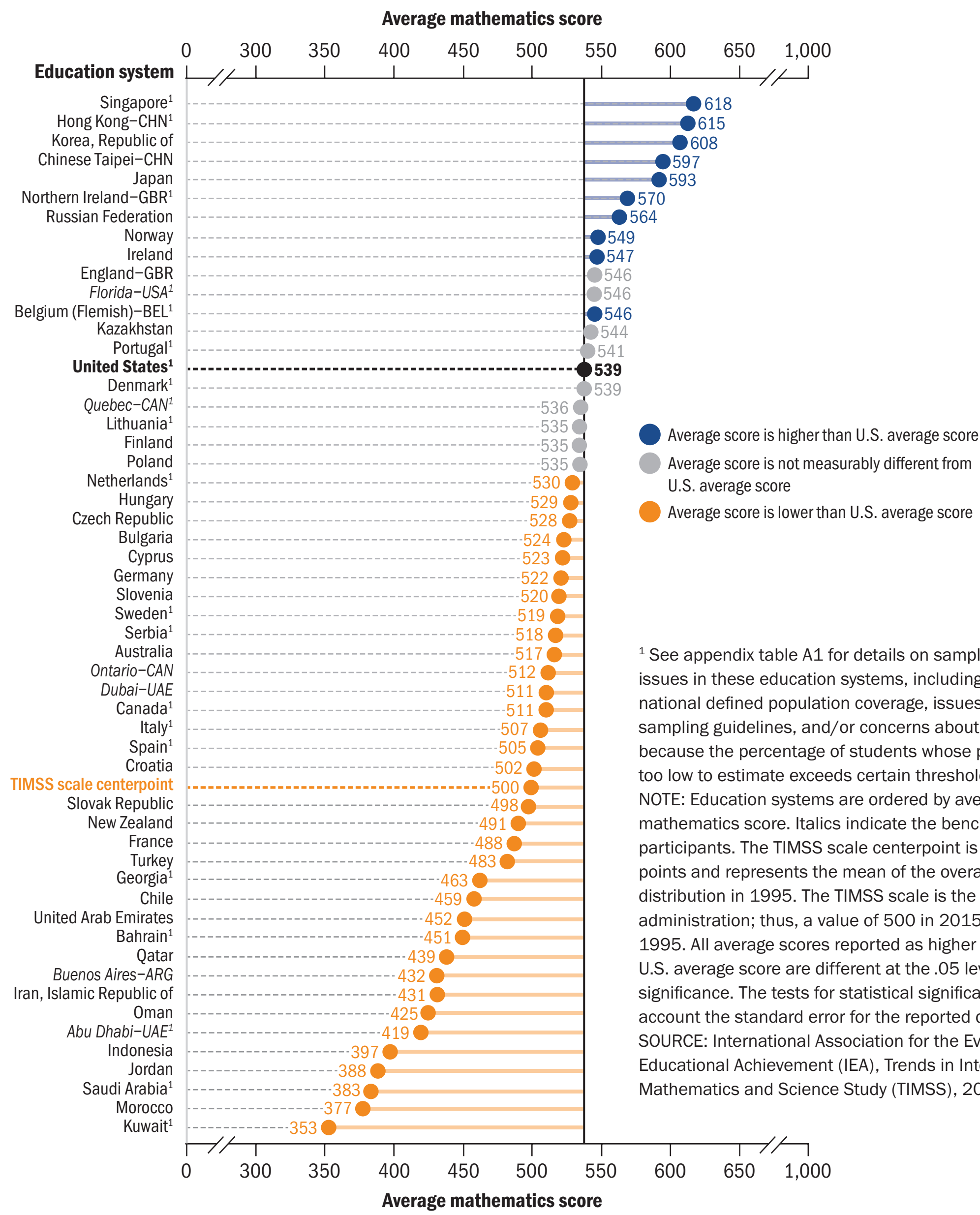
[3] All differences referenced in the text were tested using *t* tests and are significant at the .05 level. No adjustments were made for multiple comparisons.

Results from TIMSS 2015

How well do U.S. students perform in mathematics?

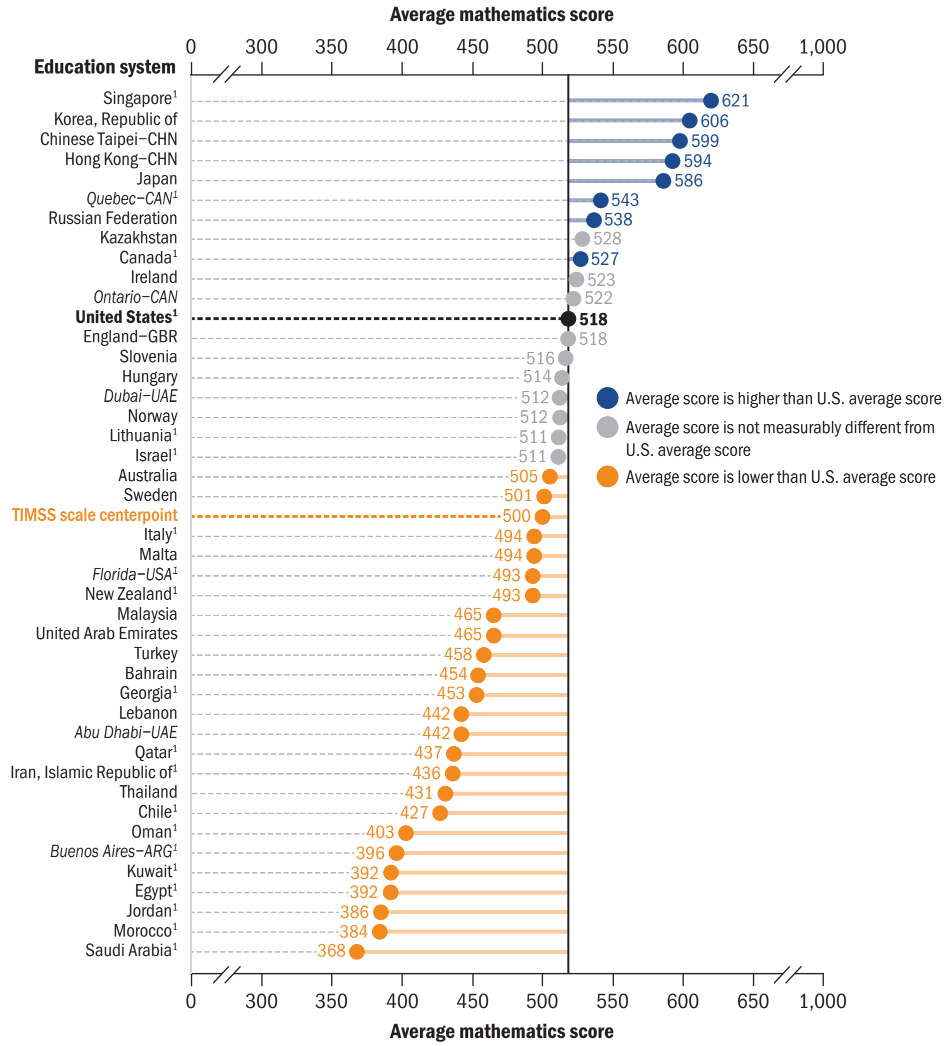
In 2015, U.S. fourth-graders' average score in mathematics was 539, which was higher than the average scores of students in 34 education systems and lower than the average scores of students in 10 education systems (figure 1a). U.S. eighth-graders' average score in mathematics was 518, which was higher than the average scores of students in 24 education systems and lower than the average scores of students in 8 education systems (figure 1b).

Figure 1a. Average mathematics scores of 4th-grade students, by education system: 2015



[1] See appendix table A1 for details on sampling or other issues in these education systems, including issues with the national defined population coverage, issues with satisfying sampling guidelines, and/or concerns about estimation because the percentage of students whose performance is too low to estimate exceeds certain thresholds.
NOTE: Education systems are ordered by average mathematics score. Italics indicate the benchmarking participants. The TIMSS scale centerpoint is set at 500 points and represents the mean of the overall achievement distribution in 1995. The TIMSS scale is the same in each administration; thus, a value of 500 in 2015 equals 500 in 1995. All average scores reported as higher or lower than the U.S. average score are different at the .05 level of statistical significance. The tests for statistical significance take into account the standard error for the reported difference.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2015.

Figure 1b. Average mathematics scores of 8th-grade students, by education system: 2015



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SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2015.

Explore student performance in detail

The TIMSS 2015 website provides more in-depth information on student achievement in mathematics and science, including data on content subscales, cognitive subscales, and different groups of U.S. students. Explore these results and more at http://nces.ed.gov/timss.

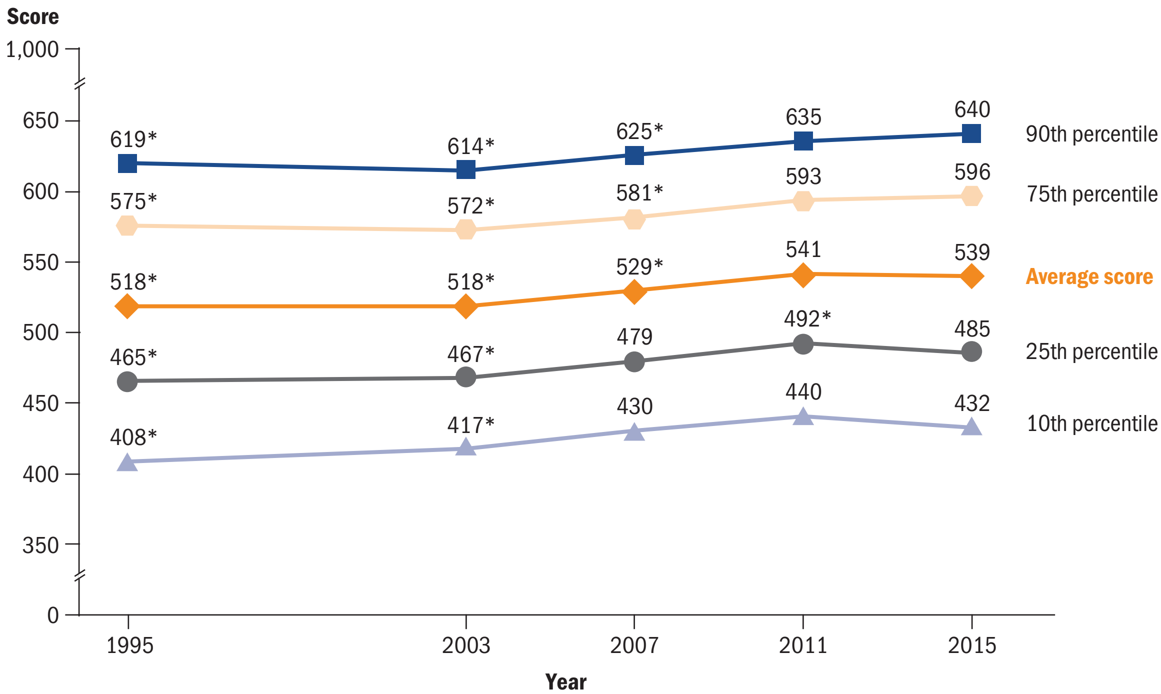
Are U.S. students making progress in mathematics?

U.S. fourth- and eighth-grade students have, on average, shown long-term improvement on the TIMSS mathematics assessments. Between 1995 and 2015, U.S. fourth-graders' average mathematics scores increased from 518 to 539 points (figure 2a, middle line). The fourth-grade average mathematics score in 2015 was also higher than in 2003 and 2007, but not measurably different from the most recent assessment in 2011.

Improvements in fourth-graders' mathematics scores were seen across the distribution of achievement over these 20 years. This is observed by examining the threshold (or cut) scores for the lowest 10 percent, lowest quarter, highest quarter, and highest 10 percent of students (i.e., at the 10th, 25th, 75th, and 95th percentiles).

In 2015, the mathematics cut scores of students at all of the selected percentiles were higher than in 1995 and 2003, and the cut scores of higher-performing students (i.e., at the 75th and 95th percentiles) were also higher than in 2007 (figure 2a). However, the mathematics cut score of students at the 25th percentile was lower in 2015 than in 2011.

Figure 2a. Trends in U.S. 4th-grade students' average mathematics scores and cut scores at the 10th, 25th, 75th, and 90th percentiles: 1995, 2003, 2007, 2011, and 2015



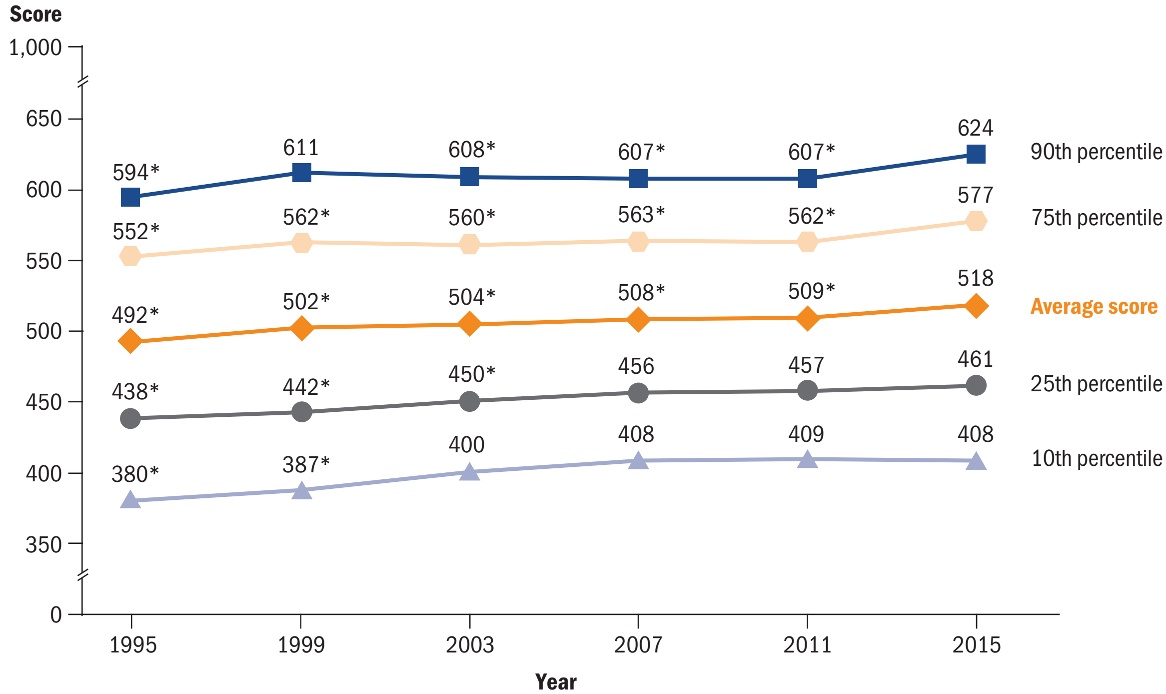
* Score is statistically different from the 2015 score (*p* < .05).
NOTE: TIMSS was not administered at the fourth grade in 1999. See appendix tables A1 and A2 for details on coverage and sampling issues in the United States for 2015 and earlier years, respectively.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 1995, 2003, 2007, 2011, and 2015.

MATHEMATICS

U.S. eighth-graders' average mathematics score also increased between 1995 and 2015 from 492 to 518 points (figure 2b, middle line). The eighth-grade average mathematics score in 2015 was higher than in any prior administration of TIMSS (1995, 1999, 2003, 2007, or 2011).

This was also true for students at the 75th percentile, for whom the 2015 mathematics cut score was higher than in any prior administration (figure 2b). The cut score of the highest-performing students (i.e., at the 90th percentile) in 2015 was higher than those in most prior administrations (1995, 2003, 2007, and 2011). However, among lower-performing students (i.e., at the 10th and 25th percentiles), there was no measurable difference from 2007 or 2011 to 2015, though the cut scores for the lower-performing students were higher in 2015 than in 1995 and 1999.

Figure 2b. Trends in U.S. 8th-grade students' average mathematics scores and cut scores at the 10th, 25th, 75th, and 90th percentiles: 1995, 1999, 2003, 2007, 2011, and 2015



* Score is statistically different from the 2015 score ($p < .05$).
NOTE: See appendix tables A1 and A2 for details on coverage and sampling issues in the United States for 2015 and earlier years, respectively.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 1995, 1999, 2003, 2007, 2011, and 2015.

What level of mathematics knowledge and skills have U.S. fourth- and eighth-grade students achieved?

TIMSS defines four levels of student achievement, referred to as international benchmarks: *Advanced, High, Intermediate,* and *Low.* These international benchmarks provide a way to understand how students' proficiency in mathematics varies at different points on the TIMSS scale. Exhibit 1 describes what kinds of knowledge and skills students at each level would need to successfully answer the mathematics items at that level, as well as the score cutpoint for each level. (See chapter 2 of the international report, referenced below the exhibit, for example items at each level.)

Exhibit 1. Description of TIMSS international mathematics benchmarks, by grade: 2015

Benchmarks	4th grade	8th grade
Advanced (625)	***Students can apply their understanding and knowledge in a variety of relatively complex situations and explain their reasoning.*** They can solve a variety of multistep word problems involving whole numbers. Students at this level show an increasing understanding of fractions and decimals. They can apply knowledge of a range of two- and three-dimensional shapes in a variety of situations. They can interpret and represent data to solve multistep problems.	***Students can apply and reason in a variety of problem situations, solve linear equations, and make generalizations.*** They can solve a variety of fraction, proportion, and percent problems and justify their conclusions. Students can use their knowledge of geometric figures to solve a wide range of problems about area. They demonstrate understanding of the meaning of averages and can solve problems involving expected values.
High (550)	***Students can apply their knowledge and understanding to solve problems.*** They can solve word problems involving operations with whole numbers, simple fractions, and two-place decimals. Students demonstrate an understanding of geometric properties of shapes and angles that are less than or greater than a right angle. Students can interpret and use data in tables and a variety of graphs to solve problems.	***Students can apply their understanding and knowledge in a variety of relatively complex situations.*** They can use information to solve problems involving different types of numbers and operations. Students at this level show basic procedural knowledge related to algebraic expressions. They can solve a variety of problems with angles including those involving triangles, parallel lines, rectangles, and similar figures. Students can interpret data in a variety of graphs and solve simple problems involving outcomes and probabilities.
Intermediate (475)	***Students can apply basic mathematical knowledge in straightforward situations.*** They demonstrate an understanding of whole numbers and some understanding of fractions and decimals. Students can relate two- and three-dimensional shapes and identify and draw shapes with simple properties. They can read and interpret bar graphs and tables.	***Students can apply basic mathematics knowledge in straightforward situations.*** They can solve problems involving negative numbers, decimals, percentages, and proportions. Students have some knowledge of linear expressions and two- and three-dimensional shapes. They can read and interpret data in graphs and tables. They have some basic knowledge of chance.
Low (400)	***Students have some basic mathematical knowledge.*** They can add and subtract whole numbers, have some understanding of multiplication by one-digit numbers, and can solve simple word problems. They have some knowledge of simple fractions, geometric shapes, and measurement. Students can read and complete simple bar graphs and tables.	***Students have some knowledge of whole numbers and basic graphs.*** The few items at this level provide some evidence that students have an elementary understanding of whole numbers. They can match tables to bar graphs and pictographs.

SOURCE: Mullis, I.V.S., Martin, M.O., Foy, P., and Hooper, M. (2016). *TIMSS 2015 International Results in Mathematics.* Retrieved from http://timssandpirls.bc.edu/timss2015/international-results/.

In 2015, at both the fourth and eighth grades, higher percentages of U.S. students reached each of the four TIMSS international benchmarks in mathematics than the international medians (figures 3a and 3b).[4]

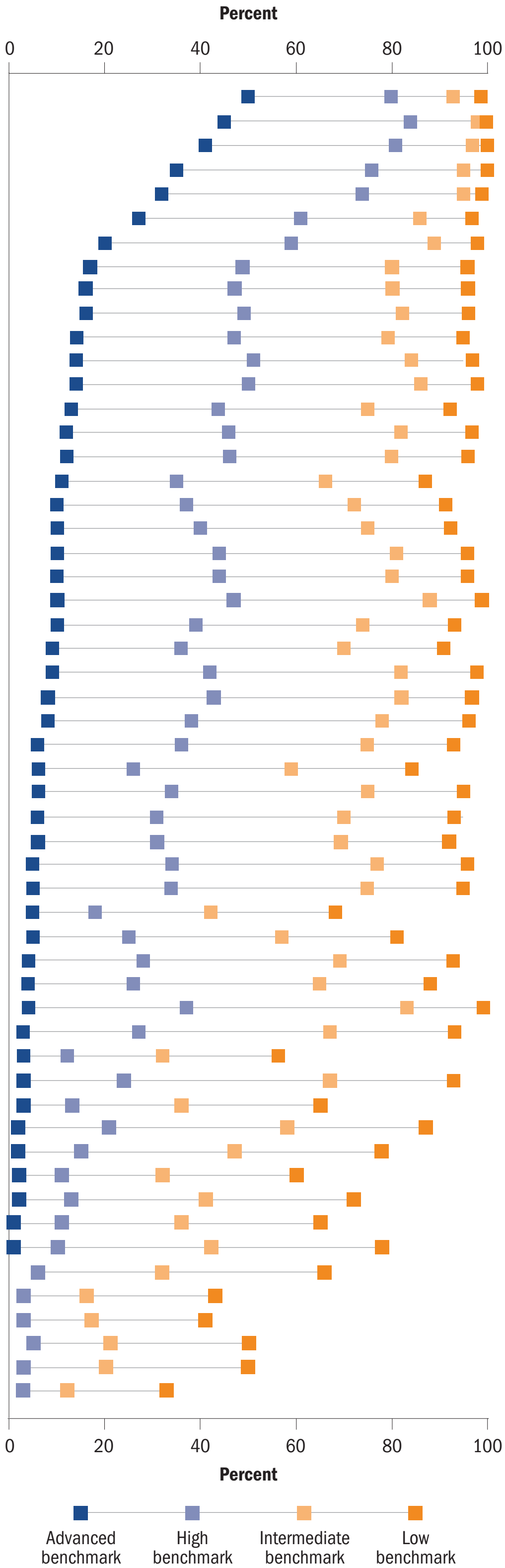
At the fourth grade, 14 percent of U.S. students reached the *Advanced* international benchmark in mathematics, 47 percent reached the *High* benchmark, 79 percent reached the *Intermediate* benchmark, and 95 percent reached the *Low* benchmark (figure 3a). At the eighth grade, 10 percent of U.S. students reached the *Advanced* international benchmark in mathematics, 37 percent reached the *High* benchmark, 70 percent reached the *Intermediate* benchmark, and 91 percent reached the *Low* benchmark (figure 3b).

The percentage of fourth-graders who reached the *Advanced* international benchmark in mathematics was higher than the United States in 7 education systems; was not measurably different from the United States in 8 education systems; and was lower than the United States in 38 education systems. Singapore, Hong Kong-CHN, the Republic of Korea, Chinese Taipei-CHN, Japan, Northern Ireland-GBR, and the Russian Federation had higher percentages of students who reached the *Advanced* international benchmark in mathematics than the United States at the fourth grade. England-GBR, Kazakhstan, Florida-USA, Ireland, Norway, Hungary, Portugal, and Denmark had percentages that were not measurably different from the U.S. percentage.

The percentage of eighth-graders who reached the *Advanced* international benchmark in mathematics was higher than the United States in 8 education systems; was not measurably different from the United States in 5 education systems; and was lower than the United States in 29 education systems. Singapore, Chinese Taipei-CHN, the Republic of Korea, Hong Kong-CHN, Japan, Kazakhstan, the Russian Federation, and Israel had higher percentages of students who reached the *Advanced* international benchmark in mathematics than the United States at the eighth grade. Hungary, Dubai-UAE, England-GBR, Quebec-CAN, and Florida-USA had percentages that were not measurably different from the U.S. percentage.

[4] The international median is the median percentage for all IEA member countries (see table 2 for IEA member countries). Thus, the international median at each benchmark represents the percentage at which half of the participating IEA member countries have that percentage of students at or above the median and half have that percentage of students below the median. For example, the *Low* international benchmark median of 93 percent at grade 4 indicates that half of the countries have 93 percent or more of their students who met the *Low* benchmark, and half have less than 93 percent of their students who met the *Low* benchmark.

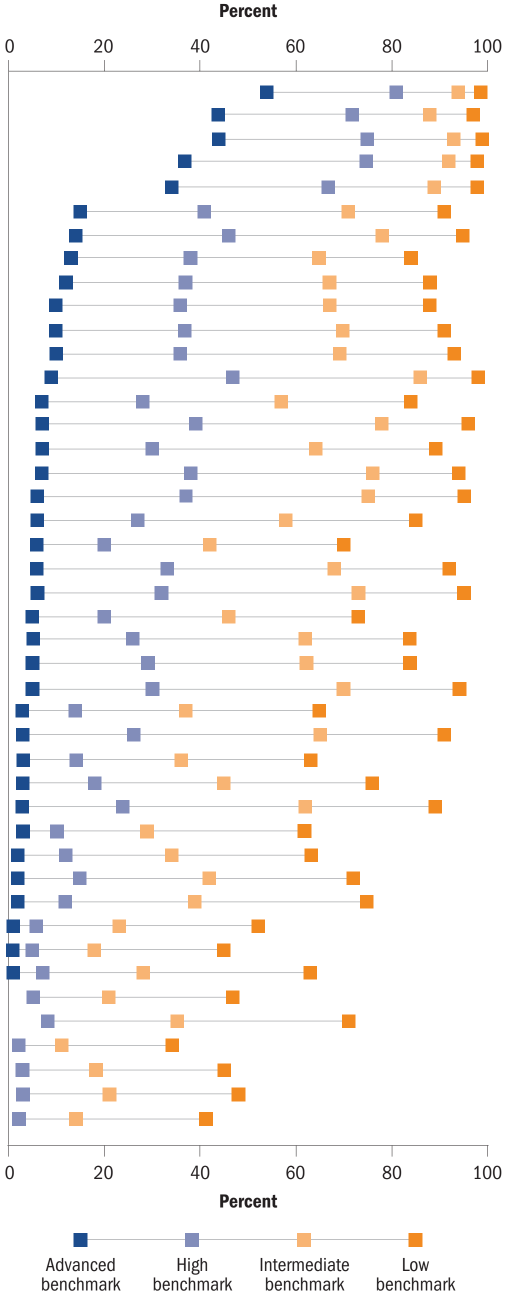
Figure 3a. Percentage of 4th-grade students reaching the TIMSS international benchmarks in mathematics, by education system: 2015



Education system	Advanced (625)	High (550)	Inter-mediate (475)	Low (400)
Singapore[1]	50 *	80 *	93 *	99 *
Hong Kong–CHN[1]	45 *	84 *	98 *	100 *
Korea, Republic of	41 *	81 *	97 *	100 *
Chinese Taipei–CHN	35 *	76 *	95 *	100 *
Japan	32 *	74 *	95 *	99 *
Northern Ireland–GBR[1]	27 *	61 *	86 *	97 *
Russian Federation	20 *	59 *	89 *	98 *
England–GBR	17	49	80	96
Kazakhstan	16	47	80	96 *
Florida–USA[1]	16	49	82	96
United States[1]	**14**	**47**	**79**	**95**
Ireland	14	51 *	84 *	97 *
Norway	14	50	86 *	98 *
Hungary	13	44	75 *	92 *
Portugal[1]	12	46	82 *	97 *
Denmark[1]	12	46	80	96
Dubai–UAE	11 *	35 *	66 *	87 *
Serbia[1]	10 *	37 *	72 *	91 *
Bulgaria	10 *	40 *	75	92 *
Lithuania[1]	10 *	44	81	96 *
Poland	10 *	44	80	96 *
Belgium (Flemish)–BEL[1]	10 *	47	88 *	99 *
Cyprus	10 *	39 *	74 *	93 *
Australia	9 *	36 *	70 *	91 *
Quebec–CAN[1]	9 *	42	82	98 *
Finland	8 *	43 *	82 *	97 *
Czech Republic	8 *	38 *	78	96
International median	6 *	36 *	75 *	93 *
New Zealand	6 *	26 *	59 *	84 *
Slovenia	6 *	34 *	75 *	95
Ontario–CAN	6 *	31 *	70 *	93
Canada[1]	6 *	31 *	69 *	92 *
Germany	5 *	34 *	77	96 *
Sweden[1]	5 *	34 *	75 *	95
United Arab Emirates	5 *	18 *	42 *	68 *
Turkey	5 *	25 *	57 *	81 *
Italy[1]	4 *	28 *	69 *	93 *
Slovak Republic	4 *	26 *	65 *	88 *
Netherlands[1]	4 *	37 *	83 *	99 *
Spain[1]	3 *	27 *	67 *	93
Abu Dhabi–UAE[1]	3 *	12 *	32 *	56 *
Croatia	3 *	24 *	67 *	93
Qatar	3 *	13 *	36 *	65 *
France	2 *	21 *	58 *	87 *
Georgia[1]	2 *	15 *	47 *	78 *
Oman	2 *	11 *	32 *	60 *
Bahrain[1]	2 *	13 *	41 *	72 *
Iran, Islamic Republic of	1 *	11 *	36 *	65 *
Chile	1 *	10 *	42 *	78 *
Buenos Aires–ARG	# *	6 *	32 *	66 *
Saudi Arabia[1]	# *	3 *	16 *	43 *
Morocco	# *	3 *	17 *	41 *
Jordan	# *	5 *	21 *	50 *
Indonesia	# *	3 *	20 *	50 *
Kuwait[1]	# *	3 *	12 *	33 *

Rounds to zero.
* Percentage is statistically different from the U.S. percentage at the same benchmark ($p < .05$).
[1] See appendix table A1 for details on sampling or other issues in these education systems, including issues with the national defined population coverage, issues with satisfying sampling guidelines, and/or concerns about estimation because the percentage of students whose performance is too low to estimate exceeds certain thresholds.
NOTE: Education systems are ordered by the percentage of students reaching the *Advanced* international benchmark in mathematics. Italics indicate the benchmarking participants. The international median represents all participating TIMSS education systems, including the United States; benchmarking participants are not included in the median.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2015.

Figure 3b. Percentage of 8th-grade students reaching the TIMSS international benchmarks in mathematics, by education system: 2015



Education system	Advanced (625)	High (550)	Inter-mediate (475)	Low (400)
Singapore[1]	54 *	81 *	94 *	99 *
Chinese Taipei–CHN	44 *	72 *	88 *	97 *
Korea, Republic of	43 *	75 *	93 *	99 *
Hong Kong–CHN	37 *	75 *	92 *	98 *
Japan	34 *	67 *	89 *	98 *
Kazakhstan	15 *	41	71	91
Russian Federation	14 *	46 *	78 *	95 *
Israel[1]	13 *	38	65 *	84 *
Hungary	12	37	67	88 *
Dubai–UAE	10	36	67	88 *
United States[1]	**10**	**37**	**70**	**91**
England–GBR	10	36	69	93
Quebec–CAN[1]	9	47 *	86 *	98 *
Florida–USA[1]	7	28 *	57 *	84 *
Canada[1]	7 *	39	78 *	96 *
Australia	7 *	30 *	64 *	89
Ireland	7 *	38	76 *	94 *
Ontario–CAN	6 *	37	75 *	95 *
New Zealand[1]	6 *	27 *	58 *	85 *
Turkey	6 *	20 *	42 *	70 *
Lithuania[1]	6 *	33	68	92
Slovenia	6 *	32 *	73	95 *
United Arab Emirates	5 *	20 *	46 *	73 *
International median	5 *	26 *	62 *	84 *
Malta	5 *	29 *	62 *	84 *
Norway	5 *	30 *	70	94 *
Abu Dhabi–UAE	3 *	14 *	37 *	65 *
Sweden	3 *	26 *	65 *	91
Qatar[1]	3 *	14 *	36 *	63 *
Malaysia	3 *	18 *	45 *	76 *
Italy[1]	3 *	24 *	62 *	89
Thailand	3 *	10 *	29 *	62 *
Iran, Islamic Republic of[1]	2 *	12 *	34 *	63 *
Georgia[1]	2 *	15 *	42 *	72 *
Bahrain	2 *	12 *	39 *	75 *
Oman[1]	1 *	6 *	23 *	52 *
Kuwait[1]	1 *	5 *	18 *	45 *
Chile[1]	1 *	7 *	28 *	63 *
Egypt[1]	# *	5 *	21 *	47 *
Lebanon	# *	8 *	35 *	71 *
Saudi Arabia[1]	# *	2 *	11 *	34 *
Jordan[1]	# *	3 *	18 *	45 *
Buenos Aires–ARG[1]	# *	3 *	21 *	48 *
Morocco[1]	# *	2 *	14 *	41 *

Rounds to zero.

* Percentage is statistically different from the U.S. percentage at the same benchmark ($p < .05$).

[1] See appendix table A1 for details on sampling or other issues in these education systems, including issues with the national defined population coverage, issues with satisfying sampling guidelines, and/or concerns about estimation because the percentage of students whose performance is too low to estimate exceeds certain thresholds.

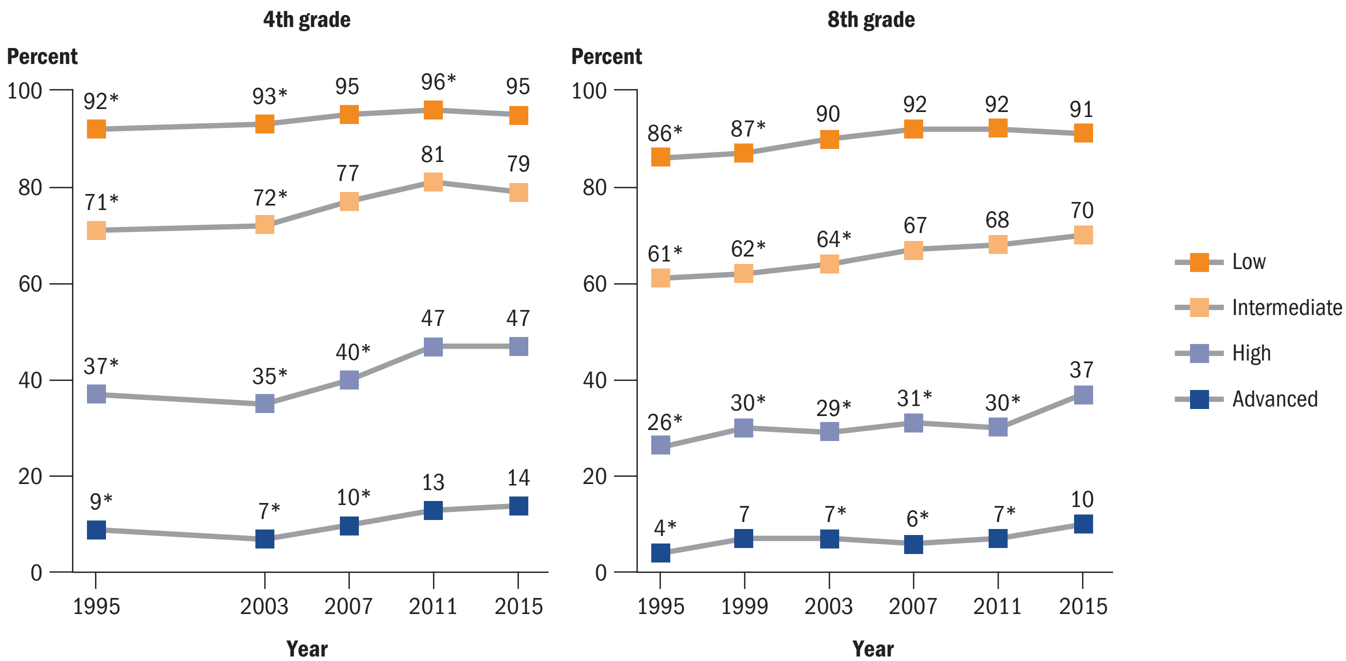
NOTE: Education systems are ordered by the percentage of students reaching the *Advanced* international benchmark in mathematics. Italics indicate the benchmarking participants. The international median represents all participating TIMSS education systems, including the United States; benchmarking participants are not included in the median.

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2015.

Looking over time, the percentages of U.S. fourth-graders reaching each of the four TIMSS international benchmarks in mathematics were greater in 2015 than in 1995 and 2003 (figure 4). In addition, the percentages of students reaching the *Advanced* and *High* international benchmarks in mathematics were greater in 2015 than in 2007. However, the percentages of students reaching the *Intermediate* and *Low* benchmarks were not measurably different over this period. The percentage of students reaching the *Low* international benchmark in 2015 was lower than in 2011.

At the eighth grade, the percentages of students reaching each of the four TIMSS international benchmarks in mathematics were also greater in 2015 than in 1995. Notably, the percentages of students reaching the *Advanced* and *High* international benchmark in mathematics were greater in 2015 than in 2003, 2007, and 2011 as well, and the percentage reaching the *High* international benchmark was the greatest of any administration.

Figure 4. Trends in percentage of U.S. 4th- and 8th-grade students reaching the TIMSS international benchmarks in mathematics: 1995, 1999, 2003, 2007, 2011, and 2015



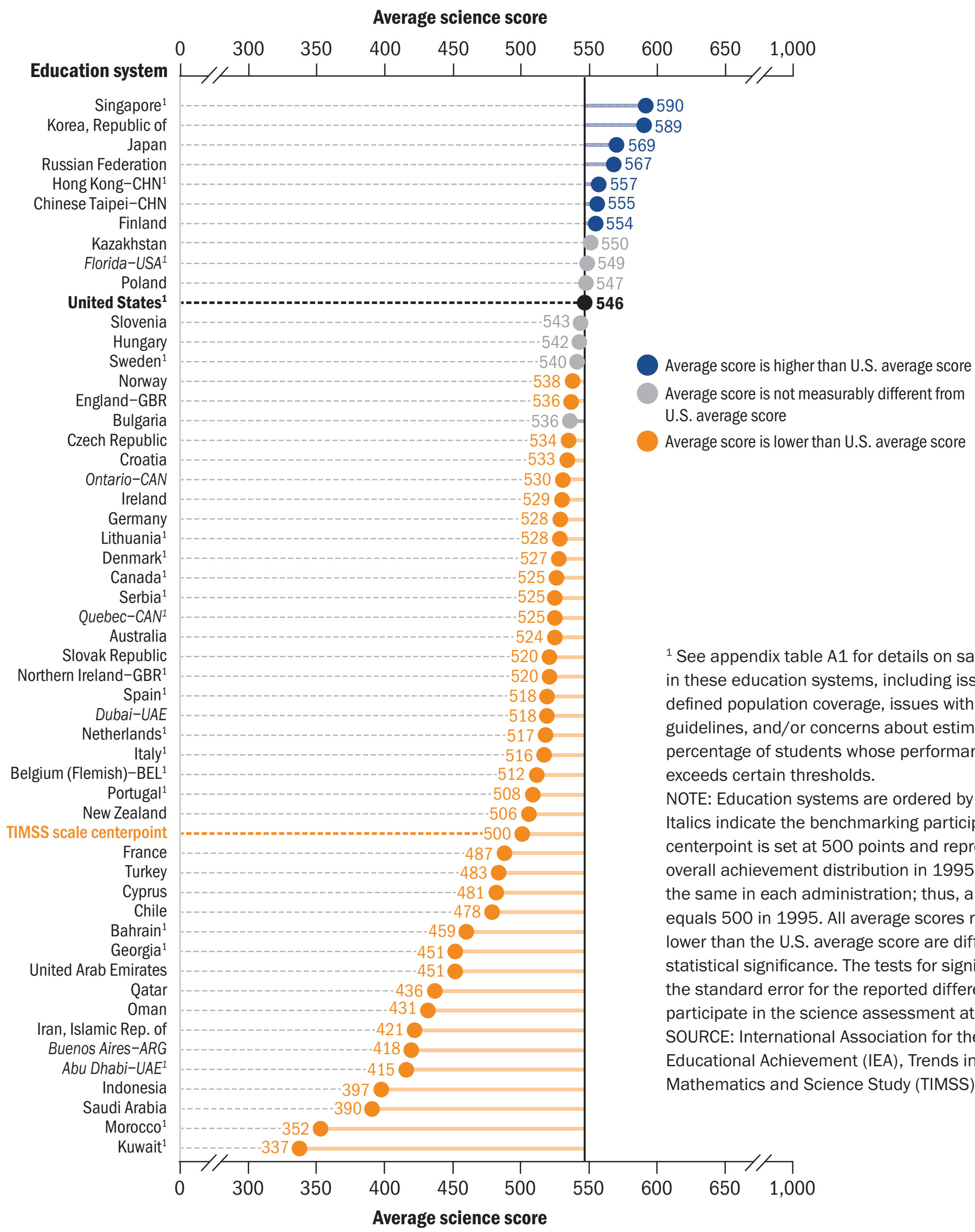
* Percentage is statistically different from the 2015 percentage at the same benchmark ($p < .05$).
NOTE: TIMSS was not administered at the fourth grade in 1999. See appendix tables A1 and A2 for details on coverage and sampling issues in the United States for 2015 and earlier years, respectively.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 1995, 1999, 2003, 2007, 2011, and 2015.

SCIENCE

How well do U.S. students perform in science?

In 2015, U.S. fourth-graders' average score in science was 546, which was higher than the average scores of students in 38 education systems and lower than the average scores of students in 7 education systems (figure 5a). U.S. eighth-graders' average score in science was 530, which was higher than the average scores of students in 26 education systems and lower than the average scores of students in 7 education systems (figure 5b).

Figure 5a. Average science scores of 4th-grade students, by education system: 2015

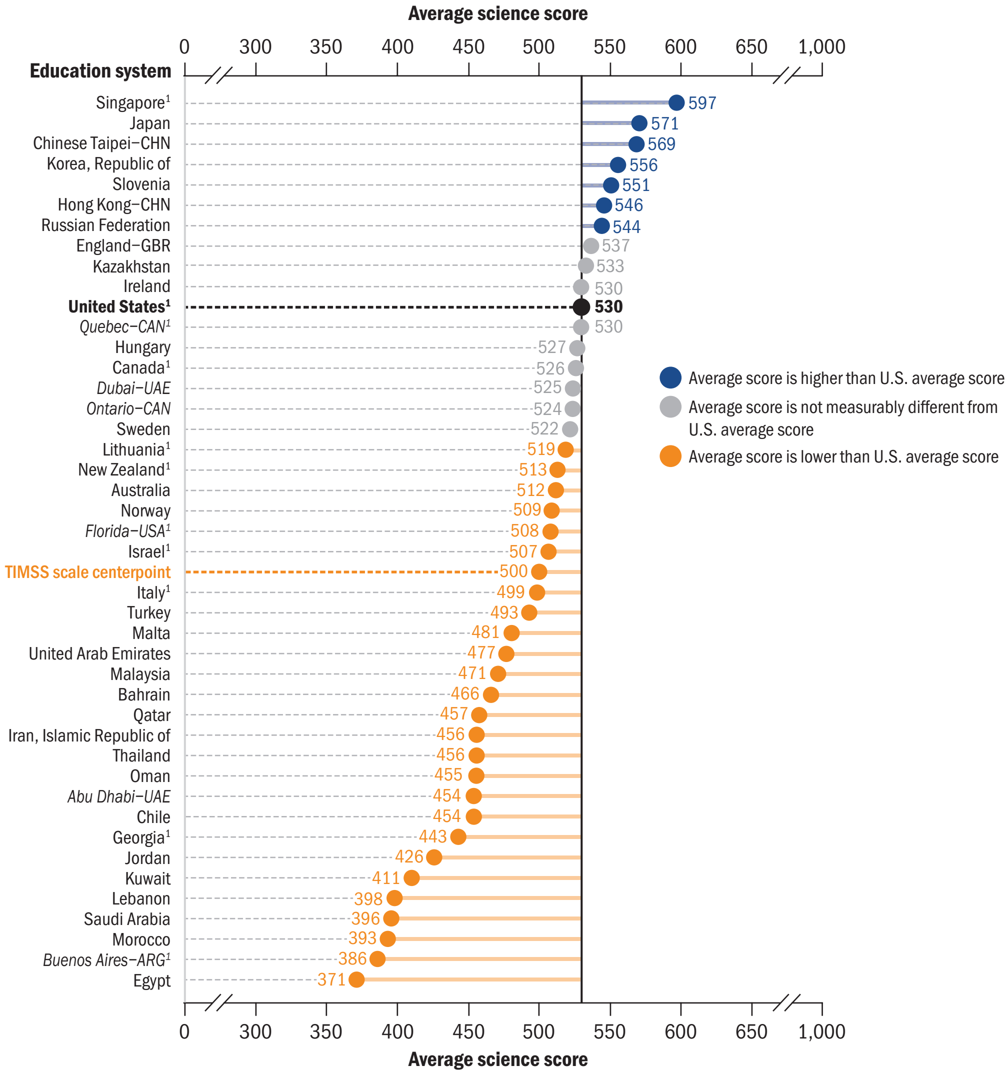


[1] See appendix table A1 for details on sampling or other issues in these education systems, including issues with the national defined population coverage, issues with satisfying sampling guidelines, and/or concerns about estimation because the percentage of students whose performance is too low to estimate exceeds certain thresholds.

NOTE: Education systems are ordered by average science score. Italics indicate the benchmarking participants. The TIMSS scale centerpoint is set at 500 points and represents the mean of the overall achievement distribution in 1995. The TIMSS scale is the same in each administration; thus, a value of 500 in 2015 equals 500 in 1995. All average scores reported as higher or lower than the U.S. average score are different at the .05 level of statistical significance. The tests for significance take into account the standard error for the reported difference. Jordan did not participate in the science assessment at the fourth grade.

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2015.

Figure 5b. Average science scores of 8th-grade students, by education system: 2015



[1] See appendix table A1 for details on sampling or other issues in these education systems, including issues with the national defined population coverage, issues with satisfying sampling guidelines, and/or concerns about estimation because the percentage of students whose performance is too low to estimate exceeds certain thresholds.

NOTE: Education systems are ordered by average science score. Italics indicate the benchmarking participants. The TIMSS scale centerpoint is set at 500 points and represents the mean of the overall achievement distribution in 1995. The TIMSS scale is the same in each administration; thus, a value of 500 in 2015 equals 500 in 1995. All average scores reported as higher or lower than the U.S. average score are different at the .05 level of statistical significance. The tests for significance take into account the standard error for the reported difference.

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2015.

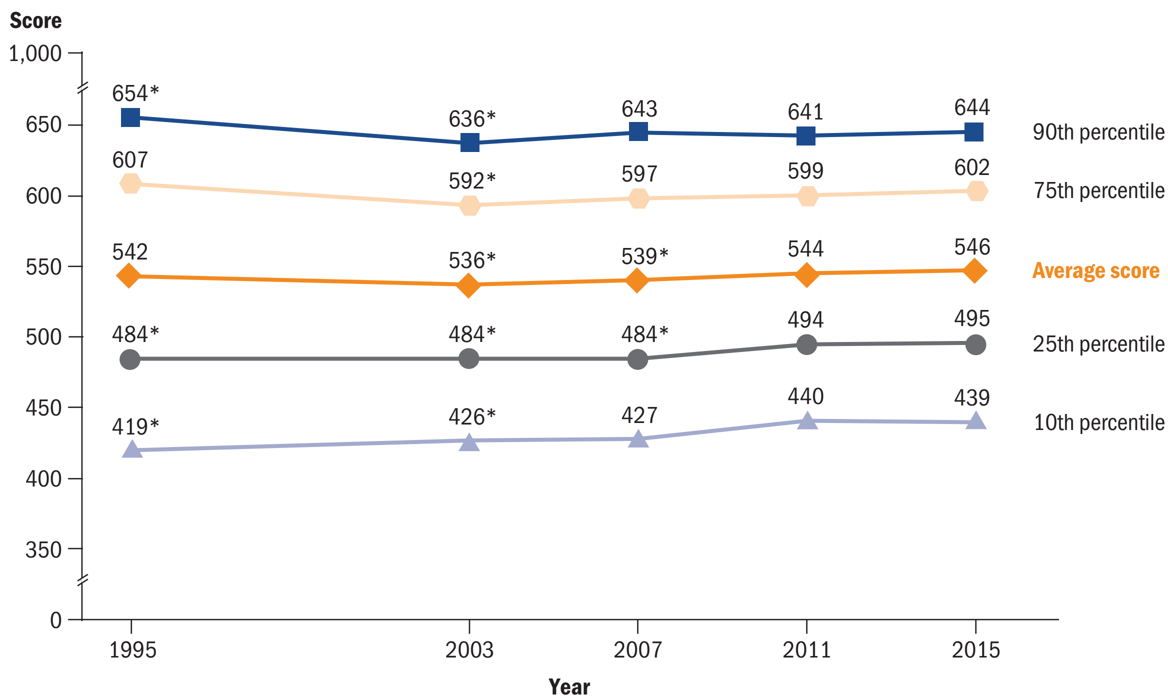
SCIENCE

Are U.S. students making progress in science?

U.S. fourth-grade students have shown improvement on the TIMSS science assessments over some time periods: the average score in 2015 was higher than in 2003 and 2007 (figure 6a, middle line). However, there was no measurable difference between the average science score in 2015 and the average science score in 1995 or 2011. The apparent difference between the average score in 1995 and in 2015 (542 versus 546 points) was not statistically significant.

Trends across the distribution of science achievement were mixed. At the fourth grade, the science cut scores of the lower-performing students (i.e., at the 10th and 25th percentiles) were higher in 2015 than in 1995 and 2003, and the cut score of students at the 25th percentile was higher in 2015 than in 2007 (figure 6a). However, there were no measurable differences at any of the selected percentiles (10th, 25th, 75th, or 90th) between 2011 and 2015. Moreover, over the long term, from 1995 to 2015, science cut scores decreased for the highest-performing fourth-grade students (i.e., at the 90th percentile).

Figure 6a. Trends in U.S. 4th-grade students' average science scores and cut scores at the 10th, 25th, 75th, and 90th percentiles: 1995, 2003, 2007, 2011, and 2015

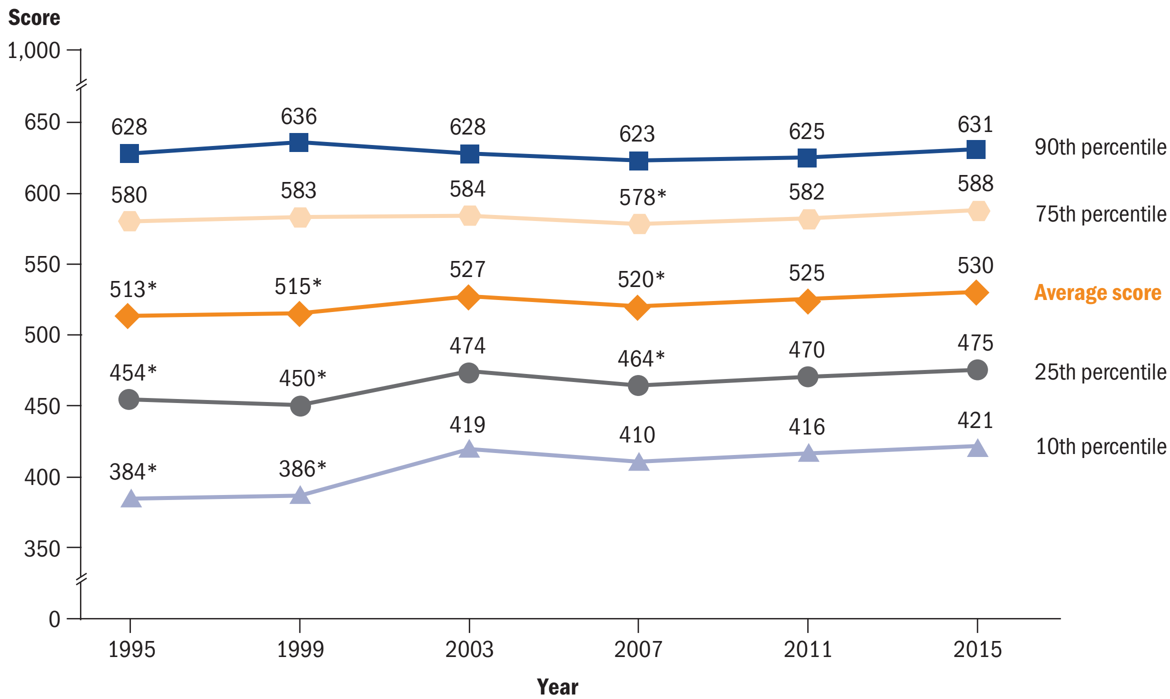


* Score is statistically different from the 2015 score ($p < .05$).
NOTE: TIMSS was not administered at the fourth grade in 1999. See appendix tables A1 and A2 for details on coverage and sampling issues in the United States for 2015 and earlier years, respectively.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 1995, 2003, 2007, 2011, and 2015.

U.S. eighth-graders' average science score increased between 1995 and 2015: from 513 to 530 points (figure 6b, middle line). The eighth-grade average science score was also higher in 2015 than in 1999 and 2007, but there were no measurable differences from 2003 or the most recent time point (2011) to 2015.

At the eighth grade, U.S. science cut scores increased for lower-performing students (i.e., at the 10th and 25th percentiles) over the long-term from 1995 and 1999 to 2015 (figure 6b). However, there were no measurable differences in the science cut scores of eighth-grade students at any of the selected percentiles (10th, 25th, 75th, or 90th) between 2011 and 2015.

Figure 6b. Trends in U.S. 8th-grade students' average science scores and cut scores at the 10th, 25th, 75th, and 90th percentiles: 1995, 1999, 2003, 2007, 2011, and 2015



* Score is statistically different from the 2015 score ($p < .05$).
NOTE: See appendix tables A1 and A2 for details on coverage and sampling issues in the United States for 2015 and earlier years, respectively.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 1995, 1999, 2003, 2007, 2011, and 2015.

SCIENCE

What level of science knowledge and skills have U.S. fourth- and eighth-grade students achieved?

As noted earlier, TIMSS defines four levels of student achievement, referred to as international benchmarks: *Advanced, High, Intermediate,* and *Low.* These international benchmarks provide a way to understand how students' proficiency in science varies at different points on the TIMSS scale. Exhibit 2 describes what kinds of knowledge and skills students at each level would need to successfully answer the science items at that level, as well as the score cutpoint for each level. (See chapter 2 of the international report, referenced below the exhibit, for example items at each level.)

Exhibit 2. Description of TIMSS international science benchmarks, by grade: 2015

Benchmarks	4th grade	8th grade
Advanced (625)	***Students communicate understanding of life, physical, and Earth sciences and demonstrate some knowledge of the process of scientific inquiry.*** Students demonstrate knowledge of characteristics and life processes of a variety of organisms, communicate understanding of relationships in ecosystems and interactions between organisms and their environment, and communicate and apply knowledge of factors related to human health. They communicate understanding of properties and states of matter and physical and chemical changes, apply some knowledge of forms of energy and energy transfer, and show some knowledge of forces and an understanding of their effect on motion. Students communicate understanding of Earth's structure, physical characteristics, processes, and history and show knowledge of Earth's revolution and rotation. Students demonstrate basic knowledge and skills related to scientific inquiry, recognizing how a simple experiment should be set up, interpreting the results of an investigation, reasoning and drawing conclusions from descriptions and diagrams, and evaluating and supporting an argument.	***Students communicate understanding of complex concepts related to biology, chemistry, physics, and Earth science in practical, abstract, and experimental contexts.*** Students apply knowledge of cells and their functions as well as characteristics and life processes of organisms. They demonstrate understanding of diversity, adaptation, and natural selection among organisms, and of ecosystems and the interactions of organisms within the environment. Students apply knowledge of life cycles, and heredity in plants and animals. Students demonstrate knowledge of the composition and physical properties of matter and apply knowledge of physical states and changes in matter and practical and experimental contexts, apply knowledge of energy transfer, and demonstrate knowledge of electricity and magnetism. Students communicate understanding of forces and pressure and demonstrate knowledge of light and sound in practical and abstract situations. Students communicate understanding of Earth's structure, physical features, and resources as well as of Earth in the solar system. Students show understanding of basic aspects of scientific investigation. They identify which variables to control in an experimental situation, compare information from several sources, combine information to predict and draw conclusions, and interpret information in diagrams, maps, graphs, and tables to solve problems. They provide written explanations to communicate scientific knowledge.

Exhibit 2. Description of TIMSS international science benchmarks, by grade: 2015—*Continued*

Benchmarks	4th grade	8th grade
High (550)	***Students communicate and apply knowledge of the life, physical, and Earth sciences in everyday and abstract contexts.*** Students communicate knowledge of characteristics of plants, animals, and their life cycles, and apply knowledge of ecosystems and of humans' and organisms' interactions with their environment. Students communicate and apply knowledge of states and properties of matter, and of energy transfer in practical contexts, as well as showing some understanding of forces and motion. Students apply knowledge of Earth's structure, physical characteristics, processes, and history and show basic understanding of the Earth-Moon-Sun system. Students compare, contrast, and make simple inferences using models, diagrams, and descriptions of investigations, and provide brief descriptive responses using science concepts, both in everyday and abstract contexts.	***Students apply and communicate understanding of concepts from biology, chemistry, physics, and Earth sciences in everyday and abstract situations.*** Students apply knowledge of cells and their function and of the characteristics and life processes of organisms. They communicate understanding of ecosystems and the interaction of organisms with their environment and apply some knowledge of human health related to nutrition and infectious disease. Students show some knowledge and understanding of the composition and properties of matter and chemical change. They apply basic knowledge of energy transformation and transfer of light and sound in practical situations, and demonstrate understanding of simple electrical circuits and properties of magnets. Students apply their knowledge of forces and motion to everyday and abstract situations. They apply knowledge of Earth's physical features, processes, cycles, and history, and show some understanding of Earth's resources, their use, and conservation as well as some knowledge of the interaction between the Earth and the Moon. Students demonstrate some scientific inquiry skills, including selecting and justifying an appropriate experimental method. They combine and interpret information from various types of diagrams, graphs, and tables; select relevant information from various types of diagrams, graphs, and tables; and provide explanations conveying scientific knowledge.
Intermediate (475)	***Students show basic knowledge and understanding of life, physical, and Earth sciences.*** Students demonstrate some knowledge of life processes of plants and humans, communicate and apply knowledge of the interaction of living things with their environments as well as impacts humans can have on their environment, and communicate knowledge of basic facts related to human health. They apply knowledge about some properties of matter and about some facts related to electricity and to energy transfer, and apply elementary knowledge of forces and motion. They show some understanding of Earth's physical characteristics and demonstrate some basic knowledge of Earth in the solar system. Students interpret information in diagrams, apply factual knowledge to everyday situations, and provide simple explanations for biological and physical phenomena.	***Students demonstrate and apply their knowledge of biology, chemistry, physics, and Earth science in various contexts.*** Students demonstrate some knowledge of characteristics and life processes of animals and human health. They apply knowledge of ecosystems, the interaction of living things, and the adaptation of animals to their environments. Students apply some knowledge of the composition of matter and properties of matter. They also show knowledge of some aspects of force, motion, and energy. Students apply knowledge of Earth's processes, resources, and physical features. They interpret information from tables, graphs, and pictorial diagrams to draw conclusions, apply knowledge to practical situations, and communicate their understanding through brief descriptive responses.
Low (400)	***Students show basic knowledge of life science and physical sciences.*** Students demonstrate some basic knowledge of behavioral and physical characteristics of plants and animals as well as of the interaction of living things with their environments, and apply knowledge of some facts related to human health. Students show basic knowledge of states of matter and physical properties of matter. They interpret simple diagrams, complete simple tables, and provide short, fact-based written responses.	***Students show some basic knowledge of biology, chemistry, physics, and Earth science.*** Students apply basic knowledge of ecosystems and adaptation of animals to their environment, show knowledge of basic facts related to thermal electrical conductivity and electromagnetism, and show knowledge of some basic Earth science facts. Students interpret simple pictorial diagrams and apply basic knowledge to practical situations.

SOURCE: Martin, M.O., Mullis, I.V.S., Foy, P., and Hooper, M. (2016). *TIMSS 2015 International Results in Science.* Retrieved from http://timssandpirls.bc.edu/timss2015/international-results/.

SCIENCE

In 2015, at both the fourth and eighth grades, higher percentages of U.S. students reached the *Advanced, High,* and *Intermediate* TIMSS international benchmarks in science than the international medians (figures 7a and 7b).[5]

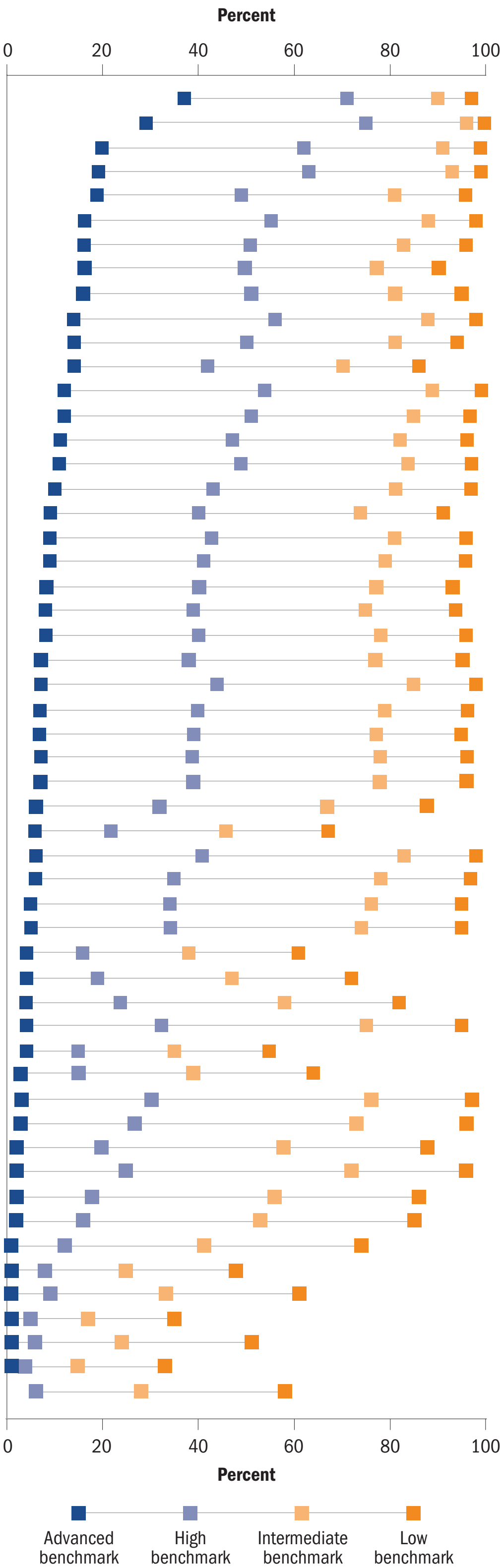
At the fourth grade, 16 percent of students reached the *Advanced* international benchmark in science, 51 percent reached the *High* benchmark, 81 percent reached the *Intermediate* benchmark, and 95 percent reached the *Low* benchmark (figure 7a). At the eighth grade, 12 percent of students reached the *Advanced* international benchmark in science, 43 percent reached the *High* benchmark, 75 percent reached the *Intermediate* benchmark, and 93 percent reached the *Low* benchmark (figure 7b). The percentage of U.S. students reaching the *Low* benchmark in eighth grade was also higher than the median percentage reaching that benchmark internationally.

The percentage of fourth-graders who reached the *Advanced* international benchmark in science was higher than the United States in 4 education systems; was not measurably different from the United States in 7 education systems; and was lower than the United States in 41 education systems. Singapore, the Republic of Korea, the Russian Federation, and Japan had higher percentages of students who reached the *Advanced* international benchmark in science than the United States at fourth grade. Kazakhstan, Hong Kong-CHN, Florida-USA, Bulgaria, Chinese Taipei-CHN, Hungary, and Dubai-UAE had percentages that were not measurably different from the U.S. percentage.

The percentage of eighth-graders who reached the *Advanced* international benchmark in science was higher than the United States in 6 education systems; was not measurably different from the United States in 10 education systems; and was lower than the United States in 26 education systems. Singapore, Chinese Taipei-CHN, Japan, the Republic of Korea, Slovenia, and Kazakhstan had higher percentages of students who reached the *Advanced* international benchmark in science than the United States at the eighth grade. England-GBR, the Russian Federation, Dubai-UAE, Israel, Hungary, Hong Kong-CHN, Ireland, Sweden, New Zealand, and Florida-USA had percentages that were not measurably different from the U.S. percentage.

[5] The international median is the median percentage for all IEA member countries (see table 2 for IEA member countries). Thus, the international median at each benchmark represents the percentage at which half of the participating IEA member countries have that percentage of students at or above the median and half have that percentage of students below the median. For example, the *Low* international benchmark median of 95 percent at grade 4 indicates that half of the countries have 95 percent or more of their students who met the *Low* benchmark and half have less than 95 percent of their students who met the *Low* benchmark.

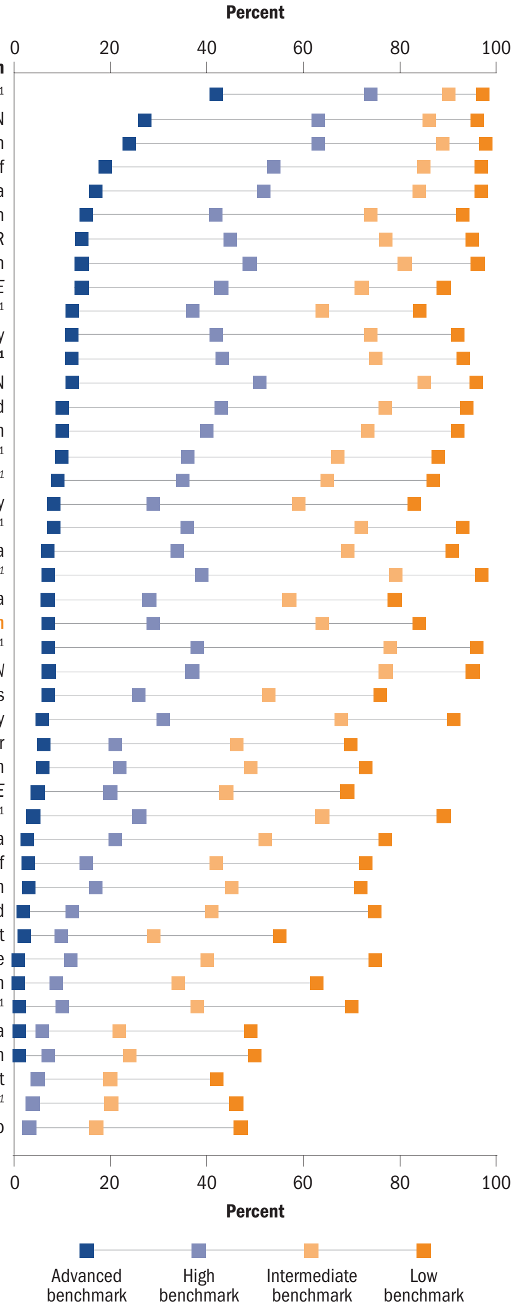
Figure 7a. Percentage of 4th-grade students reaching the TIMSS international benchmarks in science, by education system: 2015



Education system	Advanced (625)		High (550)		Inter-mediate (475)		Low (400)	
Singapore[1]	37	*	71	*	90	*	97	*
Korea, Republic of	29	*	75	*	96	*	100	*
Russian Federation	20	*	62	*	91	*	99	*
Japan	19	*	63	*	93	*	99	*
Kazakhstan	19		49		81		96	
Hong Kong–CHN[1]	16		55	*	88	*	98	*
Florida–USA[1]	16		51		83		96	
Bulgaria	16		50		77		90	*
United States[1]	**16**		**51**		**81**		**95**	
Chinese Taipei–CHN	14		56	*	88	*	98	*
Hungary	14		50		81		94	
Dubai–UAE	14		42	*	70	*	86	*
Finland	13	*	54		89	*	99	*
Poland	12	*	51		85	*	97	*
Sweden[1]	11	*	47		82		96	
Slovenia	11	*	49		84		97	*
England–GBR	10	*	43	*	81		97	*
Slovak Republic	9	*	40	*	74	*	91	*
Czech Republic	9	*	43	*	81		96	
Ontario–CAN	9	*	41	*	79		96	
Serbia[1]	8	*	40	*	77	*	93	*
Australia	8	*	39	*	75	*	94	
Germany	8	*	40	*	78		96	
Canada[1]	7	*	38	*	77	*	95	
Norway	7	*	44	*	85	*	98	*
Ireland	7	*	40	*	79		96	
International median	7	*	39	*	77	*	95	
Lithuania[1]	7	*	39	*	78	*	96	
Denmark[1]	7	*	39	*	78	*	96	
New Zealand	6	*	32	*	67	*	88	*
United Arab Emirates	6	*	22	*	46	*	67	*
Croatia	6	*	41	*	83		98	*
Quebec–CAN[1]	6	*	35	*	78		97	*
Northern Ireland–GBR[1]	5	*	34	*	76	*	95	
Spain[1]	5	*	34	*	74	*	95	
Oman	4	*	16	*	38	*	61	*
Bahrain[1]	4	*	19	*	47	*	72	*
Turkey	4	*	24	*	58	*	82	*
Italy[1]	4	*	32	*	75	*	95	
Abu Dhabi–UAE[1]	4	*	15	*	35	*	55	*
Qatar	3	*	15	*	39	*	64	*
Netherlands[1]	3	*	30	*	76	*	97	
Belgium (Flemish)–BEL[1]	3	*	27	*	73	*	96	
France	2	*	20	*	58	*	88	*
Portugal[1]	2	*	25	*	72	*	96	
Cyprus	2	*	18	*	56	*	86	*
Chile	2	*	16	*	53	*	85	*
Georgia[1]	1	*	12	*	41	*	74	*
Saudi Arabia	1	*	8	*	25	*	48	*
Iran, Islamic Rep. of	1	*	9	*	33	*	61	*
Morocco[1]	1	*	5	*	17	*	35	*
Indonesia	1	*	6	*	24	*	51	*
Kuwait[1]	1	*	4	*	15	*	33	*
Buenos Aires–ARG	#	*	6	*	28	*	58	*

\# Rounds to zero.
* Percentage is statistically different from the U.S. percentage at the same benchmark ($p < .05$).
[1] See appendix table A1 for details on sampling or other issues in these education systems, including issues with the national defined population coverage, issues with satisfying sampling guidelines, and/or concerns about estimation because the percentage of students whose performance is too low to estimate exceeds certain thresholds.
NOTE: Education systems are ordered by the percentage of students reaching the *Advanced* international benchmark in science. Italics indicate the benchmarking participants. The international median represents all participating TIMSS education systems, including the United States; benchmarking participants are not included in the median. Jordan did not participate in the science assessment at the fourth grade.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2015.

Figure 7b. Percentage of 8th-grade students reaching the TIMSS international benchmarks in science, by education system: 2015



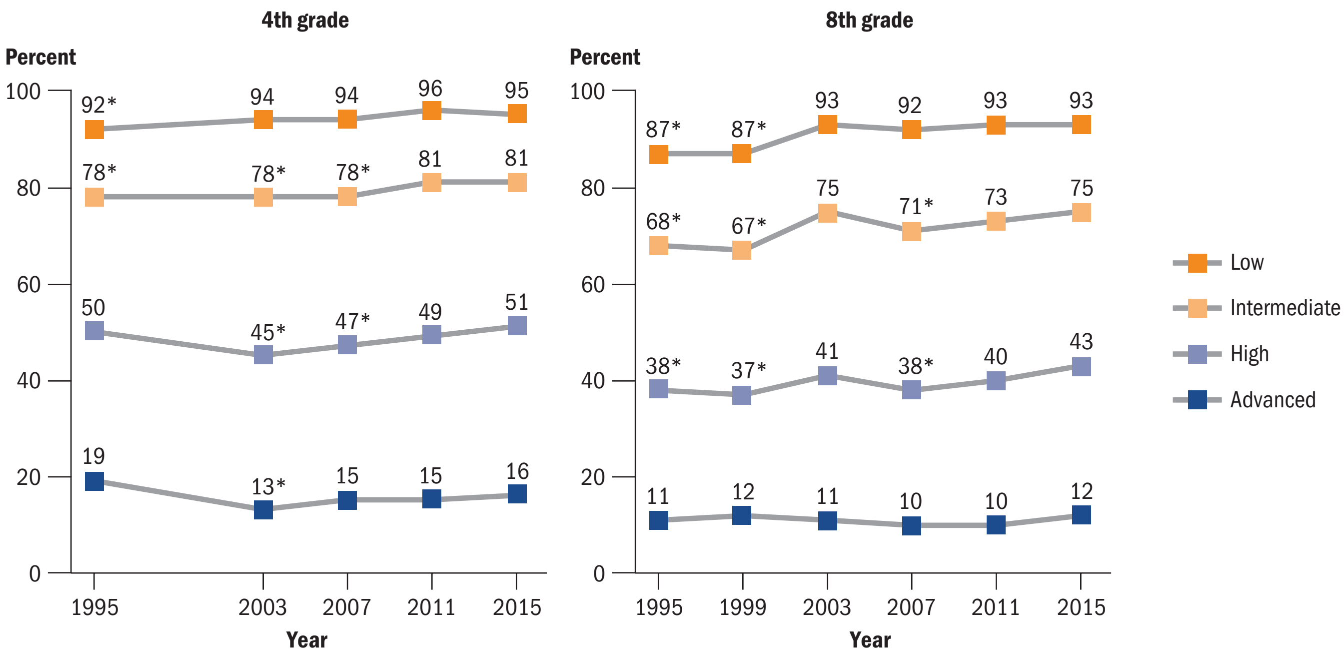
Education system	Advanced (625)	High (550)	Intermediate (475)	Low (400)
Singapore[1]	42 *	74 *	90 *	97 *
Chinese Taipei–CHN	27 *	63 *	86 *	96 *
Japan	24 *	63 *	89 *	98 *
Korea, Republic of	19 *	54 *	85 *	97 *
Slovenia	17 *	52 *	84 *	97 *
Kazakhstan	15 *	42	74	93
England–GBR	14	45	77	95
Russian Federation	14	49 *	81 *	96 *
Dubai–UAE	14	43	72 *	89 *
Israel[1]	12	37 *	64 *	84 *
Hungary	12	42	74	92
United States[1]	**12**	**43**	**75**	**93**
Hong Kong–CHN	12	51 *	85 *	96 *
Ireland	10	43	77	94
Sweden	10	40	73	92
New Zealand[1]	10	36 *	67 *	88 *
Florida–USA[1]	9	35 *	65 *	87 *
Turkey	8 *	29 *	59 *	83 *
Lithuania[1]	8 *	36 *	72	93
Australia	7 *	34 *	69 *	91 *
Quebec–CAN[1]	7 *	39	79	97 *
Malta	7 *	28 *	57 *	79 *
International median	7 *	29 *	64 *	84 *
Canada[1]	7 *	38 *	78	96 *
Ontario–CAN	7 *	37 *	77	95
United Arab Emirates	7 *	26 *	53 *	76 *
Norway	6 *	31 *	68 *	91
Qatar	6 *	21 *	46 *	70 *
Bahrain	6 *	22 *	49 *	73 *
Abu Dhabi–UAE	5 *	20 *	44 *	69 *
Italy[1]	4 *	26 *	64 *	89 *
Malaysia	3 *	21 *	52 *	77 *
Iran, Islamic Republic of	3 *	15 *	42 *	73 *
Oman	3 *	17 *	45 *	72 *
Thailand	2 *	12 *	41 *	75 *
Kuwait	2 *	10 *	29 *	55 *
Chile	1 *	12 *	40 *	75 *
Jordan	1 *	9 *	34 *	63 *
Georgia[1]	1 *	10 *	38 *	70 *
Saudi Arabia	1 *	6 *	22 *	49 *
Lebanon	1 *	7 *	24 *	50 *
Egypt	# *	5 *	20 *	42 *
Buenos Aires–ARG[1]	# *	4 *	20 *	46 *
Morocco	# *	3 *	17 *	47 *

Rounds to zero.
* Percentage is statistically different from the U.S. percentage at the same benchmark ($p < .05$).
[1] See appendix table A1 for details on sampling or other issues in these education systems, including issues with the national defined population coverage, issues with satisfying sampling guidelines, and/or concerns about estimation because the percentage of students whose performance is too low to estimate exceeds certain thresholds.
NOTE: Education systems are ordered by the percentage of students reaching the *Advanced* international benchmark in science. Italics indicate the benchmarking participants. The international median represents all participating TIMSS education systems, including the United States; benchmarking participants are not included in the median.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 2015.

Looking over time, the percentage of U.S. fourth-graders reaching the *Intermediate* TIMSS international benchmarks in science was greater in 2015 than in 1995, 2003, and 2007 (figure 8). Additionally, the 2015 percentage of U.S. fourth-graders reaching the *Low* benchmark was greater than in 1995, the percentage reaching the *High* benchmark was greater than in 2003 and 2007, and the percentage reaching the *Advanced* benchmark was greater than in 2003. However, there were no measurable differences in the percentages of U.S. fourth-graders reaching any of the international benchmarks in science between 2011 and 2015.

At the eighth grade, the percentages of U.S. students reaching the *Intermediate* and *High* international benchmarks in science were greater in 2015 than in 1995, 1999, and 2007. Additionally, the 2015 percentage of U.S. eighth-graders reaching the *Low* benchmark was greater than in 1995 and 1999. There were no measurable differences in the percentages of U.S. eighth-grade students reaching any of the international benchmarks in science between 2011 and 2015.

Figure 8. Trends in percentage of U.S. 4th- and 8th-grade students reaching the TIMSS international benchmarks in science: 1995, 1999, 2003, 2007, 2011, and 2015



* Percentage is statistically different from the 2015 percentage at the same benchmark ($p < .05$).
NOTE: TIMSS was not administered at the fourth grade in 1999. See appendix tables A1 and A2 for details on coverage or sampling issues in the United States for 2015 and earlier years, respectively.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS), 1995, 1999, 2003, 2007, 2011, and 2015.

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Results from TIMSS Advanced 2015

What are the characteristics of the students who participated in the advanced mathematics assessment at the end of high school?

The students who participated in the TIMSS Advanced assessment in advanced mathematics were students in their final year of high school who had taken or were taking advanced mathematics courses covering topics in geometry, algebra, and calculus.[6] Education systems vary in the percentage of students (of the corresponding age cohort) who take such courses, and so the results are reported with those percentages (referred to as the advanced mathematics coverage index). These advanced students also vary in other characteristics in part because of differences in the structure of the education systems and the duration of schooling in those systems. These structural differences should be kept in mind when interpreting results.

The U.S. students who took the TIMSS advanced mathematics assessment in 2015 represented 11.4 percent of the corresponding age cohort (18-year-olds) (figure 9).

Figure 9. Coverage index and covered population characteristics of TIMSS Advanced students in advanced mathematics, by education system: 2015

		Covered population characteristics			
Advanced mathematics coverage index[1] (Percent)	Education system	Percent female	Percent male	Years of formal schooling[2]	Average age
1.9	Russian Federation (intensive courses)[3]	46	54	11	17.7
3.9	Lebanon[4]	36	64	12	17.8
10.1	Russian Federation	50	50	11	17.7
10.6	Norway	38	62	13	18.7
11.4	**United States[4]**	**49**	**51**	**12**	**18.1**
14.1	Sweden	40	60	12	18.8
21.5	France	47	53	12	18.0
24.5	Italy	37	63	13	18.9
28.5	Portugal[4]	51	49	12	18.1
34.4	Slovenia	60	40	13	18.8

[1] The advanced mathematics coverage index is the percentage of the corresponding age cohort covered by students in their final year of high school who are taking or have taken advanced mathematics courses. The corresponding age cohort is determined for education systems individually. In the United States, the corresponding age cohort is 18-year-olds. For additional details, see the Technical Notes available at http://nces.ed.gov/timss/timss15technotes.asp.
[2] Years of formal schooling are counted from the first year of primary or basic education. Because of ongoing reforms in some education systems to increase the number of years of schooling, the number of years of formal schooling is not always the same as the grade assessed.
[3] Intensive courses are advanced mathematics courses that involve 6 or more hours per week. Results for students in these courses are reported separately from the results for other students from the Russian Federation taking courses that involve 4.5 hours per week.
[4] See appendix table A1 for details on sampling issues in these education systems.
NOTE: Education systems are ordered by the advanced mathematics coverage index.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS) Advanced, 2015.

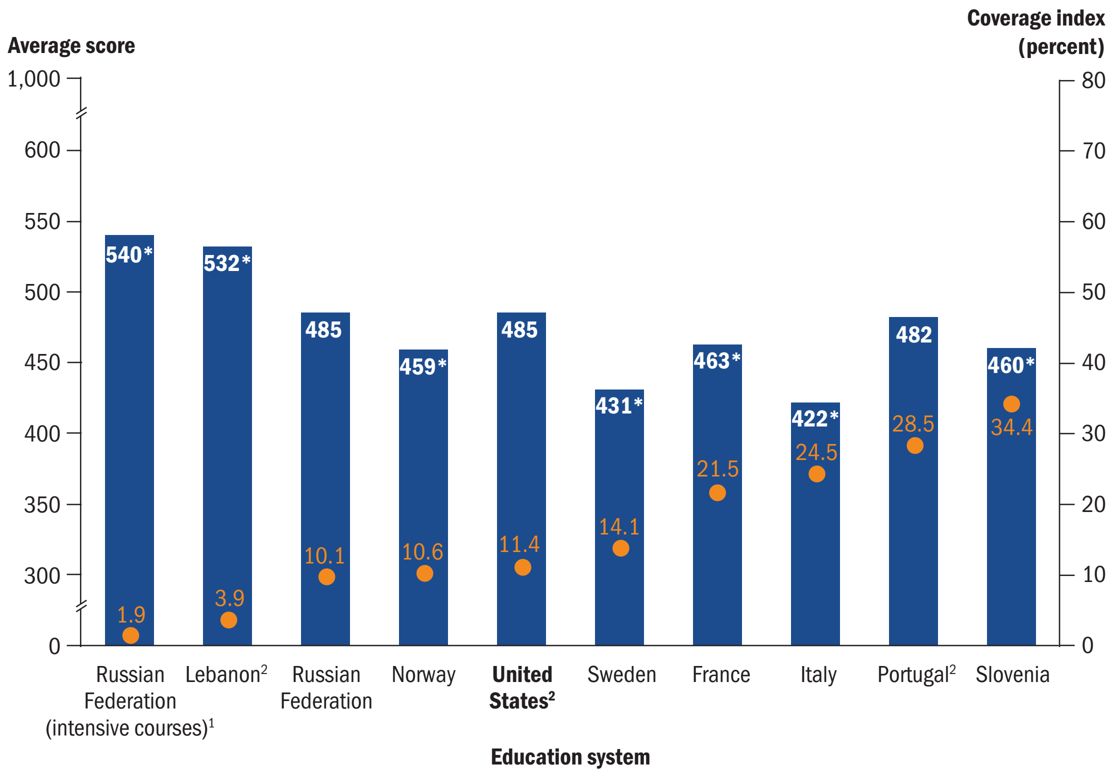
[6] In the United States, this includes courses in Advanced Placement (AP) calculus, International Baccalaureate (IB) mathematics, and state- and school-specific calculus courses.

This percentage ranged from 1.9 percent in the Russian Federation (for students taking intensive courses) to 34.4 percent in Slovenia. In the United States, 51 percent of the students who took the TIMSS advanced mathematics assessment were male and 49 percent were female. In most other education systems, TIMSS Advanced students were more heavily male, with up to 64 percent of TIMSS Advanced students being male in Lebanon. Slovenia was the only education system where females comprised more of the TIMSS Advanced population than males (60 versus 40 percent, respectively). TIMSS Advanced students ranged in age from 17.7 years in the Russian Federation (in intensive and other courses) to 18.9 years in Italy. In the United States, TIMSS Advanced students averaged 18.1 years of age and were in 12th grade.

How are advanced U.S. students performing in advanced mathematics at the end of high school?

U.S. advanced twelfth-graders' average score in advanced mathematics was 485, which was higher than the average scores of students in five education systems and lower than the average scores of students in two education systems (figure 10).

Figure 10. Average advanced mathematics scores and coverage index of TIMSS Advanced students, by education system: 2015



* Score is statistically different from the U.S. score (*p* < .05).

[1] Intensive courses are advanced mathematics courses that involve 6 or more hours per week. Results for students in these courses are reported separately from the results for other students from the Russian Federation taking courses that involve 4.5 hours per week.

[2] See appendix table A1 for details on sampling issues in these education systems.

NOTE: Education systems are ordered by the advanced mathematics coverage index, which is the percentage of the corresponding age cohort covered by students in their final year of secondary school who are taking or have taken advanced mathematics courses. The corresponding age cohort is determined for education systems individually. In the United States, the corresponding age cohort is 18-year-olds. For additional details, see the Technical Notes available at http://nces.ed.gov/timss/timss15technotes.asp.

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS) Advanced, 2015.

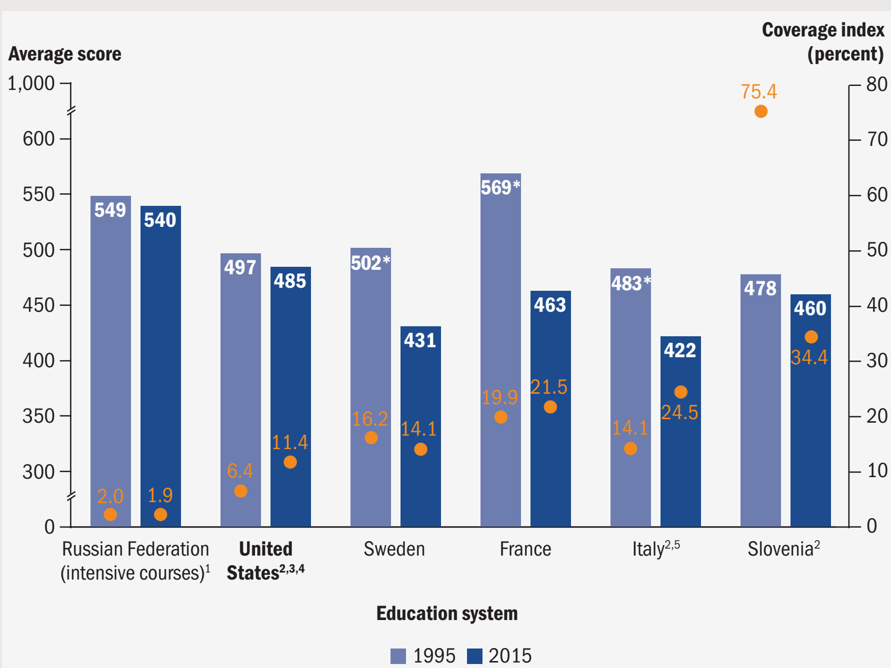
Examining progress in advanced mathematics achievement between 1995 and 2015

The United States and five other education systems participated in the advanced mathematics assessment in both 1995 and 2015. (Norway participated in the TIMSS Advanced physics assessment in 1995 but not the advanced mathematics assessment.) However, there were some changes in the sampling procedures, the definition of eligible advanced mathematics courses, and the assessment framework after 1995, as well as changes in the national coverage index in some countries that warrant caution in comparing scores over time. Differences may be partly related to these changes.

In the United States, the 1995 definition of the covered population included students not considered advanced in 2015; thus, some students who took the 1995 assessment were no longer comparable with the 2015 advanced student sample and were dropped for the trend comparisons. The 1995 students who were compared with the 2015 advanced students are those twelfth-graders from 1995 who self-reported taking or having completed a second-year, International Baccalaureate, or Advanced Placement mathematics course. For additional information on how the trend analyses were undertaken for the United States and the measures to minimize the impacts of the aforementioned changes, see the Technical Notes on the TIMSS 2015 website, at http://nces.ed.gov/timss/timss15technotes.asp.

As figure 11 shows, the U.S. score in advanced mathematics in 2015 (485) was not measurably different from the U.S. score in 1995 (497). No education systems had higher average advanced mathematics scores in 2015 than in 1995, but three education systems (France, Italy, and Sweden) had lower average scores.

Figure 11. Average advanced mathematics scores and coverage index of TIMSS Advanced students, by education system: 1995 and 2015



* The average score is statistically different from the 2015 average score ($p < .05$).

[1] Intensive courses are advanced mathematics courses that involve 6 or more hours per week. Results for students in these courses are reported separately from the results for other students from the Russian Federation taking courses that involve 4.5 hours per week.

[2] See appendix table A2 for details on sampling issues in these education systems in 1995.

[3] See appendix table A1 for details on sampling issues in these education systems in 2015.

[4] The United States' 1995 sample was adjusted to correspond with the course-taking definitions used in 2015 and thus the 1995 results were recomputed.

[5] The 1995 advanced mathematics coverage index for Italy was recomputed for this report.

NOTE: Education systems are ordered by the 2015 advanced mathematics coverage index, which is the percentage of the corresponding age cohort covered by students in their final year of secondary school who are taking or have taken advanced mathematics courses. The corresponding age cohort is determined for education systems individually. In the United States, the corresponding age cohort is 18-year-olds. For additional details, see the Technical Notes available at http://nces.ed.gov/timss/timss15technotes.asp.

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS) Advanced, 1995 and 2015.

As noted earlier, TIMSS Advanced defines three levels of student achievement, referred to as international benchmarks. These international benchmarks provide a way to understand how students' proficiency in advanced mathematics varies at different points on the TIMSS Advanced scale. Exhibit 3 describes what kinds of knowledge and skills students at each level would need to successfully answer the advanced mathematics items at that level, as well as the score cutpoint for each level. (See chapter 2 of the international report, referenced below the exhibit, for example items at each level.)

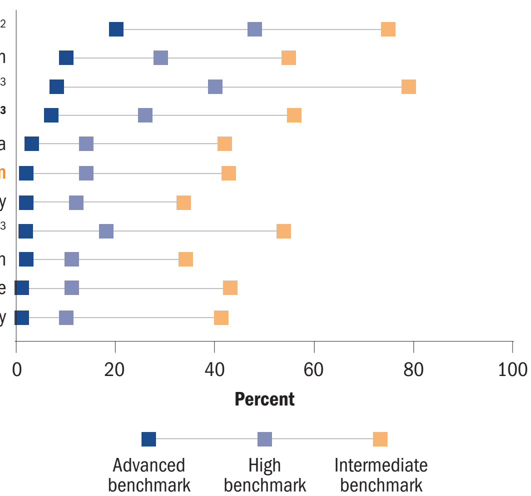
Exhibit 3. Description of TIMSS Advanced international benchmarks in advanced mathematics: 2015

Benchmarks	Advanced mathematics
Advanced (625)	***Students demonstrate thorough understanding of concepts, mastery of procedures, and mathematical reasoning skills. They can solve problems in complex contexts in algebra, calculus, geometry, and trigonometry.*** In algebra, students can reason with functions to solve pure mathematical problems. They demonstrate facility with complex numbers and permutations and can find sums of algebraic and infinite geometric series. In calculus, students demonstrate thorough understanding of continuity and differentiability. They can solve problems about optimization in different contexts and justify their solutions. They can use definite integrals to calculate the area between the curves. Students use geometric reasoning to solve complex problems. They use properties of vectors to express relationships among vectors. They can use trigonometric properties including the sine and cosine rules to solve nonroutine problems about geometric figures.
High (550)	***Students can apply a broad range of mathematical concepts and procedures in algebra, calculus, geometry, and trigonometry to analyze and solve multistep problems set in routine and nonroutine contexts.*** Students can analyze and solve algebra problems, including problems set in a practical context. They can solve problems requiring interpretation of information related to functions and graphs of functions. They can determine a sum of an arithmetic sequence and solve quadratic and other inequalities. They can simplify logarithmic expressions and multiply complex numbers. In calculus, students have a basic understanding of continuity and differentiability. They can analyze equations of functions and graphs of functions. They can relate the graphs of functions to graphs and signs of their first and second derivatives. Students show some conceptual understanding of definite integrals. Students can use trigonometric properties to solve a variety of problems involving trigonometric functions and geometric figures. They can use the Cartesian plane to solve problems, identify a vector perpendicular to a given vector, and prove that a quadrilateral given in the coordinate system is a parallelogram.
Intermediate (475)	***Students demonstrate basic knowledge of concepts and procedures in algebra, calculus, and geometry to solve routine problems.*** Students can apply and transform a formula to solve a word problem. They can determine a term in a geometric sequence and analyze a proposed solution of a simple logarithmic equation. They can recognize a graph of the absolute value of a function and identify and evaluate composite functions. They can make connections between the sign of the derivative and the graph of a function. Students can use knowledge of basic properties of geometric figures and the Pythagorean theorem to solve problems. They can add and subtract vectors in coordinate form.

SOURCE: Mullis, I.V.S., Martin, M.O., Foy, P., and Hooper, M. (2016). *TIMSS Advanced 2015 International Results in Advanced Mathematics and Physics.* Retrieved from http://timssandpirls.bc.edu/timss2015/international-results/advanced/.

Higher percentages of U.S. advanced twelfth-graders reached each of the international benchmarks in advanced mathematics than the international medians (figure 12).[7] Seven percent of U.S. advanced twelfth-graders reached the *Advanced* international benchmark in advanced mathematics, 26 percent reached the *High* benchmark, and 56 percent reached the *Intermediate* benchmark. Only the intensive courses in the Russian Federation had a higher percentage of students reaching the *Advanced* international benchmark than the United States. This Russian population (in the intensive courses), as well as that in Lebanon, also had higher percentages of students reaching the *High* and *Intermediate* international benchmarks than the United States. Five education systems—France, Italy, Norway, Slovenia, and Sweden—had lower percentages of students reaching each international benchmark than the United States.

Figure 12. Percentage of TIMSS Advanced students reaching the TIMSS Advanced international benchmarks in advanced mathematics, by education system: 2015



Education system	Advanced (625)	High (550)	Intermediate (475)	Advanced mathematics coverage index[1]
Russian Federation (intensive courses)[2]	20 *	48 *	75 *	1.9
Russian Federation	10	29	55	10.1
Lebanon[3]	8	40 *	79 *	3.9
United States[3]	**7**	**26**	**56**	**11.4**
Slovenia	3 *	14 *	42 *	34.4
International median	2 *	14 *	43 *	†
Italy	2 *	12 *	34 *	24.5
Portugal[3]	2 *	18 *	54	28.5
Sweden	2 *	11 *	34 *	14.1
France	1 *	11 *	43 *	21.5
Norway	1 *	10 *	41 *	10.6

† Not applicable.
* Percentage is statistically different from the U.S. percentage at the same benchmark ($p < .05$).
[1] The advanced mathematics coverage index is the percentage of the corresponding age cohort covered by students in their final year of secondary school who are taking or have taken advanced mathematics courses. The corresponding age cohort is determined for education systems individually. In the United States, the corresponding age cohort is 18-year-olds. For additional details, see the Technical Notes available at http://nces.ed.gov/timss/timss15technotes.asp.
[2] Intensive courses are advanced mathematics courses that involve 6 or more hours per week. Results for students in these courses are reported separately from the results for other students from the Russian Federation taking courses that involve 4.5 hours per week.
[3] See appendix table A1 for details on sampling issues in these education systems.
NOTE: Education systems are ordered by the percentage of students reaching the *Advanced* international benchmark in advanced mathematics. The international median represents all participating TIMSS education systems, including the United States.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS) Advanced, 2015.

[7] The international median is the median percentage for all IEA member countries (see table 2 for IEA member countries). Thus, the international median at each benchmark represents the percentage at which half of the participating IEA member countries have that percentage of students at or above the median and half have that percentage of students below the median. For example, the *Intermediate* international benchmark median of 43 percent indicates that half of the countries have 43 percent or more of their students who met the *Intermediate* benchmark, and half have less than 43 percent of their students who met the *Intermediate* benchmark.

PHYSICS

What are the characteristics of the students who participated in the physics assessment at the end of high school?

The students who participated in the TIMSS Advanced physics assessment were students in their final year of high school who had taken or were taking physics courses covering topics in mechanics and thermodynamics, electricity and magnetism, and wave phenomena and atomic/nuclear physics.[8] Education systems vary in the percentage of students (of the corresponding age cohort) who take such courses, and so the results are reported with those percentages (referred to as the physics coverage index). These advanced students also vary in other characteristics in part because of differences in the structure of the education systems and the duration of schooling in those systems. These structural differences should be kept in mind when interpreting results.

The U.S. students who took the TIMSS physics assessment in 2015 represented 4.8 percent of the corresponding age cohort (18-year-olds) (figure 13). This percentage ranged from 3.9 percent in Lebanon to 21.5 percent in France. In the United States, 61 percent of the students who took the TIMSS advanced physics assessment were male and 39 percent were female. In all education systems, there were more males in the covered population than females, with up to 75 percent of the population being male in Portugal. TIMSS Advanced students ranged in age from 17.7 years in the Russian Federation to 18.9 years in Italy. In the United States, TIMSS Advanced students averaged 18.1 years of age and were in 12th grade.

Figure 13. Coverage index and covered population characteristics of TIMSS Advanced students in physics, by education system: 2015

Physics coverage index[1] (Percent)	Education system	Covered population characteristics: Percent female	Percent male	Years of formal schooling[2]	Average age
3.9	Lebanon[3]	37	63	12	17.8
4.8	**United States[3]**	**39**	**61**	**12**	**18.1**
4.9	Russian Federation	42	58	11	17.7
5.1	Portugal	25	75	12	18.0
6.5	Norway	29	71	13	18.8
7.6	Slovenia	30	70	13	18.8
14.3	Sweden	41	59	12	18.8
18.2	Italy	46	54	13	18.9
21.5	France	47	53	12	18.0

[1] The physics coverage index is the percentage of the corresponding age cohort covered by students in their final year of secondary school who are taking or have taken physics courses. The corresponding age cohort is determined for education systems individually. In the United States, the corresponding age cohort is 18-year-olds. For additional details, see the Technical Notes available at http://nces.ed.gov/timss/timss15technotes.asp.

[2] Years of formal schooling are counted from the first year of primary or basic education. Because of ongoing reforms in some education systems to increase the number of years of schooling, the number of years of formal schooling is not always the same as the grade assessed.

[3] See appendix table A1 for details on sampling issues in these education systems.

NOTE: Education systems are ordered by the physics coverage index.

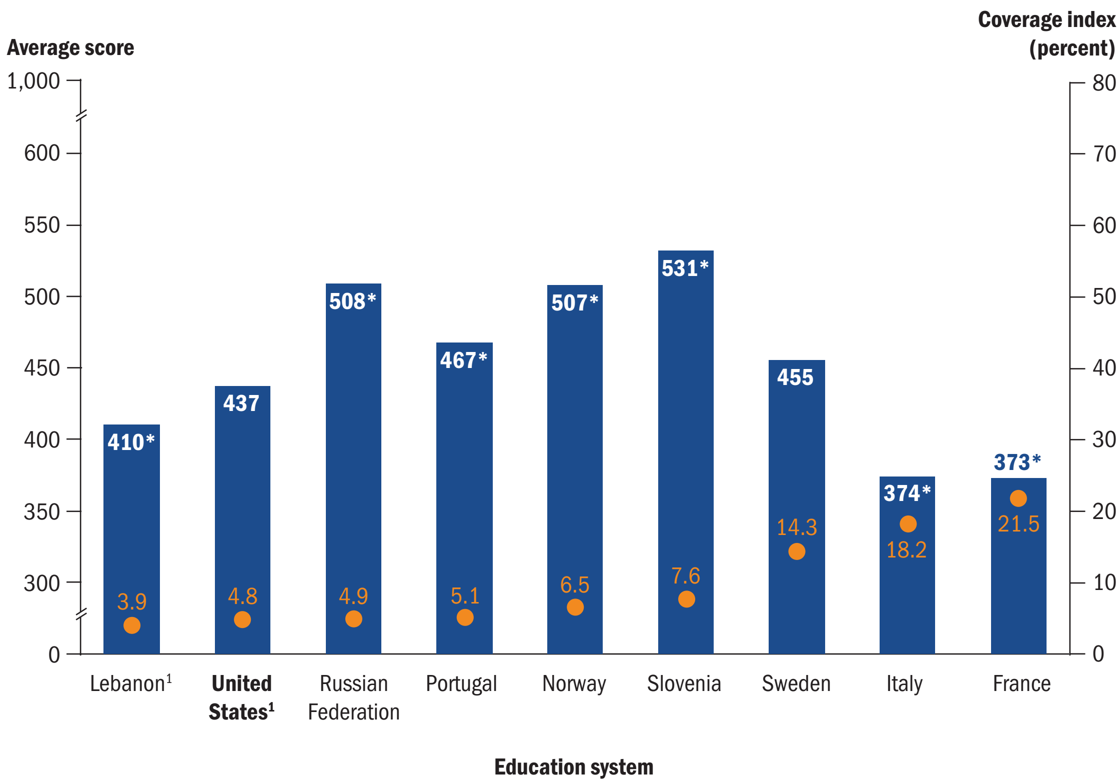
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS) Advanced, 2015.

[8] In the United States, this includes courses in Advanced Placement (AP) physics, International Baccalaureate (IB) physics, and state- and school-specific second-year physics courses.

How are advanced U.S. students performing in physics at the end of high school?

U.S. advanced twelfth-graders' average score in physics was 437, which was higher than the average scores of students in three education systems and lower than the average scores of students in four education systems (figure 14).

Figure 14. Average physics scores and coverage index of TIMSS Advanced students, by education system: 2015



* Score is statistically different from the U.S. score ($p < .05$).

[1] See appendix table A1 for details on sampling issues in these education systems.

NOTE: Education systems are ordered by the physics coverage index, which is the percentage of the corresponding age cohort covered by students in their final year of secondary school who are taking or have taken physics courses. The corresponding age cohort is determined for education systems individually. In the United States, the corresponding age cohort is 18-year-olds. For additional details, see the Technical Notes available at http://nces.ed.gov/timss/timss15technotes.asp.

SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS) Advanced, 2015.

PHYSICS

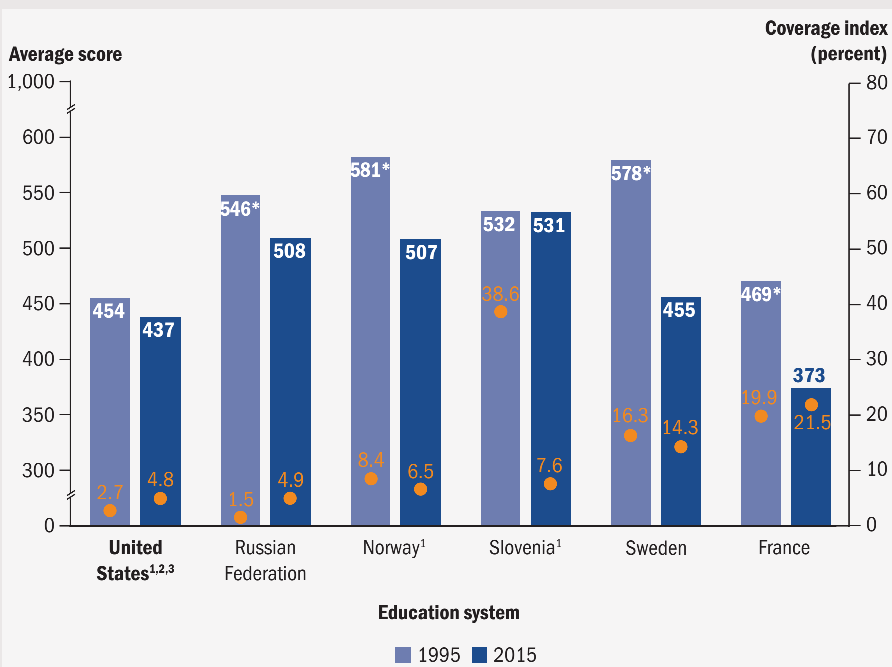
Examining progress in physics achievement between 1995 and 2015

The United States and five other education systems participated in the physics assessment in both 1995 and 2015. (Italy participated in the advanced mathematics assessment in 1995 but not the physics assessment.) However, there were some changes in the sampling procedures, the definition of eligible physics courses, and the assessment framework after 1995, as well as changes in the national coverage index in some education systems that warrant caution in comparing scores over time. Differences may be partly related to these changes.

In the United States, the 1995 definition of the covered population included students not considered advanced in 2015; thus, some students who took the 1995 assessment were no longer comparable with the 2015 advanced student sample and were dropped for the trend comparisons. The 1995 students who are compared with the 2015 advanced students are those twelfth-graders from 1995 who self-reported taking or having completed a second-year, International Baccalaureate, or Advanced Placement physics course. For additional information on how the trend analyses were undertaken for the United States and the measures to minimize the impacts of the aforementioned changes, see the Technical Notes on the TIMSS 2015 website, at http://nces.ed.gov/timss/timss15technotes.asp.

As figure 15 shows, the U.S. score in physics in 2015 (437) was not measurably different from the U.S. score in 1995 (454). No education systems had higher average physics scores in 2015 than in 1995, but four education systems (France, Norway, Russian Federation, and Sweden) had lower average physics scores.

Figure 15. Average physics scores and coverage index of TIMSS Advanced students, by education system: 1995 and 2015



* The average score is statistically different from the 2015 average score (*p* < .05).
[1] See appendix table A2 for details on sampling issues in these education systems in 1995.
[2] See appendix table A1 for details on sampling issues in these education systems in 2015.
[3] The United States' 1995 sample was adjusted to correspond with the course-taking definitions used in 2015 and thus the 1995 results were recomputed.
NOTE: Education systems are ordered by the 2015 physics coverage index, which is the percentage of the corresponding age cohort covered by students in their final year of secondary school who are taking or have taken physics courses. The corresponding age cohort is determined for education systems individually. In the United States, the corresponding age cohort is 18-year-olds. For additional details, see the Technical Notes available at http://nces.ed.gov/timss/timss15technotes.asp.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS) Advanced, 1995 and 2015.

As noted earlier, TIMSS Advanced defines three levels of student achievement, referred to as international benchmarks. These international benchmarks provide a way to understand how students' proficiency in physics varies at different points on the TIMSS Advanced scale. Exhibit 4 describes what kinds of knowledge and skills students at each level would need to successfully answer the physics items at that level, as well as the score cutpoint for each level. (See chapter 2 of the international report, referenced below the exhibit, for example items at each level.)

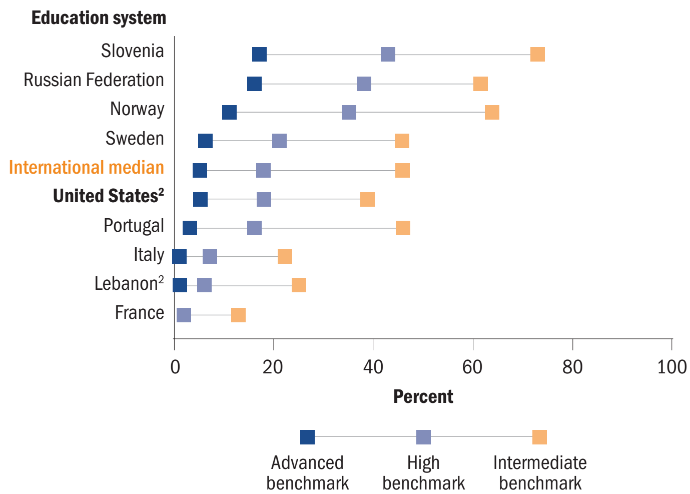
Exhibit 4. Description of TIMSS Advanced international benchmarks in physics: 2015

Benchmarks	Physics
Advanced (625)	***Students communicate their understanding of laws of physics to solve problems in practical and abstract contexts.*** They apply knowledge of the motion of objects in freefall, of heat and temperature, and of electrical circuits and electrical fields. Students communicate understanding of magnetic fields and of phenomena related to mechanical and electromagnetic waves, and demonstrate understanding of atomic and nuclear physics. Students design experimental procedures and interpret results, synthesize information in complex diagrams and graphs depicting abstract physics concepts to solve problems, provide multistep calculations of a variety of physical quantities in a range of contexts, draw conclusions about physical phenomena, and provide explanations to communicate scientific knowledge.
High (550)	***Students apply basic laws of physics in solving problems in a variety of situations.*** They apply knowledge of forces and motion, communicate understanding of the laws of conservation of energy and momentum, and apply knowledge of heat and temperature to solve problems. Students apply knowledge of Ohms' Law and Joule's Law to electric circuits, solve problems involving charged particles in electric and magnetic fields, and apply knowledge of magnetic fields and electromagnetic induction to solve problems. They show understanding of phenomena related to electromagnetic waves and knowledge of nuclear reactions. Students interpret information in complex diagrams and graphs depicting abstract concepts, derive formulas and provide calculations of a variety of physical quantities in a range of contexts, evaluate explanations for physical phenomena, and provide brief explanations to communicate scientific knowledge.
Intermediate (475)	***Students demonstrate some basic knowledge of the physics underlying a range of phenomena.*** They use their knowledge of forces and motion to solve problems, apply knowledge of heat and temperature to energy transfers, and of conservations laws to everyday and abstract contexts. They show knowledge of electric fields, point charges, and electromagnetic induction. Students apply knowledge of phenomena related to mechanical and electromagnetic waves and knowledge of atomic and nuclear physics to solve problems. Students interpret information in diagrams and graphs to solve problems, calculate a variety of physical quantities in a range of contexts, and evaluate statements to identify explanations for physical phenomena.

SOURCE: Mullis, I.V.S., Martin, M.O., Foy, P., and Hooper, M. (2016). *TIMSS Advanced 2015 International Results in Advanced Mathematics and Physics.* Retrieved from http://timssandpirls.bc.edu/timss2015/international-results/advanced/.

There were no measurable differences in the percentages of U.S. advanced twelfth graders reaching the *High* and *Advanced* international benchmarks in physics and the international medians reaching those benchmarks (figure 16).[9] However, the percentage of U.S. advanced twelfth-graders reaching the *Intermediate* international benchmark was lower than the international median for that benchmark. Five percent of U.S. advanced twelfth-graders reached the *Advanced* international benchmark in physics, 18 percent reached the *High* benchmark, and 39 percent reached the *Intermediate* benchmark. Higher percentages of students in Norway, the Russian Federation, and Slovenia reached each of the three international benchmarks in physics than in the United States. In three education systems—France, Italy, and Lebanon—lower percentages of students reached each international benchmark than the United States.

Figure 16. Percentage of TIMSS Advanced students reaching the TIMSS Advanced international benchmarks in physics, by education system: 2015



Education system	Advanced (625)	High (550)	Intermediate (475)	Physics coverage index[1]
Slovenia	17 *	43 *	73 *	7.6
Russian Federation	16 *	38 *	62 *	4.9
Norway	11 *	35 *	64 *	6.5
Sweden	6	21	46	14.3
International median	5	18	46 *	†
United States[2]	**5**	**18**	**39**	**4.8**
Portugal	3 *	16	46	5.1
Italy	1 *	7 *	22 *	18.2
Lebanon[2]	1 *	6 *	25 *	3.9
France	# *	2 *	13 *	21.5

† Not applicable.
# Rounds to zero.
* Percentage is statistically different from the U.S. percentage at the same benchmark ($p < .05$).
[1] The physics coverage index is the percentage of the corresponding age cohort covered by students in their final year of secondary school who are taking or have taken physics courses. The corresponding age cohort is determined for education systems individually. In the United States, the corresponding age cohort is 18-year-olds. For additional details, see the Technical Notes available at http://nces.ed.gov/timss/timss15technotes.asp.
[2] See appendix table A1 for details on sampling issues in these education systems.
NOTE: Education systems are ordered by the percentage of students reaching the *Advanced* international benchmark. The international median represents all participating TIMSS education systems, including the United States.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS) Advanced, 2015.

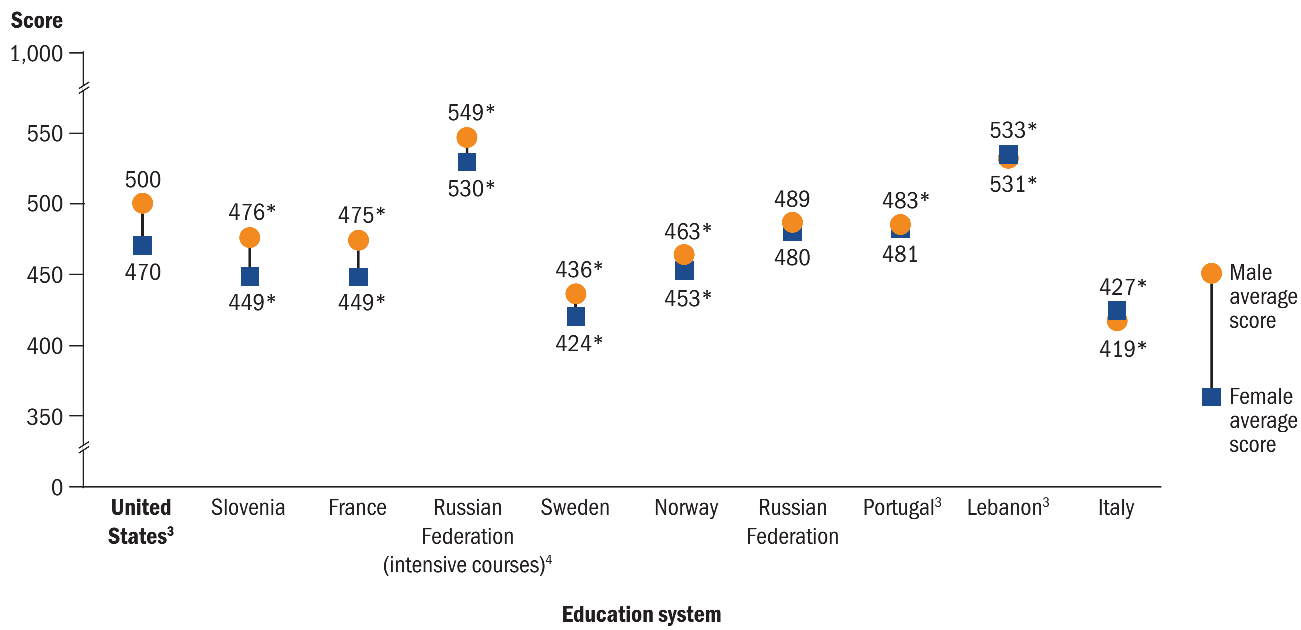
[9] The international median is the median percentage for all IEA member countries (see table 2 for IEA member countries). Thus, the international median at each benchmark represents the percentage at which half of the participating IEA member countries have that percentage of students at or above the median and half have that percentage of students below the median. For example, the *Intermediate* international benchmark median of 46 percent indicates that half of the countries have 46 percent or more of their students who met the *Intermediate* benchmark, and half have less than 46 percent of their students who met the *Intermediate* benchmark.

Do males and females perform differently in advanced mathematics and physics?

In most education systems that participated in TIMSS Advanced, males both outnumbered females among students in the covered populations—that is, students who are taking, or have taken, advanced mathematics and physics—and, on average, outscored them in both subjects (figures 17a and 17b).

In the United States, males scored 500 points, on average, in advanced mathematics, compared to 470 points for females (figure 17a). This 30-percentage-point difference was at the high end of the range of male-female differences across education systems, which otherwise ranged from 9 percentage points in the Russian Federation to 27 percentage points in Slovenia—all favoring males. In three education systems (Italy, Lebanon, and Portugal), there were no measurable male-female differences in average advanced mathematics scores. U.S. males' average advanced mathematics score was higher than males' scores in six education systems (France, Italy, Norway, Portugal, Slovenia, and Sweden), but lower than males' scores in Lebanon and in intensive courses in the Russian Federation. U.S. females' average advanced mathematics score was higher than females' scores in five education systems (France, Italy, Norway, Slovenia, and Sweden), but again lower than females' scores in Lebanon and in intensive courses in the Russian Federation.

Figure 17a. Average advanced mathematics scores of TIMSS Advanced males and females, by education system: 2015

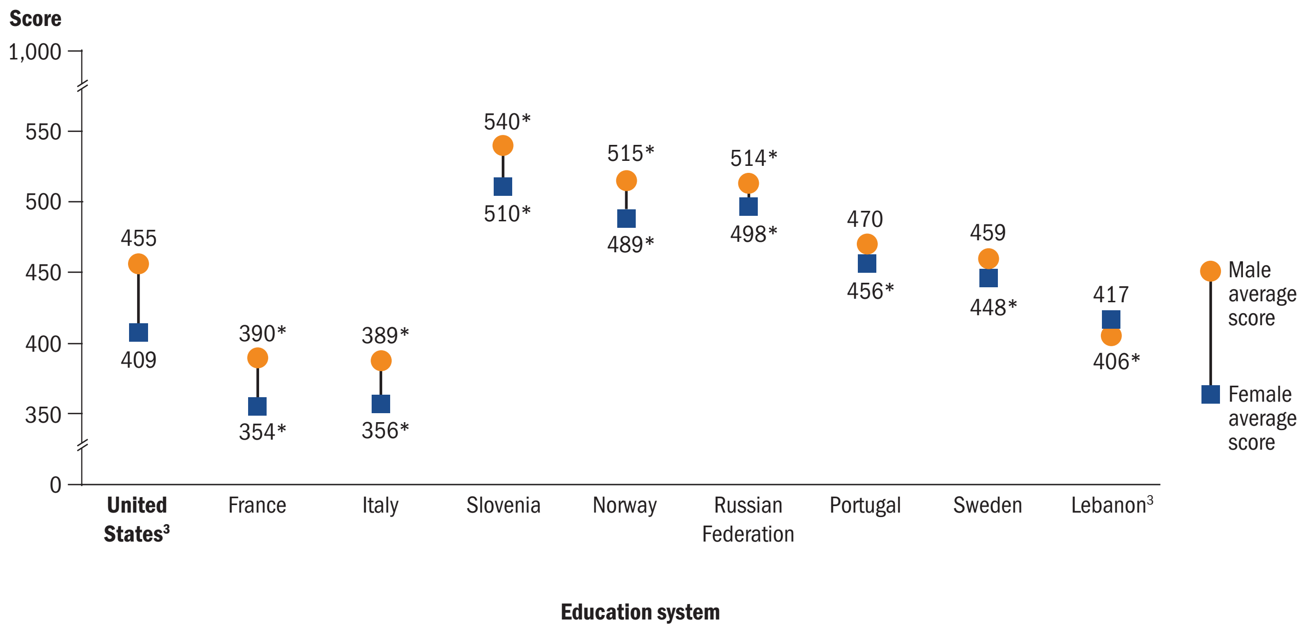


	United States[3]	Slovenia	France	Russian Federation (intensive courses)[4]	Sweden	Norway	Russian Federation	Portugal[3]	Lebanon[3]	Italy
Male-female difference in average scores:[1]	30	27	26	20	13	10	9	2	-2	-8
Advanced mathematics coverage index:[2]	11.4	34.4	21.5	1.9	14.1	10.6	10.1	28.5	3.9	24.5
Percent of covered population that is female:	49	60	47	46	40	38	50	51	36	37

* Average score is statistically different from the U.S. score of the same sex (*p* < .05).
[1] Difference in average scores is calculated by subtracting the females' estimate from the males' estimate using unrounded numbers.
[2] The advanced mathematics coverage index is the percentage of the corresponding age cohort covered by students in their final year of secondary school who are taking or have taken advanced mathematics courses. The corresponding age cohort is determined for education systems individually. In the United States, the corresponding age cohort is 18-year-olds. For additional details, see the Technical Notes available at http://nces.ed.gov/timss/timss15technotes.asp.
[3] See appendix table A1 for details on sampling issues in these education systems.
[4] Intensive courses are advanced mathematics courses that involve 6 or more hours per week. Results for students in these courses are reported separately from the results for other students from the Russian Federation taking courses that involve 4.5 hours per week.
NOTE: Education systems are ordered by the male-female difference in average scores. Male-female differences are statistically significant (*p* < .05) in all education systems except Italy, Lebanon, and Portugal.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS) Advanced, 2015.

In the United States and all other education systems except Lebanon, males scored higher than females, on average, in physics (figure 17b). In the United States, males scored 455 points in physics, compared to 409 points for females. This 46-percentage-point difference was again at the high end of the range of male-female differences across education systems, which otherwise ranged from 11 percentage points in Sweden to 35 percentage points in France. U.S. males' average physics score was higher than males' scores in France, Italy, and Lebanon, but lower than males' scores in Norway, the Russian Federation, and Slovenia. U.S. females' average physics score was higher than females' scores in France and Italy, but lower than females' scores in five education systems (Norway, Portugal, the Russian Federation, Slovenia, and Sweden).

Figure 17b. Average physics scores of TIMSS Advanced males and females, by education system: 2015



	United States[3]	France	Italy	Slovenia	Norway	Russian Federation	Portugal	Sweden	Lebanon[3]
Male-female difference in average scores:[1]	46	35	32	29	26	16	14	11	-11
Physics coverage index:[2]	4.8	21.5	18.2	7.6	6.5	4.9	5.1	14.3	3.9
Percent of covered population that is **female**:	39	47	46	30	29	42	25	41	37

* Average score is statistically different from the U.S. score of the same sex ($p < .05$).
[1] Difference in average scores is calculated by subtracting the females' estimate from the males' estimate using unrounded numbers.
[2] The physics coverage index is the percentage of the corresponding age cohort covered by students in their final year of secondary school who are taking or have taken physics courses. The corresponding age cohort is determined for education systems individually. In the United States, the corresponding age cohort is 18-year-olds. For additional details, see the Technical Notes available at http://nces.ed.gov/timss/timss15technotes.asp.
[3] See appendix table A1 for details on sampling issues in these education systems.
NOTE: Education systems are ordered by the male-female difference in average scores. Male-female differences are statistically significant ($p < .05$) in all education systems except Lebanon.
SOURCE: International Association for the Evaluation of Educational Achievement (IEA), Trends in International Mathematics and Science Study (TIMSS) Advanced, 2015.

References

Mullis, I.V.S., Martin, M.O., Foy, P., and Hooper, M. (2016). *TIMSS 2015 International Results in Mathematics.* Retrieved from http://timssandpirls.bc.edu/timss2015/international-results/.

Martin, M.O., Mullis, I.V.S., Foy, P., and Hooper, M. (2016). *TIMSS 2015 International Results in Science.* Retrieved from http://timssandpirls.bc.edu/timss2015/international-results/.

Mullis, I.V.S., Martin, M.O., Foy, P., and Hooper, M. (2016). *TIMSS Advanced 2015 International Results in Advanced Mathematics and Physics.* Retrieved from http://timssandpirls.bc.edu/timss2015/international-results/advanced/.

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Appendix: Brief Technical Notes

This appendix briefly describes features of the TIMSS and TIMSS Advanced 2015 assessments, with a particular focus on the U.S. implementation. For further details, see the full Technical Notes from NCES at http://nces.ed.gov/timss/timss15technotes.asp as well as the IEA's *Methods and Procedures in TIMSS 2015* (at http://timssandpirls.bc.edu/publications/timss/2015-methods.html) and *Methods and Procedures in TIMSS Advanced 2015* (at http://timss.bc.edu/publications/timss/2015-a-methods.html).

Sampling and response rates

TIMSS and TIMSS Advanced are sample-based assessments, meaning that while only a sample of students take the assessments, they are selected in such a way as to allow the results to be generalizable to a larger target population. The TIMSS and TIMSS Advanced target populations are based on standardized definitions, and the sampling is conducted following standardized and refereed international procedures.

TIMSS required participating countries and other education systems to draw probability samples of students who were nearing the end of their fourth or eighth year of formal schooling, counting from the first year of the International Standard Classification of Education (ISCED) Level 1 (or, primary schooling). (For additional information on ISCED levels, see http://www.uis.unesco.org/Education/Pages/international-standard-classification-of-education.aspx.) In the United States, one sample was drawn to represent the nation at grade 4 and another at grade 8. The U.S. national sample included both public and private schools, randomly selected and weighted to be representative of the nation at grade 4 and at grade 8. (See the section on sampling weights and standard errors in this report for definitions.) In addition, because Florida participated in TIMSS 2015 as a benchmarking participant, separate public school samples were drawn for Florida at both grades.

In total, the U.S. national sample in 2015 consisted of 250 schools and 10,029 students at grade 4, and 246 schools and 10,221 students at grade 8. The weighted school response rate for the United States was 77 percent at grade 4 before the use of substitute schools (schools substituted for originally sampled schools that refused to participate) and 85 percent with the inclusion of substitute schools. At grade 8, the weighted school response rate before the use of substitute schools was 78 percent, and 84 percent with the inclusion of substitute schools. The weighted student response rate at grade 4 was 96 percent, and at grade 8 was 94 percent. Student response rates are based on a combined total of students from both sampled and substitute schools.

TIMSS Advanced required participating countries and other education systems to draw probability samples of students in their final year of secondary school—ISCED Level 3—who were taking or had taken courses in advanced mathematics or who were taking or had taken courses in physics. In the United States, two samples of twelfth-graders were drawn to represent the nation—one for advanced mathematics and one for physics. (For additional information on ISCED levels, see http://www.uis.unesco.org/Education/Pages/international-standard-classification-of-education.aspx.) The courses that define the target populations had to cover most, if not all, of the advanced mathematics and physics topics that were outlined in the assessment frameworks. In the United States, this was defined as a calculus course for eligibility for the advanced mathematics population and an advanced physics course, such as Advanced Placement (AP) physics, for the physics population. The U.S. national samples included both public and private schools, randomly selected and weighted to be representative of the nation's advanced mathematics and physics students at the end of high school. (See the section on sampling weights and standard errors in this report for definitions.)

In total, the U.S. national sample in 2015 consisted of 241 schools for advanced mathematics and 165 schools for physics (of the original sample of 348 schools for both subjects). The weighted school response rate for the United States for advanced mathematics was 72 percent before the use of substitute schools and 76 percent with the inclusion of substitute schools. The weighted school response rate for the United States for physics was 65 percent before the use of substitute schools and 68 percent with the inclusion of substitute schools. In terms of the number of students, the U.S. national sample consisted of 2,954 students in advanced mathematics and 2,932 students in physics. The weighted student response rate was 87 percent for advanced mathematics and 85 percent for physics. Student response rates are based on a combined total of students from both sampled and substitute schools.

As indicated by footnotes in the cross-education system figures in this report, there were sampling or other issues in the United States and a number of education systems. For the current administration, these specific issues are detailed in table A1. For earlier administrations, these specific issues are detailed in table A2.

Additionally, as required by NCES standards, a nonresponse bias analysis was conducted because the U.S. school-level response rate for TIMSS at grades 4 and 8 and for both subjects in TIMSS Advanced fell below 85 percent of the sampled schools. The purpose of the analysis was to examine whether the participation status of schools was related to various characteristics and thus introduced the potential for bias in the results. The results suggested that there is some potential for nonresponse bias in the U.S. samples for grades 4 and 8 (prior to substitution) based on the characteristics studied. It also suggested that, while there was some evidence that the use of substitute schools at grade 4 reduced the potential for bias, it did not reduce it substantially. At grade 8, the use of substitute schools did not reduce the potential for bias nor did it add to it substantially. However, after the application of school nonresponse adjustments, there was no evidence of resulting potential bias in the final sample in either grade.

Analyses of TIMSS Advanced suggest that there is little potential for nonresponse bias in the advanced mathematics sample based on the characteristics studied. It also suggests that, while there is some evidence that the use of substitute schools has not reduced the potential for bias, it has not added to it substantially. Moreover, after the application of school nonresponse adjustments, there is little evidence of resulting potential bias in the final sample. In physics, however, the results suggest that there is some potential for nonresponse bias in the sample based on the characteristics studied. It also suggests that, while there is some evidence that the use of substitute schools reduced the potential for bias, it has not reduced it substantially. Moreover, after the application of school nonresponse adjustments, there is some evidence of resulting potential bias in the final sample with the largest bias in locale.

See the sections on Sampling, Data Collection, Response Rates and Sampling in the United States, and Nonresponse Bias Analysis in the Technical Notes at http://nces.ed.gov/timss/timss15technotes.asp for additional information.

Table A1. Sampling or other issues, by assessment, grade/subject, and education system: 2015

	Coverage			Sampling			Reliability	
	National Target Population does not include all of the International Target Population.	National Defined Population covers 90 to 95 percent of the National Target Population.	National Defined Population covers less than 90 percent of National Target Population (but at least 77 percent).	Met guidelines for sample participation rates only after replacement schools were included.	Nearly satisfied guidelines for sample participation rates after replacement schools were included.	Did not satisfy guidelines for sample participation rates.	Reservations about reliability because the percentage of students with achievement too low to estimate exceeds 15 percent but does not exceed 25 percent.	Reservations about reliability because the percentage of students with achievement too low to estimate exceeds 25 percent.
TIMSS Grade 4, Mathematics								
Abu Dhabi-UAE		•					•	
Bahrain		•						
Belgium (Flemish)-BEL				•				
Canada	•	•		•				
Denmark		•		•				
Florida-USA	•							
Georgia	•							
Hong Kong-CHN				•				
Italy		•						
Kuwait							•	
Lithuania		•						
Netherlands				•				
Northern Ireland-GBR					•			
Portugal		•						
Quebec-CAN						•		
Saudi Arabia							•	
Serbia			•					
Singapore		•						
Spain		•						
Sweden		•						
United States		•		•				

See notes at end of table.

Table A1. Sampling or other issues, by assessment, grade/subject, and education system: 2015—*Continued*

	Coverage			Sampling			Reliability	
	National Target Population does not include all of the International Target Population.	National Defined Population covers 90 to 95 percent of the National Target Population.	National Defined Population covers less than 90 percent of National Target Population (but at least 77 percent).	Met guidelines for sample participation rates only after replacement schools were included.	Nearly satisfied guidelines for sample participation rates after replacement schools were included.	Did not satisfy guidelines for sample participation rates.	Reservations about reliability because the percentage of students with achievement too low to estimate exceeds 15 percent but does not exceed 25 percent.	Reservations about reliability because the percentage of students with achievement too low to estimate exceeds 25 percent.
TIMSS Grade 4, Science								
Abu Dhabi-UAE		●						
Bahrain		●						
Belgium (Flemish)-BEL				●				
Canada	●	●		●				
Denmark		●		●				
Florida-USA	●							
Georgia	●							
Hong Kong-CHN				●				
Italy		●						
Kuwait							●	
Lithuania		●						
Morocco							●	
Netherlands				●				
Northern Ireland-GBR					●			
Portugal		●						
Quebec-CAN						●		
Serbia			●					
Singapore		●						
Spain		●						
Sweden		●						
United States		●		●				
TIMSS Grade 8, Mathematics								
Buenos Aires-ARG				●				●
Canada	●			●				
Chile							●	
Egypt							●	
Florida-USA	●							
Georgia	●	●						
Iran, Islamic Rep. of							●	

See notes at end of table.

Table A1. Sampling or other issues, by assessment, grade/subject, and education system: 2015—*Continued*

	Coverage			Sampling			Reliability	
	National Target Population does not include all of the International Target Population.	National Defined Population covers 90 to 95 percent of the National Target Population.	National Defined Population covers less than 90 percent of National Target Population (but at least 77 percent).	Met guidelines for sample participation rates only after replacement schools were included.	Nearly satisfied guidelines for sample participation rates after replacement schools were included.	Did not satisfy guidelines for sample participation rates.	Reservations about reliability because the percentage of students with achievement too low to estimate exceeds 15 percent but does not exceed 25 percent.	Reservations about reliability because the percentage of students with achievement too low to estimate exceeds 25 percent.
TIMSS Grade 8, Mathematics—*Continued*								
Israel			●					
Italy		●						
Jordan								●
Kuwait							●	
Lithuania		●						
Morocco								●
New Zealand				●				
Oman							●	
Qatar							●	
Quebec-CAN						●		
Saudi Arabia								●
Singapore		●						
United States				●				
TIMSS Grade 8, Science								
Buenos Aires-ARG				●				
Canada	●			●				
Florida-USA	●							
Georgia	●	●						
Israel			●					
Italy		●						
Lithuania		●						
New Zealand				●				
Quebec-CAN						●		
Singapore		●						
United States				●				

See notes at end of table.

Table A1. Sampling or other issues, by assessment, grade/subject, and education system: 2015—*Continued*

	Coverage			Sampling			Reliability	
	National Target Population does not include all of the International Target Population.	National Defined Population covers 90 to 95 percent of the National Target Population.	National Defined Population covers less than 90 percent of National Target Population (but at least 77 percent).	Met guidelines for sample participation rates only after replacement schools were included.	Nearly satisfied guidelines for sample participation rates after replacement schools were included.	Did not satisfy guidelines for sample participation rates.	Reservations about reliability because the percentage of students with achievement too low to estimate exceeds 15 percent but does not exceed 25 percent.	Reservations about reliability because the percentage of students with achievement too low to estimate exceeds 25 percent.
TIMSS Advanced, Advanced Mathematics								
Lebanon						●		
Portugal				●				
United States						●		
TIMSS Advanced, Physics								
Lebanon						●		
United States						●		

SOURCE: Mullis, I.V.S., Martin, M.O., Foy, P., and Hooper, M. (2016). *TIMSS 2015 International Results in Mathematics and TIMSS 2015 International Results in Science,* retrieved from http://timssandpirls.bc.edu/timss2015/international-results/; and Mullis, I.V.S., Martin, M.O., Foy, P. and Hooper, M. (2016). *TIMSS Advanced 2015 International Results in Advanced Mathematics and Physics,* retrieved from http://timssandpirls.bc.edu/timss2015/international-results/advanced/.

Table A2. Sampling or other issues, by assessment, grade/subject, and education system: 1995, 2003, 2007, and 2011

	Coverage			Sampling			Reliability	
	National Target Population does not include all of the International Target Population.	National Defined Population covers 90 to 95 percent of the National Target Population.	National Defined Population covers less than 90 percent of National Target Population (but at least 77 percent).	Met guidelines for sample participation rates only after replacement schools were included.	Nearly satisfied guidelines for sample participation rates after replacement schools were included.	Did not satisfy guidelines for sample participation rates.	Reservations about reliability because the percentage of students with achievement too low to estimate exceeds 15 percent but does not exceed 25 percent.	Reservations about reliability because the percentage of students with achievement too low to estimate exceeds 25 percent.
TIMSS Grade 4, Mathematics								
United States (2003)				●				
United States (2007)		●		●				
United States (2011)		●						
TIMSS Grade 4, Science								
United States (2003)				●				
United States (2007)		●		●				
United States (2011)		●						
TIMSS Grade 8, Mathematics								
United States (1995)				●				
United States (2003)					●			
United States (2007)		●		●				
United States (2011)		●						
TIMSS Grade 8, Science								
United States (1995)				●				
United States (2003)					●			
United States (2007)		●		●				
United States (2011)		●						
TIMSS Advanced, Advanced Mathematics								
Italy (1995)						●		
Slovenia (1995)					●			
United States (1995)						●		
TIMSS Advanced, Physics								
Norway (1995)						●		
Slovenia (1995)					●			
United States (1995)						●		

NOTE: For the TIMSS assessments, coverage, sampling, and other reliability issues from prior administrations are listed only for the United States, as other education systems are not included in the trend results in this report. There were no coverage, sampling, or other reliability issues in the United States at grade 4 in 1995 or at grade 8 in 1999. The TIMSS assessments were not administered at grade 4 in 1999. For the TIMSS Advanced assessments, coverage, sampling, and other reliability issues are listed only for 1995 because results from the 2008 administration are not included in the report.

SOURCE: Mullis, I.V.S., Martin, M.O., Foy, P., and Hooper, M. (2016). *TIMSS 2015 International Results in Mathematics and TIMSS 2015 International Results in Science,* retrieved from http://timssandpirls.bc.edu/timss2015/international-results/; and Mullis, I.V.S., Martin, M.O., Foy, P. and Hooper, M. (2016). *TIMSS Advanced 2015 International Results in Advanced Mathematics and Physics,* retrieved from http://timssandpirls.bc.edu/timss2015/international-results/advanced/.

Assessment and questionnaires

The 2015 assessment instruments for TIMSS and TIMSS Advanced were developed by international Item Review Committees and included items submitted by participating education systems and other subject matter experts. In TIMSS, about 57 percent of the items were from previous assessments and about 43 percent were developed for the 2015 assessment. In TIMSS Advanced, about 33 percent of the items were from previous assessments and about 67 percent were developed for the 2015 assessment. Items were reviewed by representatives of each country for possible bias. To further examine potential biases and design issues in the TIMSS and TIMSS Advanced assessments, nearly all participating education systems field-tested the assessment items in 2014. After the field trial, items that did not meet the established measurement criteria or were otherwise found to include intrinsic biases were dropped for the main assessment.

The 2015 assessment instruments for TIMSS and TIMSS Advanced were organized in booklets and were constructed such that no students responded to all of the items.

The TIMSS fourth-grade assessment consisted of 14 booklets, each requiring approximately 72 minutes; and the eighth-grade assessment consisted of 14 booklets, each requiring approximately 90 minutes. Each student completed just one booklet. The fourth- and eighth-grade assessments were both given in two equal time periods (i.e., 36 or 45 minutes each), with a 5- to 10-minute break in between. At both grades, the mathematics and science items were each assembled separately into 28 blocks of items. Booklets consisted of 4 blocks each, including at least one mathematics block and at least one science block.

The TIMSS Advanced assessments consisted of 6 booklets for advanced mathematics and 6 booklets for physics, each requiring approximately 90 minutes. Each student completed just one booklet. In both subjects, booklets consisted of 3 blocks each.

After the cognitive assessment, students also completed a 30-minute questionnaire designed to provide information about their backgrounds, attitudes, and experiences in school. Principals in schools where TIMSS and TIMSS Advanced were administered and teachers of students participating in the assessments also completed questionnaires designed to provide information on their school's structure, resources, instruction, climate, and policies and on their own educational background and experiences.

See the sections on Test Development and the Student, Teacher, and School Questionnaires in the Technical Notes at http://nces.ed.gov/timss/timss15technotes.asp for more information about the field trial, assessment design, and questionnaires.

Reporting results

In TIMSS and TIMSS Advanced 2015, results are generally reported in two ways: scale scores and international benchmarks of achievement. The TIMSS scales in science and mathematics and the TIMSS Advanced scales in advanced mathematics and physics are from 0 to 1,000. Both TIMSS and TIMSS Advanced provide overall scale scores as well as subscale scores for the content and cognitive domains. In addition to a range of scale scores as the basic form of measurement, TIMSS and TIMSS Advanced describe student performance in terms of the percentage of students reaching international benchmarks. These international benchmarks provide a way to interpret the scale scores and to understand how students' proficiency varies at different points on the scales, because each successive point, or benchmark, is associated with particular kinds of knowledge and skills that students must successfully demonstrate. See the Weighting, Scaling, and Plausible Values and International Benchmarks sections of the Technical Notes at http://nces.ed.gov/timss/timss15technotes.asp for more information.

Sampling weights and standard errors

Sampling weights are necessary to compute statistically sound estimates. Adjusted survey weights adjust for the probabilities of selection for individual schools and classrooms and for school or student nonresponse. As with any study, there are limitations that should be taken into consideration. Estimates produced using data from TIMSS and TIMSS Advanced 2015 are subject to two types of error: nonsampling errors and sampling errors. The sources of nonsampling errors are typically problems such as unit and item nonresponse, the differences in respondents' interpretations of the meaning of survey questions, and mistakes in data preparation. Sampling errors arise when a sample of the population, rather than the whole population, is used to estimate some statistic. Different samples from the same population would likely produce somewhat different estimates of the statistic in question. This uncertainty is referred to as sampling variance and is usually expressed as the standard error of a statistic estimated from sample data. Standard errors for all statistics reported in this report are available in the associated web tables at http://nces.ed.gov/timss/timss2015/. See the sections on Weighting, Scaling, and Plausible Values and Data Limitations in the Technical Notes at http://nces.ed.gov/timss/timss15technotes.asp.

Statistical comparisons

Comparisons made in this report have been tested for statistical significance. For example, in the commonly made comparison of education system averages against the U.S. average, tests of statistical significance were used to establish whether or not the observed differences from the U.S. average were statistically significant. The tests for significance used were standard *t* tests. These fell into two categories according to the nature of the comparison being made: comparisons of independent samples and comparisons of nonindependent samples. A difference is "significant" if the probability (*p*) associated with the *t* test is less than .05. If a test is significant, it implies that the difference between the observed means in the sample represents a real difference in the population. No adjustments were made for multiple comparisons. See the section on Statistical Procedures in the Technical Notes at http://nces.ed.gov/timss/timss15technotes.asp for more information.

Additional information

Results from the 2015 TIMSS and TIMSS Advanced assessments can be explored in more detail at http://nces.ed.gov/timss. The TIMSS 2015 website houses numerous resources—including summaries of key findings, web tables, example items, and technical notes—for exploring the TIMSS and TIMSS Advanced assessments. Additionally, the TIMSS International Data Explorer (IDE) gives users the ability to analyze TIMSS data and create customized tables and figures for the United States and other participating education systems. The TIMSS IDE is available at http://nces.ed.gov/timss/idetimss/.

The TIMSS international reports are also available online at:

- Mathematics: http://timssandpirls.bc.edu/timss2015/international-results/.
- Science: http://timssandpirls.bc.edu/timss2015/international-results/.
- Advanced mathematics and physics: http://timssandpirls.bc.edu/timss2015/international-results/advanced/.