CHAPTER 1

Elementary and Secondary Mathematics and Science Education

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Highlights

Student Learning in Mathematics and Science

The National Assessment of Educational Progress (NAEP) mathematics assessment results show that average mathematics scores for fourth, eighth, and twelfth graders declined slightly for the first time in 2015 and remained flat or showed only small gains between 2005 and 2015.

- The average NAEP mathematics score in 2015 declined by 2 points for fourth graders, 3 points for eighth graders, and 1 point for twelfth graders compared with 2013. These are the first declines since 1990 for fourth and eighth graders and since 2005 for twelfth graders.
- Although the long-term trend in average scores for fourth and eighth graders has been upward, the improvement slowed down this past decade. From 2005 to 2015, average NAEP mathematics scores increased by 2 points for fourth graders and 3 points for eighth graders; in comparison, from 1996 to 2005, the average scores increased by 14 points for fourth graders and 9 points for eighth graders.

NAEP science assessment results show that average scores increased slightly in 2015 for fourth and eighth graders but stayed similar for twelfth graders.

- The average NAEP science scores increased 4 points between 2009 and 2015 in grades 4 and 8 but did not change in grade 12.

Less than half of fourth, eighth, and twelfth grade students achieved a level of proficient (defined as "solid academic performance") or higher on NAEP mathematics and science assessments in 2015.

- Forty percent of fourth graders, 33% of eighth graders, and 25% of twelfth graders achieved a level of proficient or higher in mathematics in 2015.
- Approximately 38% of fourth graders, 34% of eighth graders, and 22% of twelfth graders achieved a level of proficient or higher on the NAEP science assessment in 2015.

Performance disparities in mathematics and science were evident among different demographic groups at all grade levels.

- Average scores on 2015 NAEP mathematics and science assessments for fourth, eighth, and twelfth grade students who were eligible for free or reduced-price lunch (an indicator of socioeconomic status) were 23 to 29 points lower than the scores of their peers who were not eligible for the program.
- Performance gaps between white students and black and Hispanic students showed similar patterns across all NAEP assessments and grade levels, with average scores of white students at least 18 points higher than those of Hispanic students and at least 24 points higher than those of black students.
- Score differences between students eligible for free or reduced-price lunch and those who were not persisted within racial or ethnic groups. For example, the gaps between eligible and non-eligible students in grade 4 mathematics were 18 points among white students, 17 points among Hispanic students, and 16 points among black students. Similar gaps held among eighth and twelfth grade students and across all grade levels in science.

- Gaps between male and female students on NAEP mathematics and science assessments were small, with average score differences of two to five points in favor of male students. There was no difference in average scores by sex for grade 8 mathematics or grade 4 science.

Performance disparities in mathematics and science begin as early as kindergarten and persist through subsequent school years.

- A study based on the mathematics and science assessment scores among the kindergarten class of 2010–11 shows that gaps in average scores by race or ethnicity and family income level evident in kindergarten do not narrow by the end of third grade.
- The gap in average mathematics scores between students in families with income below the federal poverty level and those in families with income at or above 200% of the federal poverty level was 9 points at the beginning of kindergarten and 10 points by the spring of third grade; the science score gap was 5 points at the beginning of first grade and 8 points by the spring of third grade.
- The gap in average mathematics scores between white and black students was 6 points at the beginning of kindergarten and 13 points in the spring of third grade; the science score gap was 5 points at the beginning of first grade and 9 points by the spring of third grade.

In the international arena, the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA) 2015 data show that the U.S. average mathematics assessment scores were well below the average scores of the top-performing education systems.

- On the TIMSS mathematics assessment, average scores for the top five performers—Singapore, Hong Kong, South Korea, Taiwan, and Japan—were at least 54 points higher than the United States at grade 4 (593–618 versus 539) and at least 68 points higher than the United States at grade 8 (586–621 versus 518).
- The United States' average score of 470 on the PISA mathematics literacy assessment for 15-year-olds was at least 62 points below the average scores (532–564) of the top five performers—Singapore, Hong Kong, Macau, Taiwan, and Japan.

TIMSS data show that U.S. fourth and eighth graders have raised their scores over the 20 years since administration of the first TIMSS mathematics assessment in 1995.

- Between 1995 and 2015, the average mathematics score increased by 21 points for fourth graders and by 26 points for eighth graders.

The 2015 data from PISA indicate that the United States performs better internationally in science literacy than it does in mathematics literacy.

- The United States' average science literacy score of 493 was not significantly different from the Organisation for Economic Co-operation and Development (OECD) average and put the United States behind 18 other education systems. In contrast, the mathematics literacy score was below the OECD average and put the United States behind 36 other education systems.

High School Coursetaking in Mathematics and Science

Among ninth graders who entered high school in 2009 and completed high school in 2013, the vast majority (89%) completed algebra 2 or higher in mathematics, and nearly all (98%) completed biology in science.

- Approximately one-quarter of students stopped with algebra 2 as their highest mathematics course, another quarter stopped with trigonometry or other advanced mathematics, 22% advanced to pre-calculus, and 19% finished with calculus or higher.
- In addition to taking biology, 76% of ninth graders who began high school in 2009 took chemistry and 42% took physics by the time they completed high school in 2013.

The number of high school students who take Advanced Placement (AP) exams in mathematics and science continues to rise.

- Calculus AB is the most common mathematics AP exam. The number of students who took an AP exam in calculus AB increased from 197,000 in 2006 to more than 308,000 in 2016.
- Biology is the most common science AP exam. The number of students who took an AP exam in biology increased from nearly 132,000 in 2006 to 238,000 in 2016.
- Computer science A is the fastest-growing AP exam, with the number of students taking the exam growing nearly four-fold from just under 15,000 in 2006 to nearly 58,000 in 2016.
- Passing rates for the mathematics and science AP exams in 2016 ranged from lows of 40% for physics 1 and 46% for environmental science to highs of 77% for physics C: mechanics and 81% for calculus BC.

Teachers of Mathematics and Science

The majority of K–12 mathematics and science teachers held a teaching certificate and had taught their subjects for 3 years or more.

- In 2011, the vast majority of public middle and high school mathematics (91%) and science (92%) teachers were fully certified (i.e., held regular or advanced state certification).
- In 2011, 85% of public middle and high school mathematics teachers and 90% of science teachers had more than 3 years of teaching experience.

Fully certified, well-prepared, and experienced teachers were not evenly distributed across schools or classes.

- Fully certified mathematics and science teachers were less prevalent in high-minority and high-poverty schools when compared with schools with students from higher-income families. For example, in 2011, 88% of mathematics teachers in high-poverty schools were fully certified, compared with 95% of those in low-poverty schools.
- At the middle school level, in 2011, 75% of mathematics teachers in low-poverty schools had in-field degrees, compared with 63% of teachers at high-poverty schools.
- At the high school level, 95% of mathematics teachers at low-poverty schools had in-field degrees, compared with 87% at high-poverty schools.
- The percentage of mathematics teachers with fewer than 3 years of experience was higher at high-poverty schools (18%) than at low-poverty schools (10%). The pattern was similar for science teachers.

In 2011, the average base salary of middle and high school teachers was approximately $53,000 for mathematics teachers and $54,000 for science teachers.

- Compensation for U.S. mathematics and science teachers was nearly equivalent to that of teachers of other subjects in 2011.
- In the international arena, the United States ranks low among developed countries with respect to teachers' salaries relative to the salaries of other college-educated workers. For primary school teachers, the U.S. ranking is 20th of 23 countries. For lower and upper secondary school teachers, the United States is 21st of 23 countries.

Instructional Technology and Digital Learning

The use of instructional technology in K–12 classrooms has grown, and the number of schools with adequate bandwidth for accessing the Internet has increased.

- In 2009, 97% of K–12 public school teachers reported that they had one or more computers in their classroom, and 69% said that they or their students often or sometimes used computers during class time.
- In 2016, more than two-thirds of school district technology administrators indicated that all the schools in their district fully met the Federal Communication Commission's Internet bandwidth recommendations for public schools, up from 19% in 2012.
- National data available to address the quality and effectiveness of technology-based educational programs delivered in classrooms remain limited; available research has generally shown only modest positive effects of technology on learning.

The number of students participating in online learning has also risen.

- In the 2014–15 school year, 24 states operated virtual schools that offered supplemental online courses for students. These schools served more than 462,000 students, who took a total of 815,000 online semester-long courses. Although still a small fraction of the approximately 50 million students enrolled in K–12 public schools, this was a substantial increase since 2012–13, when 721,149 semester course enrollments were recorded.
- High school students took most of these courses (85%). Math courses made up nearly 23% of the courses taken, and science courses made up 14%.

Transition to Higher Education

U.S. on-time high school graduation rates have improved steadily.

- In 2011, 79% of public high school students graduated on time with a regular diploma; by 2015, the figure had climbed to 83%.
- Although on-time graduation rates for economically disadvantaged students have improved by 6 percentage points since 2011, these students continue to graduate at lower rates than the general population (76% versus 83% in 2015).

Significant racial and ethnic differences persisted, with white and Asian or Pacific Islander students having higher graduation rates than other racial or ethnic subgroups.

- In 2015, the on-time high school graduation rates for Asian or Pacific Islander and white students were 90% and 88%, respectively; and both rates surpassed those of black, Hispanic, and American Indian or Alaska Native students (72%–78%) by at least 10 percentage points.

Immediate college enrollment rates have increased for all students from 1975 to 2015, although differences remain for demographic groups.

- Between 1975 and 2015, the percentage of high school graduates making an immediate transition to college increased from 51% to 69%.
- In 2015, the immediate college enrollment rate of students from low-income families was 14 percentage points lower than the rate of those from high-income families (69% versus 83%).
- Enrollment rates also varied widely with parental education, ranging in 2015 from 56% for students whose parents had less than a high school education to 82% for students whose parents had a bachelor's degree or higher.

Introduction

Chapter Overview

Elementary and secondary education in mathematics and science is the foundation of human capital that advances science and engineering research, technology development, innovation, and economic growth. Every U.S.-educated scientist and engineer begins his or her science, technology, engineering, and mathematics (STEM) education in the K–12 grades. There, talents may be built or discovered, interest in STEM cultivated, and knowledge acquired that allows students to succeed in pursuing STEM degrees in postsecondary education. For those who do not pursue STEM, the mathematics and science knowledge needed to function as consumers and citizens emerges largely from K–12 education. Within this context, federal and state policymakers, educators, and legislators are working to broaden and strengthen STEM education at the K–12 level. Efforts to improve mathematics and science learning include promoting early participation in STEM in the elementary grades, increasing advanced coursetaking in high school, recruiting and training more mathematics and science teachers, and expanding secondary education programs that prepare students to enter STEM fields in college.

The Every Student Succeeds Act (ESSA), the first reauthorization of the Elementary and Secondary Education Act in nearly a decade, was signed into law in late 2015. The act identifies STEM as a crucial component of a well-rounded education for all students. It also allows states to act on a variety of STEM priorities, including mathematics and science standards and assessment, recruitment and training of STEM teachers, formation of STEM specialty schools, and increased access to STEM for underserved and at-risk student populations. ESSA also provides new focus on engineering and technology by explicitly including computer science in its definition of STEM and by allocating federal funds to help states integrate engineering and technology into their science standards and assessments.

Educators have joined a state-led effort to develop common national K−12 mathematics and science standards, as well as assessments and indicators for monitoring progress in K−12 mathematics and science teaching and learning. Many states have adopted and implemented the Common Core State Standards in mathematics, and 18 states and the District of

Columbia have adopted the Next Generation Science Standards. Progress is also being made on a national system for monitoring progress in STEM education (see sidebar Developing a K–12 STEM Education Indicator System).

SIDEBAR

Developing a K–12 STEM Education Indicator System

In 2011, the National Research Council (NRC) released *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics*, which describes the components of successful science, technology, engineering, and mathematics (STEM) education (National Research Council [NRC] 2011). In response, Congress requested that the National Science Foundation (NSF) identify methods for tracking and evaluating the implementation of the components recommended by the NRC. An NRC-convened committee authored a second report that outlined 14 indicators of successful STEM education that could be monitored and tracked, including markers of students' access to quality learning, educators' capacity, and STEM policy and funding initiatives (NRC 2013). The report also addressed the need for research and data that could be used to measure progress on each indicator, noting that many of the indicators required new kinds of data collection, additional research, and conceptual development.

The STEM Indicators project has identified data sources that can be used for the indicators and other areas in which new data sources are needed (http://stemindicators.org/). New data sources include new questions on the National Teacher and Principal Survey of 2017–18, which will collect, for the first time, data on STEM school magnet programs, the amount of instructional time devoted to science, and teacher professional development in STEM topics. NSF has funded 15 research projects investigating valid and reliable measurement of the indicators and has initiated another grant cycle for additional research and development (http://stemindicators.org/stem-education-researchers/dclprojects/).

Chapter Organization

To provide a portrait of K−12 STEM education in the United States, including comparisons of U.S. student performance with that of other nations, this chapter compiles indicators of pre-college mathematics and science teaching and learning based mainly on data from the National Center for Education Statistics (NCES) of the Department of Education, supplemented by other public sources. Table 1-1 contains an overview of the topics covered in this chapter and the indicators used to address them. Whenever a comparative statistic is cited in this chapter, it is statistically significant at the 0.05 probability level.

This chapter focuses on overall patterns in STEM education and reports variation in STEM access and performance by students' socioeconomic status (SES), race or ethnicity, and sex. The chapter also examines differences by SES and sex within racial or ethnic groups. Research suggests that STEM education can provide historically underrepresented populations with pathways for obtaining good jobs and a higher standard of living, if they can access these opportunities (Doerschuk et al. 2016; Leadership Conference Education Fund 2015; Wang and Degol 2016). Data in this chapter reveal consistent achievement and opportunity gaps in STEM education across the K–12 spectrum. With few exceptions, the data show major, substantial effects of SES on achievement levels, early and persisting differences among racial or ethnic groups, often substantial achievement differences by SES within racial or ethnic groups, and some differences in male and female achievement. These results are consistent across all types of data discussed, including tests of different student panels, tests that follow specific age cohorts, international tests, student coursetaking in high school, on-time high school graduation rates, scores on college readiness assessments, and immediate college enrollment rates.

This chapter is organized into five sections. The first section presents indicators of U.S. students' performance in STEM subjects in elementary and secondary school. It begins with a review of national trends in mathematics and science assessment scores in grades 4, 8, and 12, using data from the National Assessment of Educational Progress (NAEP). The NAEP section also includes data from a new assessment of eighth graders' technology and engineering literacy. Next, the section presents data from a longitudinal study that tracks individual students' growth in mathematics and science knowledge over time: the Early Childhood Longitudinal Study, Kindergarten Class of 2010–11 (ECLS-K:2011). The section ends by placing U.S. student performance in an international context, using data from two international studies: the Trends in International Mathematics and Science Study (TIMSS), which examines the mathematics and science performance of students in grades 4, 8, and 12; and the Program for International Student Assessment (PISA), which examines the mathematics and science literacy of 15-year-olds.

The second section focuses on STEM coursetaking in high school. Using data from NCES's High School Longitudinal Study of 2009 (HSLS:09), data from the College Board's Advanced Placement (AP) program, and data collected by the Department of Education's Office for Civil Rights, it examines high school students' participation in mathematics and science courses, including engineering and computer science.

The third section turns to U.S. elementary, middle, and high school mathematics and science teachers, reviewing data presented in *Science and Engineering Indicators 2016* (National Science Board [NSB] 2016) and presenting new data comparing U.S. teachers' salaries with those of their peers in other countries.

The fourth section examines how technology is used in K−12 education. The section begins by presenting the latest national data on the availability or use of various technological devices in classrooms, Internet access in schools, and the prevalence of online learning among K–12 students. It then provides a review of research on the effectiveness of technology as an instructional tool to improve student learning outcomes.

The fifth section focuses on indicators related to U.S. students' transitions from high school to postsecondary education. It presents national data for on-time high school graduation rates, trends in immediate college enrollment after high school, academic readiness for college, and students' plans to major in a STEM subject in college. This section also examines the high school graduation rates of U.S. students relative to those of their peers in other countries. Together, these indicators present a broad picture of the transition of U.S. students from high school to postsecondary education, the topic of Chapter 2.

TABLE 1-1

Indicators of elementary and secondary school mathematics and science education

(Topic and indicator)

Topic	Indicator
Student learning in mathematics and science	• Trends in fourth, eighth, and twelfth graders' mathematics performance through 2015 • Eighth graders' technology and engineering literacy in 2014 • Mathematics and science performance of first-time kindergarten students in the 2012–13 and 2013–14 school years • International comparisons of mathematics and science performance of students in grades 4, 8, and 12 in 2015 • International comparisons of 15-year-olds' mathematics and science literacy in 2015
Student coursetaking in mathematics and science	• Highest mathematics and science course enrollment of high school completers in 2013 • Trends in participation and performance in the Advanced Placement program from 2006 to 2016
Teachers of mathematics and science	• Certification, experience, and salaries of U.S. mathematics and science teachers in 2012 • International comparisons of teacher salaries in 2014
Instructional technology and digital learning	• Review of emerging practices of instructional technology and online learning and their effects on student learning
Transitions to higher education	• Trends in on-time high school graduation rates from 2011 to 2015 • International comparisons of secondary school graduation rates in 2014 • Immediate college enrollment from 1975 to 2013 • High school students reporting plans for a postsecondary STEM major in 2013 • High school students meeting college readiness benchmarks in 2016

STEM = science, technology, engineering, and mathematics.

Science and Engineering Indicators 2018

Student Learning in Mathematics and Science

Increasing academic achievement for *all* students—with an emphasis on improving the performance of low-achieving students—is a critical goal of education reform in the United States. It is equally important to increase the number and diversity of students achieving at the highest academic levels. Many educators and policymakers focus on improving student learning in STEM subjects because workers' proficiency in STEM fields is considered vital to the health of the economy (Atkinson and Mayo 2010; PCAST 2012). This section presents indicators of U.S. students' performance in STEM subjects in elementary and secondary school. It begins with a review of national trends in scores on mathematics and science assessments, using data from NAEP. Next, it presents data from ECLS-K:2011, which focused on students' growth from kindergarten to third grade. The section ends by placing U.S. student performance in an international context, comparing the mathematics and science literacy of U.S. 15-year-olds and the mathematics and science performance of U.S. fourth, eighth, and twelfth graders with those of their peers in other countries.

National Trends in K–12 Student Achievement

This subsection looks at trends in U.S. students' achievement in mathematics and science over time, presenting estimates from NAEP, the largest nationally representative and continuing assessment of what America's students know and can do in various subject areas. Contributing to this review are 2015 data from the main NAEP mathematics and science assessments of students in grades 4, 8, and 12. All NAEP assessments include students from public and private schools, so results are representative of the in-school population in the United States. Comparable NAEP data are available beginning in 1990 for mathematics for grades 4 and 8 and beginning in 2005 for grade 12.[1] Comparable science data are available since 2009 for all three grades.[2] NAEP 2015 includes the first science achievement data collected for fourth and twelfth graders in 6 years and for eighth graders in 4 years. The section also provides information about student performance in technology and engineering, based on results from a new NAEP assessment, technology and engineering literacy (TEL), which was first administered to eighth graders in 2014. TEL will be administered to students in grades 4 and 12 in future years.

Reporting Results for the Main NAEP

The main NAEP reports student performance in two ways: scale scores and student achievement levels. A scaled score is the total number of correct questions (raw score) on an exam that have been converted onto a consistent and standardized scale. This standardization allows scores reported from a test to have consistent meaning for all test takers, especially across different editions of the same test. Main NAEP scale scores range from 0 to 500 for grades 4 and 8 and from 0 to 300 for grade 12 on the mathematics assessment. On the science and TEL assessments, however, the scale scores range from 0 to 300 for all students. With broad input from the public, educators, and policymakers, the National Assessment Governing Board (NAGB), an independent board that sets policy for NAEP, has developed achievement levels that indicate the extent of students' achievement expected for a particular grade level. There has been some debate that these levels may be too rigorous; thus, results should be interpreted with caution (Loveless 2016).[3] The three grade-specific achievement levels for mathematics, science, and technology/engineering literacy are the following:

Basic: partial mastery of knowledge and skills

Proficient: solid academic performance

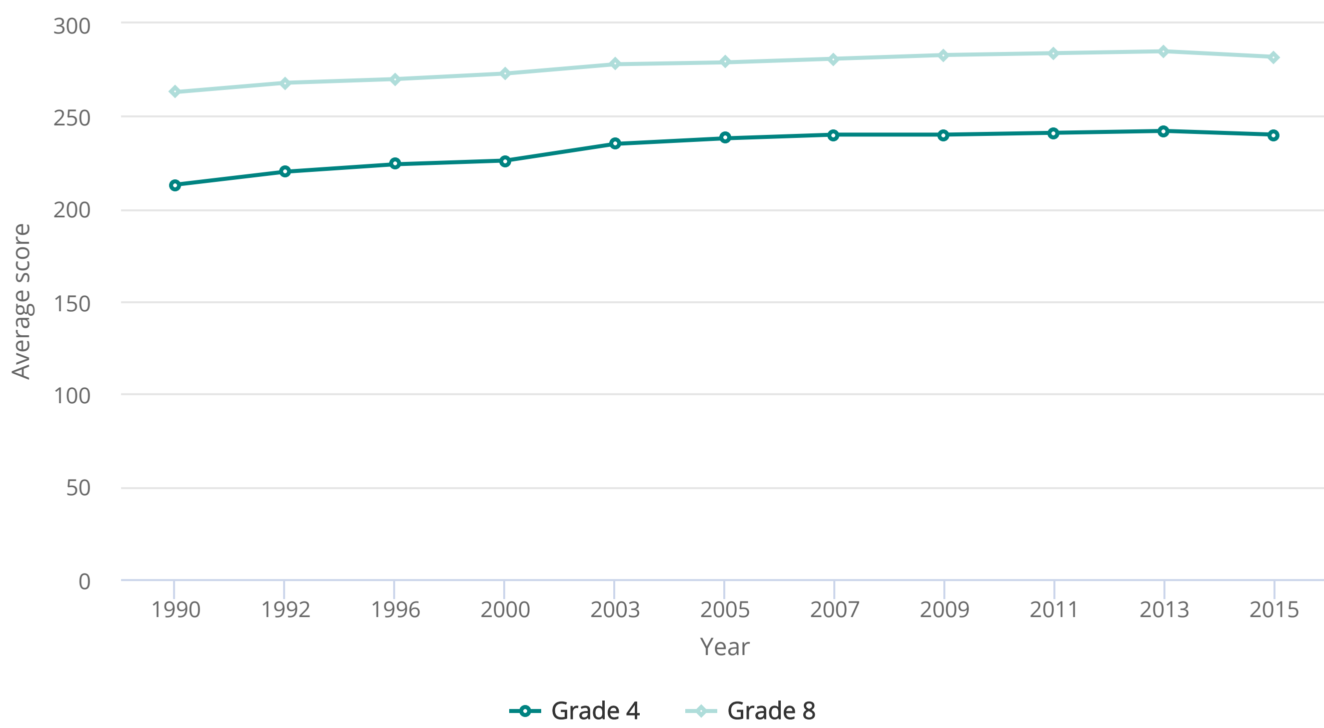
Advanced: superior academic performance

Mathematics Performance of Students in Grades 4, 8, and 12 in 2015

Average score. The average NAEP mathematics score in 2015 was 240 for fourth graders, 282 for eighth graders, and 152 for twelfth graders (Appendix Table 1-1). These scores represent a slight decline from 2013, when the scores were 242, 285, and 153, respectively. These are the first declines in NAEP mathematics assessments since 1990 for fourth and eighth graders and since 2005 for twelfth graders, although these are small changes and may be a natural fluctuation rather than the start of a downward trend. Although the scale is 0 to 500 for the fourth and eighth grade assessments and 0 to 300 for the twelfth grade, it is important to note that the effective score range (i.e., the range from the 10th to the 90th percentiles) for the preponderance of students is less than 100 points, which puts the magnitude of score differences in context. Eighty percent of fourth graders scored between 202 and 277, 80% of eighth graders scored between 235 and 329, and 80% of twelfth graders scored between 107 and 196. Although the long-term trend in average scores for fourth and eighth graders has been upward, the improvement slowed down this past decade. From 2005 to 2015, average NAEP mathematics scores increased by 2 points for fourth graders and 3 points for eighth graders; in comparison, from 1996 to 2005, the average scores increased by 14 points for fourth graders and 9 points for eighth graders (Figure 1-1).

FIGURE 1-1

Average NAEP mathematics scores of students in grades 4 and 8: 1990–2015



NAEP = National Assessment of Educational Progress.

Note(s)

NAEP mathematics assessment scores range from 0 to 500 for grades 4 and 8.

Source(s)

National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2016) of NAEP 1990, 1992, 1996, 2000, 2003, 2005, 2007, 2009, 2011, 2013, and 2015 mathematics assessments, National Center for Education Statistics. See Appendix Table 1-1.

Science and Engineering Indicators 2018

Socioeconomic status. NAEP uses eligibility for the National School Lunch Program (NSLP) as an indicator for SES, with eligibility for the program considered an indicator of SES. It is widely understood that eligibility for the NSLP is an inadequate measure of student poverty or SES for a variety of reasons (Cowan et al. 2012; Snyder and Musu-Gillette 2015). For example, students above the federal poverty level may still qualify for the NSLP, and a comprehensive measure of a student's SES would include such factors as parental education and occupation in addition to measures of poverty. NAGB and others continue to report school lunch eligibility as a proxy for SES because it is the only measure that is available at the school level. Information on family income, parental education, parental occupation, and other factors needed to better capture SES are not readily available. NAGB is pursuing other ways to report SES for students taking NAEP exams. In the meantime, readers should interpret SES results reported here with the understanding that eligibility for school lunch is not a precise measure of the construct.

Average 2015 NAEP mathematics assessment scores varied by school lunch eligibility for all grade levels, with eligible students posting average scores from 23 to 28 points lower than non-eligible students (Appendix Table 1-1). In the past decade, the gap between eligible and non-eligible students did not decrease in size at any grade level.

Race or ethnicity. Scores also varied by race or ethnicity at all grade levels, with Asian or Pacific Islander students receiving the highest average scores at all three grade levels (Appendix Table 1-1). In 2015, for example, average mathematics scores for eighth graders were 306 for Asian or Pacific Islander students, 292 for white students, 270 for Hispanic students, and 260 for black students. It is important to note that these are average scores, however, and that students from all groups score at the higher and lower ends of the score distributions. Fourth and eighth grade Hispanic and black students reduced gaps relative to white students between 2005 and 2015. Although the average score for white students in grade 4 increased by 2 points after 2005, the average score rose by 4 points for Hispanic students and by 4 points for black students. Similarly, in grade 8, scores improved by 8 and 5 points for Hispanic and black students, respectively, compared with a 3-point gain for white students.

Sex. The average mathematics scores for male fourth graders and twelfth graders were slightly higher than the average scores for female students in those grades: 241 for male versus 239 for female fourth graders, and 153 for male versus 150 for female twelfth graders. There was no difference in scores by sex for eighth graders because female students at this grade level gained more points (4 since 2005) in the past decade than male students did (2 since 2005).

Socioeconomic status and sex by race or ethnicity. Score differences between students who were eligible for free or reduced-price lunch (low SES) and those who were not eligible (high SES) were observed within racial or ethnic groups in 2015. For example, the gaps between eligible and non-eligible students in grade 4 were 25 points among Asian or Pacific Islander students, 18 points among white students, 17 points among Hispanic students, and 16 points among black students (Table 1-2). Similar gaps held among eighth and twelfth grade students, except for a smaller 9-point gap among Hispanic students in grade 12.

A few small differences in average mathematics scores by sex were observed in 2015 within racial or ethnic groups (Table 1-2). In grade 4, the average score for white male students was 2 points higher than the score for white female students. Among black students in grade 4, the pattern was reversed, with the average score for black female students 2 points higher than the score for black male students. The average score for black female students was also higher than that for black male students in grade 8, although there was no significant difference by sex at grade 12. The largest difference in average scores for male and female students was among Hispanic students in grade 12. The average score for male students was 5 points higher than that for female students.

TABLE 1-2

Average scores of students in grades 4, 8, and 12 on the main NAEP mathematics assessment, by socioeconomic status and sex within race or ethnicity: 2015

(Average score)

Grade and race or ethnicity	Socioeconomic status[a]		Sex	
	Eligible for free or reduced-price lunch	Not eligible for free or reduced-price lunch	Male	Female
All students in grade 4				
White	237	255	249	247
Black	221	237	223	225
Hispanic[b]	227	244	231	229
Asian or Pacific Islander	241	266	259	255
American Indian or Alaska Native	223	239	228	226
More than one race	233	256	246	244
All students in grade 8				
White	276	298	292	291
Black	256	273	259	262
Hispanic[b]	266	282	270	270
Asian or Pacific Islander	291	316	305	306
American Indian or Alaska Native	260	280	265	270
More than one race	271	296	285	285
All students in grade 12				
White	145	164	161	159
Black	124	140	129	131
Hispanic[b]	135	144	141	136
Asian or Pacific Islander	157	177	171	169
American Indian or Alaska Native	133	s	141	s
More than one race	144	165	158	157

s = suppressed for reasons of confidentiality and/or reliability.

NAEP = National Assessment of Educational Progress.

[a] NAEP uses eligibility for the federal National School Lunch Program (NSLP) as a measure of socioeconomic status. NSLP is a federally assisted meal program that provides low-cost or free lunches to eligible students. It is sometimes referred to as the free or reduced-price lunch program.

[b] Hispanic may be any race. American Indian or Alaska Native, Asian or Pacific Islander, black, white, and more than one race refer to individuals who are not of Hispanic origin.

Note(s)

Main NAEP mathematics assessment scores range from 0 to 500 for grades 4 and 8 and from 0 to 300 for grade 12.

Source(s)

National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2016) of main NAEP 2015 mathematics assessment, National Center for Education Statistics.

Science and Engineering Indicators 2018

Proficiency level. Forty percent of fourth graders, 33% of eighth graders, and 25% of twelfth graders achieved a level of proficient or higher in mathematics in 2015 (Appendix Table 1-2). As with average scale scores, these percentages represent slight decreases compared with 2013 for fourth and eighth graders but are slight increases since 2005. In the decade since 2005, the percentage of students scoring proficient or above increased by about 4 percentage points for fourth graders and 3 percentage points for eighth graders. In the period between 1996 and 2005, the increases were larger: about 15 percentage points for students in grade 4, and 7 percentage points for students in grade 8. Although the percentage of students reaching proficiency or better did increase, on average, it stayed well below 50% for all grade levels and decreased as the grade level increased.

Demographic patterns similar to those noted in the discussion of scale scores also characterized the proficiency levels. For example, 51% of grade 4 white and 62% of grade 4 Asian or Pacific Islander students reached proficiency in mathematics (Appendix Table 1-2). The percentages for grade 4 students in other racial or ethnic groups were much lower: 26% for Hispanic students, 23% for American Indian or Alaska Native students, and 19% for black students.

Science Performance of Students in Grades 4, 8, and 12 in 2015

Average score. The average NAEP science scores of students in 2015 were 154 for fourth and eighth graders and 150 for twelfth graders (Appendix Table 1-3). Although the overall scale for the assessments is 0 to 300, the effective score range of these tests is about 90 points: 80% of fourth graders scored between 108 and 196, 80% of eighth graders scored between 109 and 195, and 80% of twelfth graders scored between 103 and 196. The average NAEP science scores increased 4 points between 2009 and 2015 in grades 4 and 8 but did not change for grade 12.

Socioeconomic status. Students who were not eligible for free or reduced-price lunch (high SES) performed better than eligible (low SES) students at all grade levels (Appendix Table 1-3). For example, the gap between non-eligible and eligible fourth graders in 2015 was 29 points. Among eighth graders, the gap was 27 points, and twelfth graders had a gap of 26 points. The gap between non-eligible and eligible students did not decrease significantly between 2009 and 2015 for any grade level.

Race or ethnicity. As with mathematics, average science scores varied by race or ethnicity at all grade levels, with Asian or Pacific Islander and white students scoring 10–16 points above the average score, and black, Hispanic, and American Indian or Alaska Native students scoring 14–25 points below (Appendix Table 1-3). The gaps between the scores of white and black students and between those of white and Hispanic students have narrowed slightly since 2009 in grades 4 and 8 but not in grade 12.

Sex. There were no sex differences in average science scores for students in grade 4 in 2015 (Appendix Table 1-3). However, average scores for male students were higher than scores for female students by 3 points in grade 8 and by 5 points in grade 12. The gap between male and female students in grade 8 narrowed slightly from 5 points in 2011 to 3 points in 2015. The gap in science scores in grade 12 has not narrowed significantly since 2009.

Socioeconomic status and sex by race or ethnicity. There were substantial differences by SES within all racial or ethnic groups and at all grade levels (Table 1-3). For example, gaps between twelfth graders who were eligible for free or reduced-price lunch and those who were not eligible ranged from 13 points for Hispanic students to 27 points for Asian or Pacific Islander students. Average science scores showed some variation by sex within racial or ethnic groups, although, in many cases, differences between male and female students were not significant. The largest difference was among Hispanics in grades 8 and 12, with male students earning higher average scores than female students by 5 points in grade 8 and 7 points in grade 12.

Proficiency level. In 2015, 38% of fourth graders, 34% of eighth graders, and 22% of twelfth graders achieved a level of proficient or higher on the NAEP science assessment (Appendix Table 1-4). The percentage of fourth and eighth grade students scoring at or above the proficient level increased by 4 points since 2009. The percentage of twelfth graders scoring at or above the proficient level did not change significantly during that same period.

TABLE 1-3

Average scores of students in grades 4, 8, and 12 on the main NAEP science assessment, by socioeconomic status and sex within race or ethnicity: 2015

(Average score)

Grade and race or ethnicity	Socioeconomic status[a]		Sex	
	Eligible for free or reduced-price lunch	Not eligible for free or reduced-price lunch	Male	Female
All students in grade 4				
White	154	172	166	165
Black	129	148	132	134
Hispanic[b]	134	157	139	139
Asian or Pacific Islander	150	178	168	166
American Indian or Alaska Native	134	158	139	140
More than one race	147	171	157	159
All students in grade 8				
White	153	171	167	164
Black	127	146	131	132
Hispanic[b]	135	154	142	137
Asian or Pacific Islander	148	174	165	164
American Indian or Alaska Native	134	155	142	136
More than one race	146	170	161	158
All students in grade 12				
White	146	164	162	159
Black	119	136	127	123
Hispanic[b]	132	145	140	133
Asian or Pacific Islander	150	177	167	165
American Indian or Alaska Native	s	s	s	s
More than one race	145	162	160	151

s = suppressed for reasons of confidentiality and/or reliability.

NAEP = National Assessment of Educational Progress.

[a] NAEP uses eligibility for the federal National School Lunch Program (NSLP) as a measure of socioeconomic status. NSLP is a federally assisted meal program that provides low-cost or free lunches to eligible students. It is sometimes referred to as the free or reduced-price lunch program.

[b] Hispanic may be any race. American Indian or Alaska Native, Asian or Pacific Islander, black, white, and more than one race refer to individuals who are not of Hispanic origin.

Note(s)

Main NAEP science assessment scores range from 0 to 300 for grades 4, 8, and 12.

Source(s)

National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2016) of main NAEP 2015 science assessment, National Center for Education Statistics.

Science and Engineering Indicators 2018

Technology and Engineering Performance of Students in Grade 8 in 2014

The NAEP TEL assessment is the newest addition to NAEP assessment tests. It was first administered in winter 2014 to a nationally representative sample of eighth graders. Rather than testing students for their ability to “do” engineering or produce technology, TEL was designed to gauge how well students can apply their understanding of technology principles to real-life situations. TEL departs from the typical NAEP assessment design because it is completely computer based and includes interactive scenario-based tasks—an innovative component of NAEP (see sidebar About the NAEP Technology and Engineering Literacy Assessment).

SIDEBAR

About the NAEP Technology and Engineering Literacy Assessment

The National Assessment Governing Board (NAGB) is an independent, bipartisan organization that oversees the National Assessment of Educational Progress (NAEP). Because of the growing importance of technology and engineering in the educational landscape, and to support America's ability to contribute to and compete in a global economy, NAGB set out in 2008 to develop a framework for a national assessment of students' knowledge and skills in technology and engineering (NAGB 2013). NAGB solicited input for the framework from technology and engineering experts, business leaders, educational policymakers, teachers, parents, and the public via regional forums, webinars, and committee meetings to draft and refine the NAEP technology and engineering literacy (TEL) framework. The framework describes the specific knowledge and skills to be assessed and how the assessment questions should be designed and scored. In the framework, technology is defined as "any modification of the natural world done to fulfill human needs or desires" and engineering is "a systematic and often iterative approach to designing objects, processes, and systems to meet human needs and wants" (NAGB 2013:xi). The framework defines technological and engineering literacy as "the capacity to use, understand, and evaluate technology as well as to understand technological principles and strategies needed to develop solutions and achieve goals" (NAGB 2013:xi).

The first completely computer-based NAEP assessment, TEL includes interactive scenario-based tasks in addition to more traditional short-answer and multiple-choice questions.* Using videos and interactive graphics, scenario-based tasks ask students to demonstrate their knowledge and skills to solve problems within realistic situations. For example, one task requires students to develop an online exhibit on water pollution, whereas other tasks require students to design a safe bike lane or create an ideal iguana habitat. Each scenario includes several questions and takes between 10 and 30 minutes to complete. These scenario-based tasks are designed to measure three major interconnected content areas—Technology and Society, Design and Systems, and Information and Communication Technology—and three practices that cut across the content areas—Understanding Technological Principles, Developing Solutions and Achieving Goals, and Communicating and Collaborating. Some tasks measure students' abilities in one content area and practice, and other tasks measure more than one content area or practice.

TEL was piloted in 2013 and administered to 21,500 students in approximately 840 public and private schools around the country in 2014. The National Center for Education Statistics, which administers NAEP, brought its own Internet service and laptop computers into schools to avoid any technical difficulties associated with administering computer-based assessments in classrooms. Before the assessment began, students viewed a tutorial that helped them become familiar with the computer interface and how to use the assessment program.

* All NAEP exams were digitally administered as of 2017.

The average TEL score was set to 150 out of 300 as a baseline for future comparisons, and 43% of test takers scored at or above the proficient level (Appendix Table 1-5).

Socioeconomic status. Scores on the TEL varied considerably by school lunch eligibility, with the average score for eligible students nearly 30 points below that of non-eligible students. The percentage of non-eligible students scoring at or above the proficient level (59%) was more than double the percentage of eligible students scoring at that level (25%).

Race or ethnicity. The average scores for Asian or Pacific Islander (159) and white (160) students were higher than the average scores for Hispanic (138) and black (128) students. More than half of Asian or Pacific Islander and white students scored at or above the proficient level, compared with 28% of Hispanic students and 18% of black students.

Sex. Female students had an average score of 151, which was slightly higher than male students' average score of 149. A slightly higher percentage of female than male students scored at or above the proficient level (45% versus 42%).

Socioeconomic status and sex by race or ethnicity. Some sex and school-lunch eligibility differences in TEL achievement were observed within racial or ethnic groups (Table 1-4). Within each racial or ethnic group, students who were eligible for free or reduced-price lunch had average scores at least 19 points lower than non-eligible students. The average score for white female students was slightly higher than the average for white male students, and the same held true for black female and male students.

TABLE 1-4

Average scores of students in grade 8 on the main NAEP technology and engineering literacy assessment, by socioeconomic status and sex within race or ethnicity: 2014

(Average score)

Race or ethnicity	Socioeconomic status[a]		Sex	
	Eligible for free or reduced-price lunch	Not eligible for free or reduced-price lunch	Male	Female
White	145	166	158	162
Black	122	144	126	131
Hispanic[b]	133	152	137	139
Asian or Pacific Islander	144	171	159	159
American Indian or Alaska Native	137	s	s	s
More than one race	143	163	149	160

s = suppressed for reasons of confidentiality and/or reliability.

NAEP = National Assessment of Educational Progress.

[a] NAEP uses eligibility for the federal National School Lunch Program (NSLP) as a measure of socioeconomic status. NSLP is a federally assisted meal program that provides low-cost or free lunches to eligible students. It is often referred to as the free or reduced-price lunch program.

[b] Hispanic may be any race. American Indian or Alaska Native, Asian or Pacific Islander, black, white, and more than one race refer to individuals who are not of Hispanic origin.

Note(s)

Main NAEP technology and engineering literacy assessment scores range from 0 to 300.

Source(s)

National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2016) of main NAEP 2014 technology and engineering literacy assessment, National Center for Education Statistics.

Science and Engineering Indicators 2018

State-Level Performance in Mathematics and Science in 2015

In addition to reporting NAEP achievement at the national level, NAEP also reports achievement at the state level. The NAEP sample in each state is designed to be representative of the students in that state, and results can be compared across states. At the state level, results are reported for public school students only and are broken down by several demographic groupings. In this chapter, we present 2015 NAEP state-level data (average scores and percentages reaching proficient or above) broken out by sex and race or ethnicity for fourth and eighth graders in mathematics and science (Appendix Table 1-6 through Appendix Table 1-13). The *Science and Engineering Indicators* State Indicators data tool provides NAEP performance and proficiency data for all students in each state—not broken out by sex, race, or ethnicity.

Mathematics and Science Knowledge in Early Childhood

ECLS-K:2011 is a nationally representative, longitudinal study of children's development, early learning, and school progress (Mulligan, Hastedt, and McCarroll 2012). Data for the ECLS-K:2011 study were first collected in fall 2010 from approximately 18,200 kindergarten students. ECLS-K:2011 has followed and tested the same student sample each year through spring 2016, when most students were in fifth grade. This section provides information about mathematics and science achievement for children in the ECLS-K:2011 cohort who were in kindergarten for the first time in the 2010–11 school year and in the third grade by the spring of 2014. It compares students' mathematics scores from the beginning of kindergarten to the end of third grade and students' science scores from the beginning of first grade to the end of third grade. Science was not assessed in kindergarten. Results are reported as scale scores and are used here for comparative purposes rather than as indicators of student progress in meeting grade-level objectives. Students' mathematics and science assessment results cannot be compared with each other because scales are developed independently for each subject. The possible range of scores for the third grade mathematics assessment in spring 2014 was 0–135, with an actual range of scores of 39–133 and an overall average score of 99 (Table 1-5; Appendix Table 1-14). The possible range of scores for the third grade science assessment in spring 2014 was 0–87, with an actual range of scores of 21–78 and an overall average score of 56 (Appendix Table 1-15).

TABLE 1-5

Average mathematics and science assessment test scores of children who were in kindergarten for the first time during the 2010–11 school year and in third grade during the 2013–14 school year, by child and family characteristics

(Average score)

Child and family characteristic	Mathematics		Science	
	Fall 2010	Spring 2014	Fall 2011[a]	Spring 2014
All children	29.3	99.2	23.9	55.6
Sex				
Male	29.4	100.9	23.9	56.3
Female	29.2	97.4	23.9	55.0
Race or ethnicity[b]				
White	31.7	102.9	26.0	58.5
Black	25.8	90.2	21.0	50.0
Hispanic[c]	24.7	94.3	20.5	51.5
Asian	34.5	104.3	23.4	57.5
American Indian or Alaska Native	26.3	99.2	24.7	54.3
Family poverty status in fall 2010[d]				
Income below the federal poverty level	24.1	93.3	20.7	51.0
Income at or above 200% of the federal poverty level	33.3	103.2	25.9	58.9

[a] There was no science assessment in academic year 2010–11. Science assessment began in grade 1.

[b] Other racial and ethnic groups are included in all children but are not shown separately in the table.

[c] Hispanic may be any race. American Indian or Alaska Native, Asian, black, and white refer to individuals who are not of Hispanic origin.

[d] Poverty status is based on 2010 U.S. Census poverty thresholds, which identify incomes determined to meet household needs, given family size. For example, in 2010, a family of two was below the poverty threshold if its income was lower than $14,220.

Note(s)

Mathematics was first assessed in kindergarten in fall 2010. Science was first assessed in first grade in fall 2011. The mathematics assessment scale was 0 to 75 in kindergarten and 0 to 135 in third grade. The actual score range in third grade was 39 to 133. The science assessment scale was 0 to 47 in first grade and 0 to 87 in third grade. The actual score range in third grade was 21 to 78.

Source(s)

Mulligan GM, Hastedt S, McCarroll JC, *First-Time Kindergartners in 2010–11*: *First Findings From the Kindergarten Rounds of the Early Childhood Longitudinal Study, Kindergarten Class of 2010–11 (ECLS-K:2011)*, NCES 2012-049 (2012); Mulligan GM, McCarroll JC, Flanagan KD, Potter D, *Findings From the First-Grade Rounds of the Early Childhood Longitudinal Study, Kindergarten Class of 2010–11 (ECLS-K: 2011)*, NCES 2015-109 (2014); Mulligan GM, McCarroll JC, Flanagan KD, Potter D, *Findings From the Third-Grade Round of the Early Childhood Longitudinal Study, Kindergarten Class of 2010–11 (ECLS-K:2011),* NCES 2016-094 (2016). See Appendix Table 1-14 and Appendix Table 1-15.

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Socioeconomic status. In spring of third grade, the average score for students in families with income at or above 200% of the federal poverty level was 10 points higher on the mathematics assessment and 8 points higher on the science assessment than for students in families with income below the federal poverty level.

Race or ethnicity. Asian students achieved an average score of 104 on the mathematics assessment at the end of third grade, followed by white (103), Hispanic (94), and black (90) students (Table 1-5). Science assessment scores followed a similar pattern, except that white students (59) earned a slightly higher average score than Asian students (58). In mathematics, black students (26) and Hispanic students (25) earned similar average scores when entering kindergarten, but this pattern reversed by third grade, with Hispanic students earning higher average scores than black students (94 versus 90, respectively). A similar pattern was seen in science.

Sex. ECLS-K:2011 data revealed achievement gaps between male and female students (see sidebar Early Gender Gaps in Mathematics and Teachers' Perceptions). Although they began kindergarten with the same average scale score in mathematics (29), the average score for male students was higher than for female students by the end of third grade (101 versus 97) (Table 1-5). Science scores showed a similar pattern, with male and female students posting the same average score in first grade (24) and male students slightly outscoring female students by the end of third grade (56 versus 55).

SIDEBAR

Early Gender Gaps in Mathematics and Teachers' Perceptions

Women are appreciably underrepresented in many high-paying science, technology, engineering, and mathematics (STEM) fields (National Science Foundation [NSF] 2017). Early achievement and self-concepts may matter for STEM career paths. For example, grade 12 mathematics achievement and mathematics self-concepts influence eventual STEM career choices (Eccles and Wang 2016; Mann and DiPrete 2013).

In their examination of Early Childhood Longitudinal Study, Kindergarten (ECLS-K) data from two longitudinal series beginning in 1999 and 2011, Cimpian and colleagues (2016) found that gender gaps in mathematics worsen in early education and that teachers misperceive girls' mathematics ability. ECLS-K data have advantages over other data sources because they use computerized adaptive testing—in which the test questions become progressively easier or harder based on how students are performing on the test. Such testing more accurately discerns student ability at various points on the ability spectrum, particularly the extremes.

Cimpian and colleagues found that, for the 2011 cohort, about equal numbers of boys and girls scored below the 85th percentile in mathematics achievement upon entry into kindergarten. Above the 85th percentile, however, there were fewer girls than boys: girls made up 45% of all those above the 85th percentile and only 33% of those above the 99th percentile. The gender gap worsened and spread further down the distribution with more schooling. By the spring of second grade, the most recent data available to the researchers, male students were favored at all points above the 15th percentile, and female students constituted only 20% of those above the 99th percentile. Examining students with comparable demographic characteristics, learning behaviors, and past mathematics achievement does not remove gender gaps throughout the distribution.

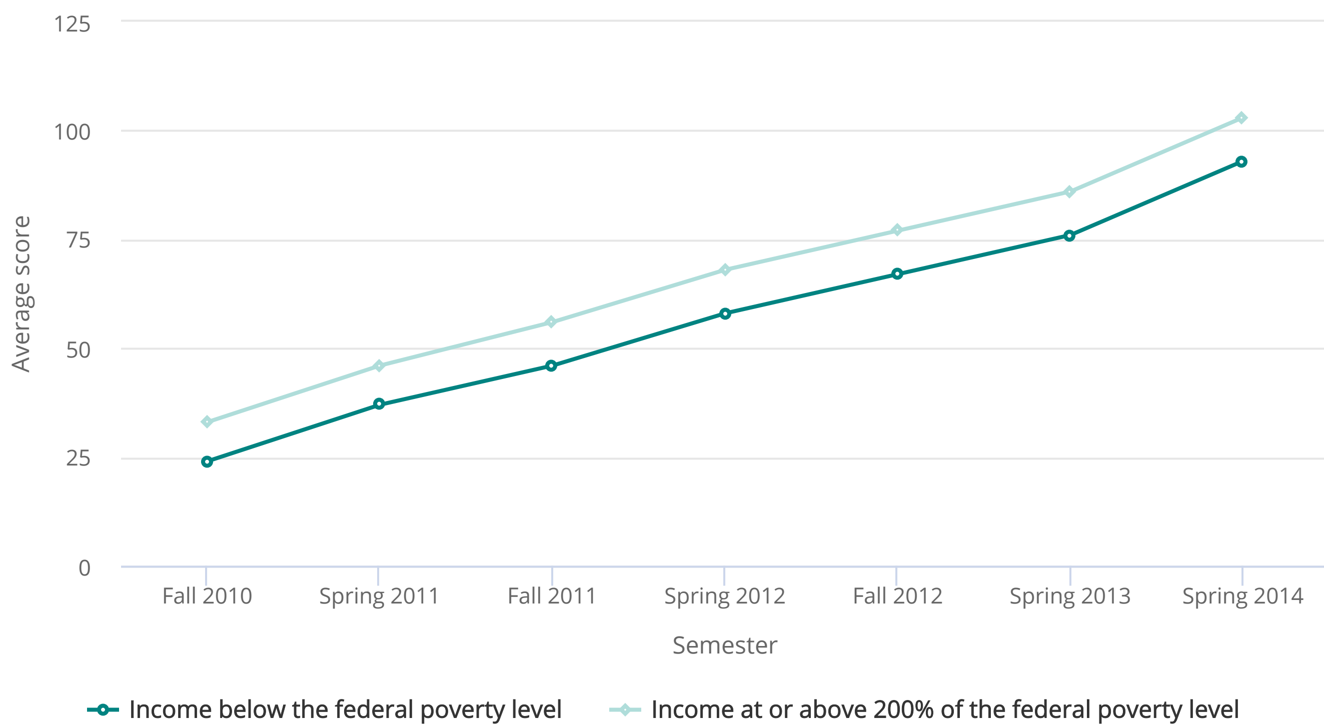
The authors found virtually no significant differences between the 1999 and 2011 cohorts. There were a few percentile points in the upper range of the distribution in which boys were doing better than girls in 2011, but otherwise, there were no differences. This suggests that efforts to improve mathematics education during this time did not lift the relative performance of female students.

This study also asked teachers to give their subjective estimation of every student's proficiencies in various mathematical skills, which were then converted to single scores that were ranked among all students to yield each student's percentile (e.g., student x is at the 90th percentile in mathematical ability). For each student, this subjective percentile was then directly compared with the student's actual percentile. For the 2011 cohort, the study found that teachers' subjective ratings of mathematical proficiency underestimate the proficiency of girls at the higher end of the ability spectrum, above the 75th percentile, by the spring of first grade. Robinson-Cimpian and colleagues (2014) present evidence that teachers' more negative perceptions of girls' proficiency are substantially related to their future performance.

Achievement gap over time. The ECLS-K:2011 mathematics and science results show that students from different racial, ethnic, and socioeconomic groups enter school with different levels of preparation and that those differences persist as they move to higher grades, a finding that is supported in the research literature (Loeb and Bassok 2007; Magnuson and Duncan 2006). For example, the gap in mathematics assessment scores between white and black students was 6 points at the beginning of kindergarten and 13 points in the spring of third grade (Table 1-5). Similarly, the gap in science assessment scores between white and black students was 5 points at the beginning of first grade and 9 points in the spring of third grade. The mathematics score gap between students in families with income below the federal poverty level and those in families with income at or above 200% of the federal poverty level was 9 points at the beginning of kindergarten and 10 points by the spring of third grade (Figure 1-2); the science score gap was 5 points at the beginning of first grade and 8 points by the spring of third grade.

FIGURE 1-2

Average mathematics assessment test scores of children who were in kindergarten for the first time during the 2010–11 school year and in the third grade during the 2013–14 school year, by family income level



Note(s)

The mathematics assessment scale was 0 to 75 in kindergarten, 0 to 96 in first grade, 0 to 113 in second grade, and 0 to 135 in third grade. Mathematics was assessed in the fall and spring of each school year with the exception of third grade when students were assessed only in the spring. Poverty status is based on 2010 U.S. Census poverty thresholds, which identify incomes determined to meet household needs, given family size. For example, in 2010, a family of two was below the poverty threshold if its income was lower than $14,220.

Source(s)

Mulligan GM, Hastedt S, McCarroll JC, *First-Time Kindergartners in 2010–11*: *First Findings From the Kindergarten Rounds of the Early Childhood Longitudinal Study, Kindergarten Class of 2010–11 (ECLS-K:2011)*, NCES 2012-049 (2012); Mulligan GM, McCarroll JC, Flanagan KD, Potter D, *Findings From the First-Grade Rounds of the Early Childhood Longitudinal Study, Kindergarten Class of 2010–11 (ECLS-K:2011)*, NCES 2015-109 (2014); Mulligan GM, McCarroll JC, Flanagan KD, Potter D, *Findings From the Second-Grade Rounds of the Early Childhood Longitudinal Study, Kindergarten Class of 2010–11 (ECLS-K:2011)*, NCES 2015-077 (2015); and Mulligan GM, McCarroll JC, Flanagan KD, Potter D, *Findings From the Third-Grade Round of the Early Childhood Longitudinal Study, Kindergarten Class of 2010–11 (ECLS-K:2011)*, NCES 2016-094 (2016).

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International Comparisons of Mathematics and Science Performance

Two international assessments—the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA)—compare U.S. students' achievement in mathematics and science with that of students in other countries. TIMSS and PISA give different impressions of the United States' standing relative to other countries, with TIMSS results placing the United States in a higher relative position compared with PISA. This disparity can be traced, in part, to differences in the design and purpose of the assessments. TIMSS focuses on academic content, whereas PISA is designed to measure students' ability to apply their mathematics and science knowledge to real-world situations. The two tests also vary in other fundamental ways, including age of the students tested and number of participating nations, making direct comparisons difficult. TIMSS and PISA have sampling requirements to ensure that student populations are similar across countries and report when countries do not meet these guidelines. TIMSS and PISA samples include students from public and private schools in the United States. This section presents an overview of each assessment, examines long-term trends in performance on both assessments, and provides a detailed look at the latest data from 2015.

The Trends in International Mathematics and Science Study

TIMSS includes two assessments: TIMSS for students in grades 4 and 8 and TIMSS Advanced for students in their final year of high school. First conducted in 1995, TIMSS assesses the mathematics and science performance of fourth and eighth graders every 4 years. Since its inception, TIMSS has been administered six times, most recently in 2015, when 20,000 fourth and eighth grade students in approximately 500 schools across the United States participated (Provasnik et al. 2016).[4] TIMSS Advanced was administered in 1995, 2008, and 2015. It is designed to assess the advanced mathematics and physics achievement of students in their final year of high school who are taking or have taken advanced courses.[5] The United States participated in the 1995 and 2015 administrations.

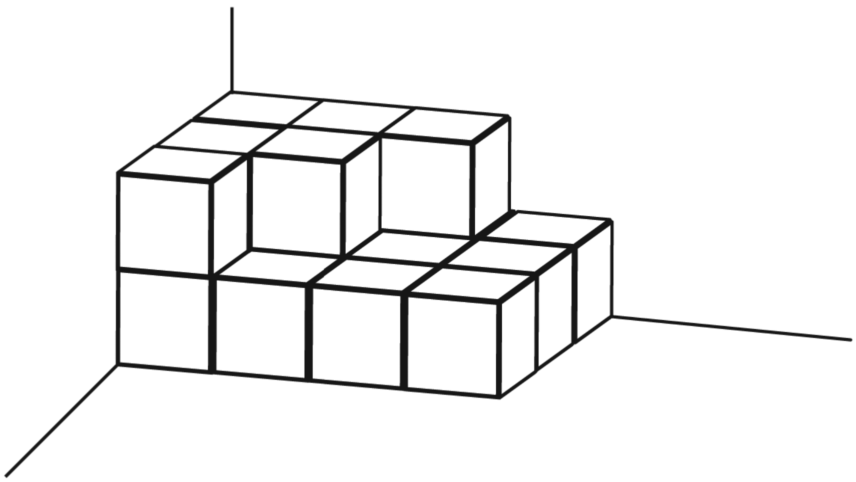
TIMSS and TIMSS Advanced measure students' knowledge and skills in mathematics and science and their ability to apply their knowledge in problem-solving situations. Both are designed to align broadly with mathematics and science curricula in the participating education systems and, therefore, to reflect students' school-based learning. 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 (see sidebar Sample Items from the Trends in International Mathematics and Science Study 2015).

SIDEBAR

Sample Items from the Trends in International Mathematics and Science Study 2015

The examples shown below and other mathematics and science sample questions are available at https://timssandpirls.bc.edu/timss2015/downloads/T15_FW_AppB.pdf and https://timssandpirls.bc.edu/timss2015/downloads/T15_FW_AppC.pdf, respectively.

Sample for Grade 4 Mathematics



Ann stacks these boxes in the corner of the room. All the boxes are the same size. How many boxes does she use?

- (A) 25
- (B) 19
- ● 18
- (D) 13

Sample for Grade 4 Science

Water that has its salt removed before it can be used as drinking water is most likely to have come from

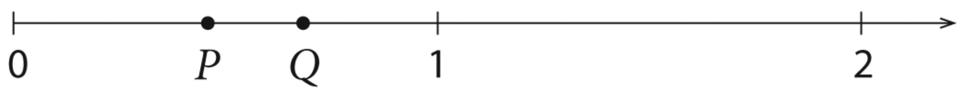
Ⓐ underground

Ⓑ a river

Ⓒ a lake

● a sea

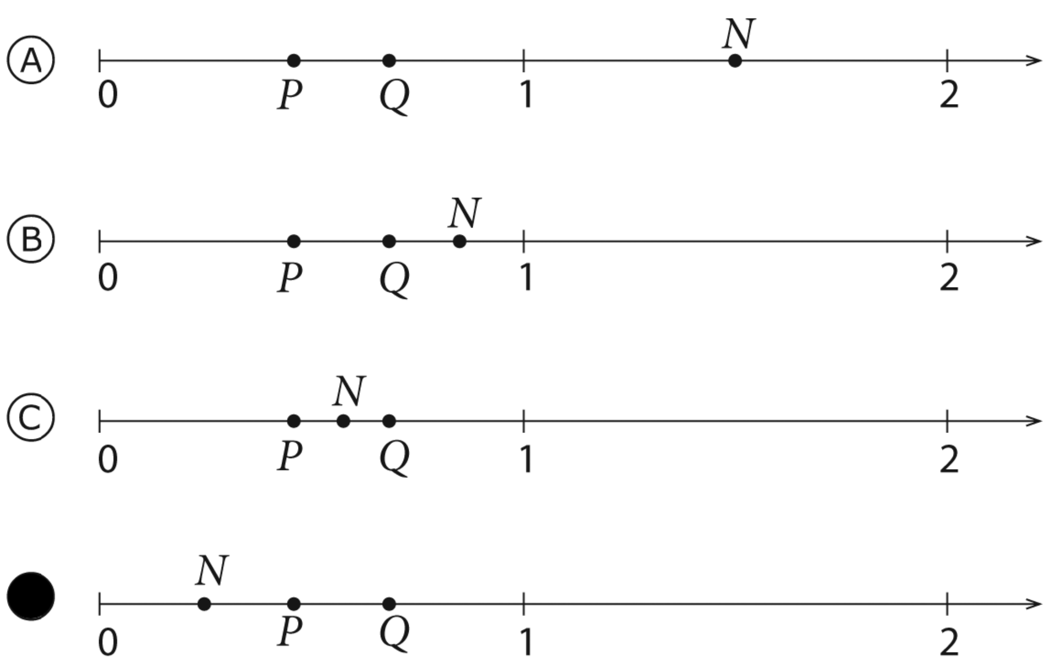
Sample for Grade 8 Mathematics



P and Q represent two fractions on the number line above.

$P \times Q = N$.

Which of these shows the location of N on the number line?



Sample for Grade 8 Science

During which chemical process is energy absorbed?

Ⓐ iron nails rusting

Ⓑ candles burning

Ⓒ vegetables rotting

● plants photosynthesizing

TIMSS and TIMSS Advanced are both sponsored by the International Association for the Evaluation of Educational Achievement (IEA), an international, nonprofit organization consisting of research institutions and government research agencies from member countries and economies. In 2015, 48 IEA member countries or economies and 6 benchmarking participants[6] took part in the grade 4 assessment, and 37 IEA member countries and 6 benchmarking participants took part in the grade 8 assessment.[7] Nine education systems—all IEA member countries—participated in TIMSS Advanced 2015. IEA member countries include "countries," which are complete, independent political entities, and non-national entities (e.g., England, Hong Kong, or the Flemish community of Belgium). The term *education systems* is used in the analysis here in recognition of the fact that not all TIMSS participants are countries, and this fact should be kept in mind when comparing the performance of the United States and that of other education systems.

Mathematics Performance of U.S. Students in Grades 4 and 8 on TIMSS

Performance on the 2015 TIMSS mathematics tests. The U.S. average score on the 2015 TIMSS mathematics assessment was 539 for grade 4 and 518 for grade 8 (Table 1-6).[8] Although the scale is 0–1,000 for both grades, the effective score range of these tests for the preponderance of American students is about 200 points. Eighty percent of fourth graders scored between 432 and 640; for grade 8, it was between 408 and 624. Among the 48 education systems that participated in the 2015 TIMSS mathematics assessment at grade 4, the U.S. average mathematics score was among the top 18 (10 scored higher; 7 did not differ), outperforming 30 education systems (Appendix Table 1-16).[9] At grade 8, the U.S. average mathematics score was among the top 16 (7 scored higher; 8 did not differ), outperforming 21 education systems. (Appendix Table 1-17). The same 5 Asian education systems—Singapore, Hong Kong, South Korea, Taiwan, and Japan—were the top scorers on the fourth and eighth grade assessments. All 5 outscored the United States by at least 50 points (Table 1-7).

TABLE 1-6

Average TIMSS mathematics scores of U.S. students in grades 4 and 8, by selected student and school characteristics: 2015

(Average score)

Characteristic	Grade 4	Grade 8
U.S. total	539	518
Sex		
Male	543	519
Female	536	517
Race or ethnicity		
White	559	541
Black	495	462
Hispanic	515	492
Asian	605	585
Native Hawaiian or Pacific Islander	502	495
American Indian or Alaska Native	527	477
Multiracial	565	521
Percentage of public school students eligible for free or reduced-price lunch		
Less than 10%	600	573
10% to 24.9%	575	553
25% to 49.9%	559	531
50% to 74.9%	531	505
75% or more	499	477
Percentiles		
10th percentile	432	408
25th percentile	485	461
75th percentile	596	577
90th percentile	640	624

TIMSS = Trends in International Mathematics and Science Study.

Note(s)

Black includes African American, and Hispanic includes Latino. Racial categories exclude Hispanic origin. Data on free or reduced-price lunch are for public schools only.

Source(s)

Provasnik S, Malley L, Stephens M, Landeros K, Perkins R, Tang JH, *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 (2016); U.S. Department of Education, National Center for Education Statistics, TIMSS data tables, Table 19. Average mathematics scores of U.S. 4th-grade students, by selected characteristics: 2015, https://nces.ed.gov/timss/timss2015/timss2015_table19.asp, accessed 15 September 2017, and Table 20. Average mathematics scores of U.S. 8th-grade students, by selected characteristics: 2015, https://nces.ed.gov/timss/timss2015/timss2015_table20.asp, accessed 15 September 2017.

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TABLE 1-7

Average TIMSS mathematics scores of students in grades 4 and 8, by education system: 2015

(Average score)

Comparison with U.S. score	Education system	Grade 4	Education system	Grade 8
Score higher than that of the United States	Singapore[a]	618	Singapore[a]	621
	Hong Kong (China)[a]	615	South Korea	606
	South Korea	608	Taiwan (China)	599
	Taiwan (China)	597	Hong Kong (China)	594
	Japan	593	Japan	586
	Northern Ireland (UK)[a]	570	Russia	538
	Russia	564	Canada[a]	527
	Norway (grade 5)[a]	549		
	Ireland	547		
	Belgium (Flemish)[a]	546		
Score not statistically different from that of the United States	England (UK)	546	Kazakhstan	528
	Kazakhstan	544	Ireland	523
	Portugal[a]	541	United States[a]	518
	United States[a]	539	England (UK)	518
	Denmark[a]	539	Slovenia	516
	Lithuania[a]	535	Hungary	514
	Finland	535	Norway (grade 9)[a]	512
	Poland	535	Lithuania[a]	511
			Israel[a]	511

Comparison with U.S. score	Education system	Grade 4	Education system	Grade 8
Score lower than that of the United States (selected countries)	Netherlands[a]	530	Australia	505
	Hungary	529	Sweden	501
	Czech Republic	528	Italy[a]	494
	Bulgaria	524	Malta	494
	Cyprus	523	New Zealand[a]	493
	Germany	522	Malaysia	465
	Slovenia	520	United Arab Emirates	465
	Sweden[a]	519	Turkey	458
	Serbia[a]	518	Bahrain	454
	Australia	517	Georgia[a]	453

TIMSS = Trends in International Mathematics and Science Study; UK = United Kingdom.

[a] See Appendix Table 1-16 and Appendix Table 1-17 for details about TIMSS administration in these education systems.

Note(s)

Education systems are ordered by the 2015 average score. The countries shown in the Score lower than that of the United States section are the 10 with the highest average scores below the United States.

Source(s)

Provasnik S, Malley L, Stephens M, Landeros K, Perkins R, Tang JH, *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 (2016).

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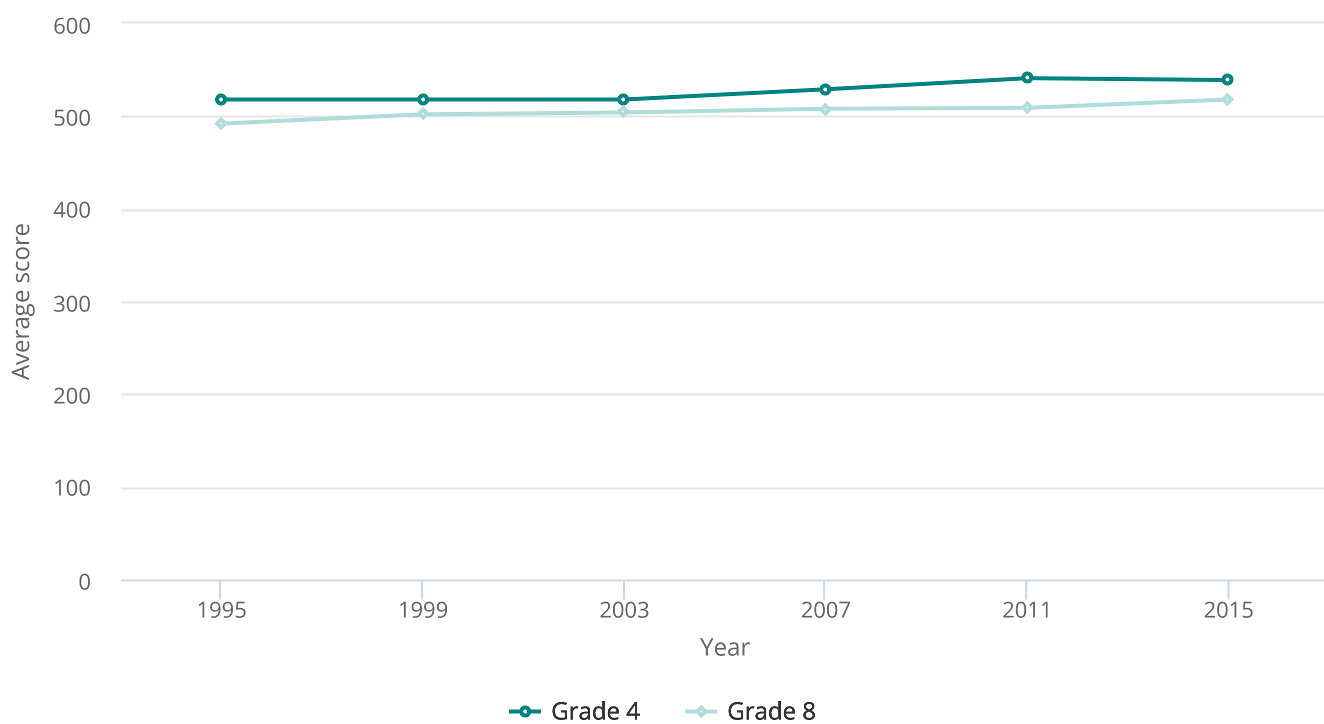
Performance trends. U.S. fourth and eighth graders have raised their scores and international ranking over the 20 years since the first TIMSS mathematics administration in 1995. At grade 4, the average mathematics score of 539 in 2015 was 21 points higher than the score of 518 in 1995 (Figure 1-3), although the 2015 average score was not significantly different from the most recent assessment in 2011 (541). The position of U.S. fourth graders relative to other nations climbed as well over this period: among the 16 education systems that participated in the 1995 and 2015 TIMSS mathematics assessment of fourth graders, 7 outscored the United States in 1995 compared with 5 in 2015 (Provasnik et al. 2016). At grade 8, the U.S. average score of 518 in 2015 reflected a 26-point increase over the 1995 score of 492 and an increase of 9 points since the most recent assessment in 2011 (509) (Figure 1-3). The relative standing of U.S. eighth graders' mathematics performance also improved over this period: among the 15 countries that participated in the 1995 and 2015 TIMSS mathematics assessment of eighth graders, 5 outperformed the United States in 2015, down from 8 in 1995 (Provasnik et al. 2016).

FIGURE 1-3

Average TIMSS mathematics scores of U.S. students in grades 4 and 8: 1995–2015



TIMSS = Trends in International Mathematics and Science Study.

Note(s)

TIMSS mathematics assessment scores range from 0 to 1,000 for grades 4 and 8. U.S. fourth graders did not participate in TIMSS in 1999; score is interpolated. Average mathematics scores of students in grade 4 and grade 8 cannot be compared directly because the test items differ across grade levels to reflect the nature, difficulty, and emphasis of the subject matter taught in school at each grade.

Source(s)

Provasnik S, Malley L, Stephens M, Landeros K, Perkins R, Tang JH, *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 (2016).

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Demographic differences. U.S. scores in 2015 differed according to the percentage of students eligible for free or reduced-price lunch at participants' schools (Table 1-6). Students at schools with less than 10% of eligible students scored approximately 100 points higher than students at schools with 75% or more eligible students in fourth (600 versus 499) and eighth (573 versus 477) grade. In 2015, the average mathematics assessment score for male fourth graders (543) was higher than the average score for female fourth graders (536), but there was no statistically significant difference in average scores for male and female eighth graders. The average score for grade 4 Asian students (605) was significantly higher than that for white students (559), and both were significantly higher than the average scores for Hispanic (515) and black (495) students. A similar pattern was seen among grade 8 students.

Science Performance of U.S. Students in Grades 4 and 8 on TIMSS

Performance on the 2015 TIMSS science tests. In 2015, the U.S. average science scores were 546 for fourth graders and 530 for eighth graders (Table 1-8). As with mathematics, the effective score range for most students was about 200 points, with 80% of fourth graders scoring between 439 and 644 and 80% of eighth graders scoring between 421 and 631. At grade 4, the United States was among the top 14 education systems (7 scored higher; 6 did not differ), outperforming 33 among a total of 47 participants (Appendix Table 1-18). At grade 8, the U.S. average science score was also among the top 14 education systems (7 scored higher; 6 did not differ), outperforming 23 among a total of 37 participants (Appendix Table 1-19). As with mathematics, the 5 Asian education systems of Singapore, South Korea, Hong Kong, Taiwan, and Japan were among the top scorers on the science assessment at both grade levels (Table 1-9).

TABLE 1-8

Average TIMSS science scores of U.S. students in grades 4 and 8, by selected student and school characteristics: 2015

(Average score)

Characteristic	Grade 4	Grade 8
U.S. total	546	530
Sex		
Male	548	533
Female	544	527
Race or ethnicity		
White	570	557
Black	501	469
Hispanic	518	502
Asian	598	573
Native Hawaiian or Pacific Islander	503	498
American Indian or Alaska Native	530	497
Multiracial	571	536
Percentage of public school students eligible for free or reduced-price lunch		
Less than 10%	603	579
10% to 24.9%	584	563
25% to 49.9%	565	544
50% to 74.9%	541	519
75% or more	502	489
Percentiles		
10th percentile	439	421
25th percentile	495	475
75th percentile	602	588
90th percentile	644	631

TIMSS = Trends in International Mathematics and Science Study.

Note(s)

Black includes African American, and Hispanic includes Latino. Racial categories exclude Hispanic origin. Data on free or reduced-price lunch are for public schools only.

Source(s)

Provasnik S, Malley L, Stephens M, Landeros K, Perkins R, Tang JH, *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 (2016); U.S. Department of Education, National Center for Education Statistics, TIMSS data tables, Table 41. Average science scores of U.S. 4th-grade students, by selected characteristics: 2015, https://nces.ed.gov/timss/timss2015/timss2015_table41.asp, accessed 15 September 2017, and Table 42. Average science scores of U.S. 8th-grade students, by selected characteristics: 2015, https://nces.ed.gov/timss/timss2015/timss2015_table42.asp, accessed 15 September 2017.

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TABLE 1-9

Average TIMSS science scores of students in grades 4 and 8, by education system: 2015

(Average score)

Comparison with U.S. score	Education system	Grade 4	Education system	Grade 8
Score higher than that of the United States	Singapore[a]	590	Singapore[a]	597
	South Korea	589	Japan	571
	Japan	569	Taiwan (China)	569
	Russia	567	South Korea	556
	Hong Kong (China)[a]	557	Slovenia	551
	Taiwan (China)	555	Hong Kong (China)	546
	Finland	554	Russia	544
Score not statistically different from that of the United States	Kazakhstan	550	England (UK)	537
	Poland	547	Kazakhstan	533
	United States[a]	546	Ireland	530
	Slovenia	543	United States[a]	530
	Hungary	542	Hungary	527
	Sweden[a]	540	Canada[a]	526
	Bulgaria	536	Sweden	522
Score lower than that of the United States (selected countries)	Norway (grade 5)[a]	538	Lithuania[a]	519
	England (UK)	536	New Zealand[a]	513
	Czech Republic	534	Australia	512
	Croatia	533	Norway (grade 9)[a]	509
	Ireland	529	Israel[a]	507
	Germany	528	Italy[a]	499
	Lithuania[a]	528	Turkey	493

Comparison with U.S. score	Education system	Grade 4	Education system	Grade 8
	Denmark[a]	527	Malta	481
	Canada[a]	525	United Arab Emirates	477
	Serbia[a]	525	Malaysia	471

TIMSS = Trends in International Mathematics and Science Study; UK = United Kingdom.

[a] See Appendix Table 1-18 and Appendix Table 1-19 for details about TIMSS administration in these education systems.

Note(s)

Education systems are ordered by the 2015 average score. The countries shown in the Score lower than that of the United States section are the 10 with the highest average scores below the United States.

Source(s)

Provasnik S, Malley L, Stephens M, Landeros K, Perkins R, Tang JH, *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 (2016).

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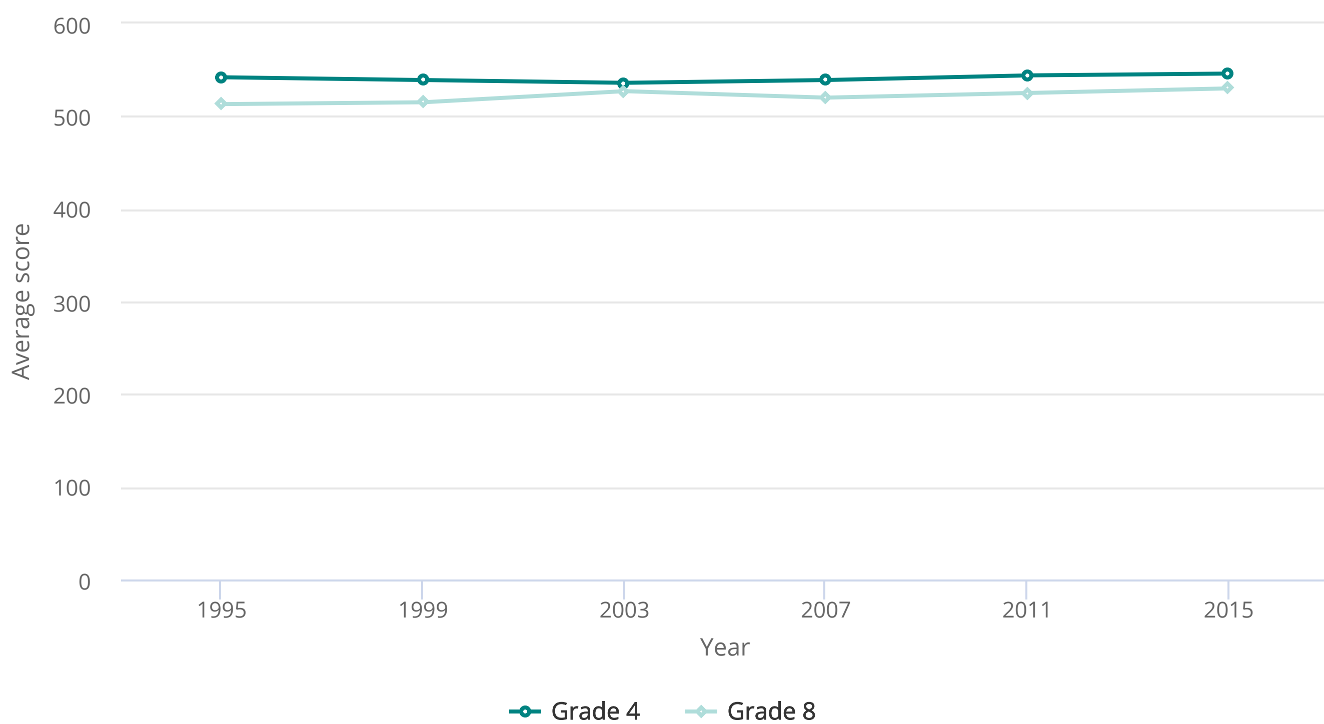
Performance trends. In contrast to the mathematics trends, which showed significant improvement in both grades, the average scores of U.S. students on the TIMSS science assessment remained flat since 1995 for fourth graders but improved 17 points for eighth graders (Figure 1-4). U.S. fourth and eighth graders have not improved their international position in science achievement since 1995. Among the 17 education systems that participated in the 1995 and 2015 grade 4 TIMSS science assessments, the United States slipped in rank, from 3rd in 1995 to 5th in 2015; at grade 8, the position of the United States did not move between 1995 and 2015 (Provasnik et al. 2016).

FIGURE 1-4

Average TIMSS science scores of U.S. students in grades 4 and 8: 1995–2015



TIMSS = Trends in International Mathematics and Science Study.

Note(s)

TIMSS science assessment scores range from 0 to 1,000 for grades 4 and 8. U.S. fourth graders did not participate in TIMSS in 1999; score is interpolated. Average science scores of students in grade 4 and grade 8 cannot be compared directly because the test items differ across grade levels to reflect the nature, difficulty, and emphasis of the subject matter taught in school at each grade.

Source(s)

Provasnik S, Malley L, Stephens M, Landeros K, Perkins R, Tang JH, *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 (2016).

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Demographic differences. As with mathematics, U.S. students' science scores differed according to the percentage of students eligible for free or reduced-price lunch at participants' schools, with students at schools with less than 10% of eligible students scoring approximately 100 points higher than students at schools with 75% or more eligible students at fourth (603 versus 502) and eighth (579 versus 489) grade (Table 1-8). At grade 4 and grade 8, there were no significant differences in average scores between male and female students. The average scores for Asian (598) and white (570) students in grade 4 were significantly higher than the scores for Hispanic (518) and black (501) students. A similar pattern was seen for students in grade 8.

U.S. Performance in TIMSS Advanced Mathematics and Physics at the End of High School

Only U.S. performance on TIMSS Advanced is reported here because countries varied in their rates of participation in the exam and in the characteristics of students taking the assessment, making it difficult to accurately rank education systems in order of performance. IEA calculates a coverage index for the advanced mathematics and physics exams for education systems participating in the exam. The coverage index is the percentage of all people in an age cohort who are students in their final year of secondary school who have taken or are taking advanced mathematics or physics courses. The corresponding age cohort is determined for education systems individually. In the United States, 18-year-olds are considered to be the corresponding age cohort. The U.S. coverage index was 11.4 for advanced mathematics and 4.8 for physics. The coverage index for advanced mathematics for other education systems ranged from 3.9 for Lebanon to 34.4 for Slovenia. The coverage index for physics ranged from 3.9 for Lebanon to 21.5 for France.[10]

Performance trends. In 2015, the U.S. average scores were 485 in advanced mathematics and 437 in physics (Table 1-10). These scores are not significantly different from the scores reported for both exams in 1995 (Provasnik et al. 2016). The effective score range for the mathematics exam was about 250 points, with 80% of scores (from the 10th to the 90th percentiles) falling between 352 and 608. The score range for physics was larger, at more than 300 points, with 80% of scores falling between 283 and 589.

Demographic differences. U.S. students' average scores on the advanced mathematics and physics assessments differed according to the percentage of students eligible for free or reduced-price lunch at participants' schools (Table 1-10). In advanced mathematics, students at schools with less than 10% of students eligible scored more than 100 points higher than students at schools with 75% or more eligible (534 versus 425). In physics, the difference in average scores was nearly 150 points (506 versus 363). The average scores for U.S. male students on both TIMSS Advanced assessments were considerably higher than those for female students. Male students outperformed female students by 30 points on the TIMSS Advanced mathematics assessment and by 46 points on the physics assessment. The proportion of male and female students taking the advanced mathematics assessment was close to even, but the physics exam was skewed toward male students, with U.S. male students comprising 61% of exam takers (Provasnik et al. 2016). As with the fourth and eighth grade students in mathematics and science, the average scores on the advanced mathematics assessment were higher for white (495) and Asian (506) students than for Hispanic (440) and black (400) students. A similar pattern in average scores was seen among white, black, and Hispanic students on the TIMSS Advanced physics assessment.

TABLE 1-10

Average advanced mathematics and physics scores of U.S. TIMSS Advanced students, by selected student and school characteristics: 2015

(Average score)

Characteristic	Advanced mathematics	Physics
U.S. total	485	437
Sex		
Male	500	455
Female	470	409
Race or ethnicity		
White	495	463
Black	400	334
Hispanic	440	390
Asian	506	433
Multiracial	525	470
Percentage of public school students eligible for free or reduced-price lunch		
Less than 10%	534	506
10% to 24.9%	515	482
25% to 49.9%	485	414
50% to 74.9%	454	426
75% or more	425	363
Percentiles		
10th percentile	352	283
25th percentile	419	357
75th percentile	554	522
90th percentile	608	589

TIMSS = Trends in International Mathematics and Science Study.

Note(s)

Black includes African American, and Hispanic includes Latino. Racial categories exclude Hispanic origin. Data on free or reduced-price lunch are for public schools only.

Source(s)

Provasnik S, Malley L, Stephens M, Landeros K, Perkins R, Tang JH, *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 (2016); U.S. Department of Education, National Center for Education Statistics, TIMSS data tables, Table 52. Average advanced mathematics scores of U.S. TIMSS Advanced students, by selected characteristics: 2015, https://nces.ed.gov/timss/timss2015/timss2015_table52.asp, accessed 15 September 2017, and Table 61. Average physics scores of U.S. TIMSS Advanced students, by selected characteristics: 2015, https://nces.ed.gov/timss/timss2015/timss2015_table61.asp, accessed 15 September 2017.

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The Program for International Student Assessment

PISA assessments measure the performance of 15-year-old students in science and mathematics literacy every 3 years. Coordinated by the Organisation for Economic Co-operation and Development (OECD), PISA was first implemented in 2000 in 32 countries and has since grown to 73 education systems in 2015.[11] Participants in PISA include countries and cities, so rankings should be assessed within that context. The United States has participated in every cycle of PISA since its inception in 2000. PISA's goal is to assess students' preparation for the challenges of life as young adults. The study assesses the application of knowledge in science, reading, and mathematics literacy to problems within a real-life context. Unlike TIMSS, PISA does not focus explicitly on school-based curricula and uses the term *literacy* in each subject area to indicate its broad focus on the application of knowledge and skills learned in and outside of school. For example, when assessing science, PISA examines how well 15-year-old students can understand, use, and reflect on science for various real-life problems and settings that they may encounter in and out of school (see sidebar Sample Items from the Program for International Student Assessment Mathematics and Science Assessments).

SIDEBAR

Sample Items from the Program for International Student Assessment Mathematics and Science Assessments

Sample Items from the 2012 Mathematics Assessment

Sample 1

Peter's bicycle has a wheel circumference of 96 cm (or 0.96 m). It is a three-speed bicycle with a low, a middle, and a high gear. The gear ratios of Peter's bicycle are:

Low 3:1 Middle 6:5 High 1:2

How many pedal turns would Peter take to travel 960 m in middle gear? Show your work.

NOTE: A gear ratio of 3:1 means 3 complete pedal turns yields 1 complete wheel turn.

(Correct answer: 1,200 pedal turns, with a fully correct method.)

Sample 2

One advantage of using a kite sail is that it flies at a height of 150 m. There, the wind speed is approximately 25% higher than down on the deck of the ship.

At what approximate speed does the wind blow into a kite sail when a wind speed of 24 km/h is measured on the deck of the ship?

a. 6 km/h

b. 18 km/h

c. 25 km/h

d. 30 km/h

e. 49 km/h

(Correct answer: D)

Sample Items from the 2015 Science Assessment

Sample 1

Meteoroids and Craters

Rocks in space that enter Earth's atmosphere are called meteoroids. Meteoroids heat up and glow as they fall through Earth's atmosphere. Most meteoroids burn up before they hit Earth's surface. When a meteoroid hits Earth, it can make a hole called a crater.

As a meteoroid approaches Earth and its atmosphere, it speeds up. Why does this happen?

a. The meteoroid is pulled in by the rotation of Earth.

b. The meteoroid is pushed by the light of the Sun.

c. The meteoroid is attracted to the mass of Earth.

d. The meteoroid is repelled by the vacuum of space.

(Correct answer: C)

Sample 2

What is the effect of a planet's atmosphere on the number of craters on a planet's surface?

*The thicker a planet's atmosphere is, the (**1. More or Fewer**) craters its surface will have because (**2. More or Fewer**) meteoroids will burn up in the atmosphere.*

(Correct answer: 1. Fewer; 2. More)

Additional sample questions are available at https://nces.ed.gov/surveys/pisa/pdf/items_math2012.pdf and https://www.oecd.org/pisa/test/PISA2015-Released-FT-Cognitive-Items.pdf.

International Comparison of Mathematics Literacy among U.S. 15-Year-Olds

U.S. students' average PISA mathematics score of 470 in 2015 was lower than the OECD average score of 490, on a scale of 0–1,000 (Table 1-11). The effective score range for U.S. students was 230 points, with 80% of students scoring between 355 and 585. The U.S. average score was lower than that of 36 other education systems and was not significantly different from 5 (Appendix Table 1-20). The top 5 performers were all located in Asia (Singapore, Hong Kong, Macau, Taiwan, and Japan), with average scores surpassing the U.S. score by at least 62 points (Table 1-12). The U.S. students' average mathematics score was also lower than those of several developing countries, including Vietnam (495), Russia (494), and Lithuania (478).[12]

TABLE 1-11

Average scores of U.S. 15-year-old students on the PISA mathematics and science literacy scales, by selected student characteristics: 2015

(Average score)

Student characteristic	Mathematics	Science
OECD average	490	493
All U.S. students	470	496
Sex		
Male	474	500
Female	465	493
Race or ethnicity		
White	499	531
Black	419	433
Hispanic	446	470
Asian or Pacific Islander	498	525
More than one race	475	503
Socioeconomic status		
Bottom quarter	431	457
Second quarter	453	478
Third quarter	480	508
Top quarter	517	546
Percentiles		
10th percentile	355	368
25th percentile	408	425
75th percentile	532	567
90th percentile	585	626

OECD = Organisation for Economic Co-operation and Development; PISA = Program for International Student Assessment.

Note(s)

Reporting standards were not met for American Indian or Alaska Native and Native Hawaiian or Other Pacific Islander. Black includes African American, and Hispanic includes Latino. Students who identified themselves as being of Hispanic origin were classified as Hispanic, regardless of their race. Although data for some races or ethnicities were not shown separately because the reporting standards were not met, they are included in the U.S. totals. The PISA index of economic, social, and cultural status was created using student reports on parental occupation, the highest level of parental education, and an index of home possessions related to family wealth, home educational resources, and possessions related to "classical" culture in the family home. The home possessions relating to classical culture in the family home included possessions such as works of classical literature, books of poetry, and works of art (e.g., paintings). The OECD average is the average of the national averages of the OECD member countries, with each country weighted equally.

Source(s)

Kastberg D, Chan JY, Murray G, *Performance of U.S. 15-Year-Old Students in Science, Reading, and Mathematics Literacy in an International Context: First Look at PISA 2015,* NCES 2017-048 (2016).

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TABLE 1-12

Average mathematics literacy assessment scores for 15-year-olds participating in PISA, by education system: 2015

(Average score)

Education system	Score	OECD member
Score higher than U.S. score of 470		
Singapore	564	N
Hong Kong (China)	548	N
Macau (China)	544	N
Taiwan (China)	542	N
Japan	532	Y
Beijing, Shanghai, Jiangsu, and Guangdong (China)	531	N
South Korea	524	Y
Switzerland	521	Y
Estonia	520	Y
Canada	516	Y
Netherlands	512	Y
Denmark	511	Y
Finland	511	Y
Slovenia	510	Y
Belgium	507	Y
Germany	506	Y
Poland	504	Y
Ireland	504	Y
Norway	502	Y
Austria	497	Y
New Zealand	495	Y
Vietnam	495	N
Russia	494	N

Education system	Score	OECD member
Sweden	494	Y
Australia	494	Y
France	493	Y
United Kingdom	492	Y
Czech Republic	492	Y
Portugal	492	Y
OECD average	490	-
Italy	490	Y
Iceland	488	Y
Spain	486	Y
Luxembourg	486	Y
Latvia	482	Y
Malta	479	N
Lithuania	478	N
Score not statistically different from U.S. score of 470		
Hungary	477	Y
Slovakia	475	Y
Israel	470	Y
United States	470	Y
Croatia	464	N
Buenos Aires (Argentina)	456	N
Score lower than U.S. score of 470 (selected education systems)		
Greece	454	Y
Romania	444	N
Bulgaria	441	N
Cyprus	437	N
United Arab Emirates	427	N

Education system	Score	OECD member
Chile	423	Y
Turkey	420	Y
Moldova	420	N
Uruguay	418	N
Montenegro	418	N

N = no; Y = yes.

OECD = Organisation for Economic Co-operation and Development; PISA = Program for International Student Assessment.

Note(s)

Education systems are ordered by 2015 average score. The OECD average is the average of the national averages of the OECD member countries, with each country weighted equally. Scores are reported on a scale from 0 to 1,000. All average scores reported as higher or lower than the U.S. average score are different at the .05 level of statistical significance. Although Argentina, Malaysia, and Kazakhstan participated in PISA 2015, technical problems with their samples prevent results from being discussed in this report. The countries shown in the Score lower than U.S. score section are the 10 with the highest average scores below the United States.

Source(s)

Kastberg D, Chan JY, Murray G, *Performance of U.S. 15-Year-Old Students in Science, Reading, and Mathematics Literacy in an International Context: First Look at PISA 2015,* NCES 2017-048 (2016). See Appendix Table 1-20.

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International Comparison of Science Literacy among U.S. 15-Year-Olds

The average PISA science literacy score for U.S. students in 2015 was 496, which was not significantly different from the OECD average of 493, on a scale of 0 to 1,000 (Table 1-11). The effective score range for U.S. students was 258 points, with 80% of students scoring between 368 and 626. The U.S. average score was lower than that of 18 other education systems and not significantly different from 12. The top 5 performers on the science exam were Singapore, Japan, Estonia, Taiwan, and Finland, and their average scores surpassed those of the United States by at least 35 points (Table 1-13). Unlike mathematics scores, the U.S. students' average science score was higher than those of all developing countries participating in PISA in 2015 (Appendix Table 1-21).

TABLE 1-13

Average science literacy assessment scores for 15-year-old students participating in PISA, by education system: 2015

(Average score)

Education system	Score	OECD member
Score higher than U.S. score of 496		
Singapore	556	N
Japan	538	Y
Estonia	534	Y
Taiwan (China)	532	N
Finland	531	Y
Macau (China)	529	N
Canada	528	Y
Vietnam	525	N
Hong Kong (China)	523	N
Beijing, Shanghai, Jiangsu, and Guangdong (China)	518	N
South Korea	516	Y
New Zealand	513	Y
Slovenia	513	Y
Australia	510	Y
United Kingdom	509	Y
Germany	509	Y
Netherlands	509	Y
Switzerland	506	Y
Score not statistically different from U.S. score of 496		
Ireland	503	Y
Belgium	502	Y
Denmark	502	Y
Poland	501	Y

Education system	Score	OECD member
Portugal	501	Y
Norway	498	Y
United States	496	Y
Austria	495	Y
France	495	Y
OECD average	493	-
Sweden	493	Y
Czech Republic	493	Y
Spain	493	Y
Latvia	490	Y
Score lower than U.S. score of 496 (selected education systems)		
Russia	487	N
Luxembourg	483	Y
Italy	481	Y
Hungary	477	Y
Lithuania	475	N
Croatia	475	N
Buenos Aires (Argentina)	475	N
Iceland	473	Y
Israel	467	Y
Malta	465	N

N = no; Y = yes.

OECD = Organisation for Economic Co-operation and Development; PISA = Program for International Student Assessment.

Note(s)

Education systems are ordered by 2015 average score. The OECD average is the average of the national averages of the OECD member countries, with each country weighted equally. Scores are reported on a scale from 0 to 1,000. All average scores reported as higher or lower than the U.S. average score are different at the .05 level of statistical significance. Although Argentina, Malaysia, and Kazakhstan participated in PISA 2015, technical problems with their samples prevent results from being discussed in this report. The countries shown in the Score lower than U.S. score section are the 10 with the highest average scores below that of the United States.

Source(s)

Kastberg D, Chan JY, Murray G, *Performance of U.S. 15-Year-Old Students in Science, Reading, and Mathematics Literacy in an International Context: First Look at PISA 2015,* NCES 2017-048 (2016). See Appendix Table 1-21.

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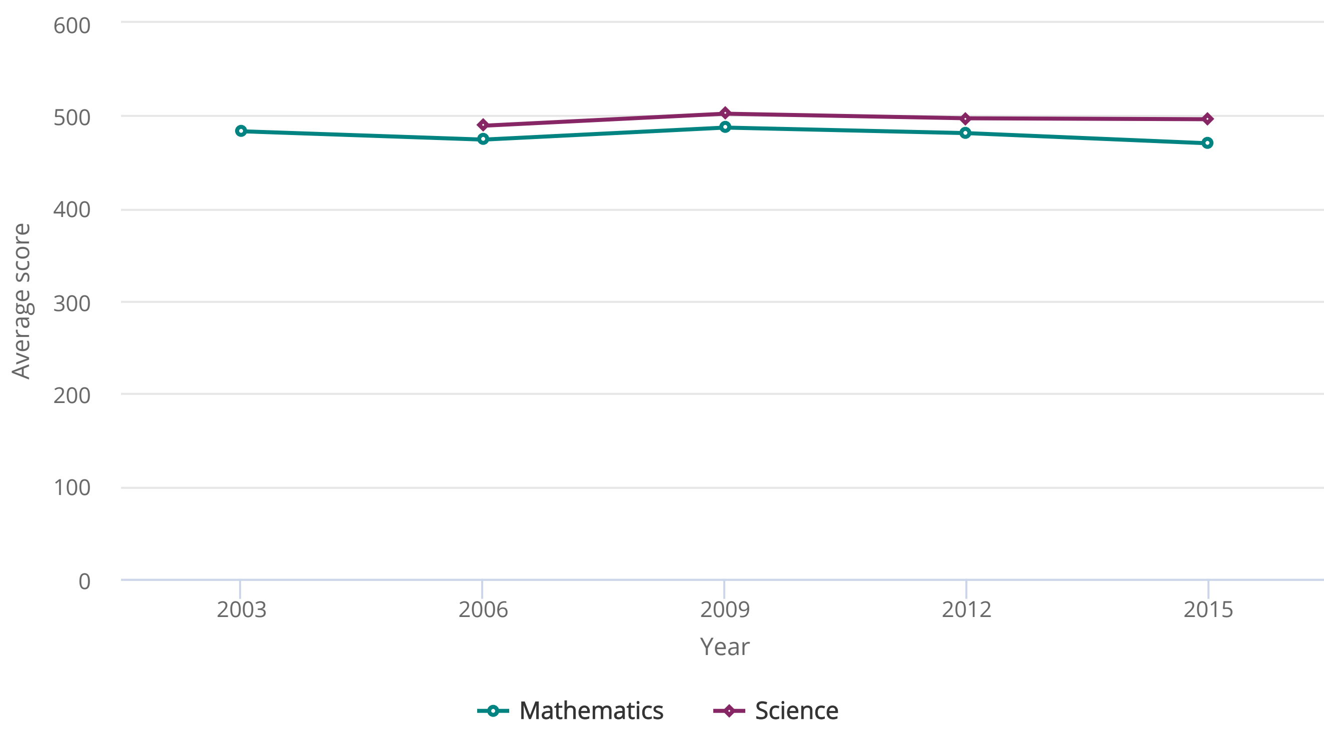
Trends in Mathematics and Science Knowledge among 15-Year-Old Students in the United States: Results from PISA

Figure 1-5 shows the average mathematics and science literacy scores for 15-year-old students in the United States between 2003 and 2015.[13] Scores decreased for mathematics since 2009 but stayed even for science. The U.S. average score in mathematics literacy in 2015 was 17 points lower than the average score in 2009 and 11 points lower than the average in 2012, but it was not significantly different from scores in 2003 and 2006. The U.S. average score in science in 2015 was not significantly different from the average scores observed in 2006, 2009, and 2012.

FIGURE 1-5

Average mathematics and science literacy assessment scores of 15-year-old students in the United States: 2003–15



Note(s)

The mathematics and science literacy assessment scores range from 0 to 1,000. Science data for 2003 are not available; science literacy assessment was not administered that year.

Source(s)

Kastberg D, Chan JY, Murray G, *Performance of U.S. 15-Year-Old Students in Science, Reading, and Mathematics Literacy in an International Context: First Look at PISA 2015,* NCES 2017-048 (2016).

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U.S. Performance on PISA, by Selected Student Characteristics

Average scores for students in the United States varied by SES, sex, and race or ethnicity on the mathematics and science PISA assessments (Table 1-11). The gap in the average scores between students in the highest and lowest socioeconomic quartiles was nearly 90 points on the mathematics assessment (517 versus 431) and the science assessment (546 versus 457). Average scores were also higher for male students than for female students on both assessments, with a gap of 9 points in favor of male students on the mathematics assessment and 7 points on science. Average mathematics scores for white (499) and Asian or Pacific Islander (498) students were higher than those of Hispanic (446) and black (419) students. Similar gaps by race or ethnicity were seen in science performance.

[1] Grade 12 mathematics data are presented from 2005 only because the grade 12 mathematics framework was substantially revised in 2005, making prior assessment results not comparable with those in or after 2005.

[2] Science data are presented beginning in 2009 only because the science framework was substantially revised in 2009, making prior assessment results not comparable with those in or after 2009.

[3] The NAGB, as directed by NAEP legislation, has been developing achievement levels for NAEP since 1990. A broadly representative panel of teachers, education specialists, and the public help define and review achievement levels. As provided by law, the achievement levels are to be used on a trial basis and should be interpreted and used with caution. More information about NAEP achievement levels is available at https://nces.ed.gov/nationsreportcard/achievement.aspx.

[4] 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. 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 public and private schools, randomly selected and weighted to be representative of the nation at grade 4 and at grade 8.

[5] TIMSS Advanced required participating countries and other education systems to draw probability samples of students in their final year of secondary school who were taking or had taken courses in advanced mathematics or physics. In the United States, two samples of twelfth graders were drawn to represent the nation—one for advanced mathematics and one for physics. The courses that defined 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 AP physics, for the physics population. The U.S. national samples included public and private schools, randomly selected and weighted to be representative of the nation’s advanced mathematics and physics coursetakers at the end of high school.

[6] Non-national entities that are not IEA member countries (e.g., Abu Dhabi, Buenos Aires) may participate in TIMSS to assess their comparative international standing. These entities are designated as “benchmarking participants.”

[7] Results presented here are for 48 education systems at grade 4 and 37 at grade 8 because Armenia is excluded. Although Armenia did participate in TIMSS 2015 at grades 4 and 8, the country's results are not reported by TIMSS because the data are not comparable for trend analysis.

[8] The scores are reported on a scale from 0 to 1,000, with the TIMSS scale average set at 500 and the standard deviation set at 100.

[9] The TIMSS results presented in this report exclude individual U.S. states, Canadian provinces, Abu Dhabi, Buenos Aires, and Dubai. These states and provinces participated in 2015 TIMSS as “benchmarking participants” to assess the comparative international standing of their students’ achievement and to view their curriculum and instruction in an international context.

[10] For additional details, see the Technical Notes available at https://nces.ed.gov/timss/timss15technotes.asp.

[11] Of the 73 education systems that participated in PISA 2015, results for three of these—Argentina, Kazakhstan, and Malaysia—are not included due to technical issues with their samples that prevent results from being discussed in this report.

[12] Developing countries in this report are any countries that do not appear on the International Monetary Fund list of “advanced economies.”

[13] The PISA mathematics assessment was also conducted in 2000 but, because the framework for the mathematics assessment was revised in 2003, it is not appropriate to compare results from the 2000 assessment with subsequent PISA mathematics assessments. Similarly, the framework for the PISA science assessment was changed in 2000 and in 2003, preventing comparisons of results in 2000 or 2003 with science literacy scores from subsequent years.

High School Coursetaking in Mathematics and Science

To understand students' achievement in mathematics or science, it helps to understand what courses they have taken. In addition, STEM coursetaking in high school is predictive of earning a STEM degree in postsecondary education, with students who take more advanced mathematics and science in high school more likely to complete college with a STEM degree (Tyson et al. 2007; Wang 2013). This section examines high school students' participation in mathematics and science courses using data from HSLS:09, the College Board's AP program, and data collected by the Department of Education's Office for Civil Rights.

HSLS:09 is a longitudinal study of a nationally representative sample of approximately 20,000 students who were first surveyed in fall 2009 as ninth graders and were surveyed again in 2012, when most were spring-term eleventh graders. The HSLS:09 sample includes students from public and private schools, so it is representative of the overall in-school population. It does not include home-schooled students, who make up about 3% of the student population in the United States (Redford, Battle, and Bielick 2017). Transcript data were collected for HSLS:09 students in summer 2013, when most would have completed high school (Dalton, Ingels, and Fritch 2016). Compared with students' self-reports of coursetaking, transcript data provide a more accurate account of mathematics and science coursetaking for all students in the study for whom transcripts were collected. Transcript data are used in this section to examine the mathematics and science courses taken by students who had completed high school by summer 2013.

Given the ongoing emphasis on readiness for college and career at the completion of high school (Achieve Inc. 2016), this section focuses specifically on mathematics and science coursetaking among high school completers (i.e., students who graduated from high school with a regular diploma or an alternative credential such as a General Educational Development [GED] certificate). It is recommended that high school graduates interested in attending a public university complete a minimum of 3 years of mathematics, including algebra 2, and 3 years of science, including biology and either chemistry or physics (Bromberg and Theokas 2016).

Highest Mathematics Courses Taken by High School Completers

Among ninth graders who began high school in 2009 and completed high school in 2013, the majority (89%) completed algebra 2 or higher (Table 1-14). More specifically, approximately one-quarter of students stopped with algebra 2 as their highest mathematics course, another quarter stopped with trigonometry or other advanced mathematics, 22% advanced to pre-calculus, and 19% finished with calculus or higher.

Socioeconomic status. Students in the highest SES quintile were more likely to take advanced mathematics courses than their peers in the middle and lowest SES quintiles (Table 1-14). For example, the percentage of students in the highest SES quintile taking calculus or higher was four times higher than the percentage of students in the lowest SES quintile (37% versus 9%) and two times higher than the percentage of students in the middle SES quintiles (37% versus 16%).

TABLE 1-14

Highest-level mathematics course enrollment of high school completers, by student and family characteristics: 2013

(Percent)

Student and family characteristic	Algebra 1 or lower	Geometry	Algebra 2	Trigonometry or other	Pre-calculus	Calculus or higher
All students	2.9	7.8	24.4	23.8	21.8	19.3
Sex						
Male	3.7	9.1	23.7	23.7	20.4	19.5
Female	2.2	6.5	25.1	24.0	23.2	19.2
Race or ethnicity						
White	3.2	6.6	22.2	22.2	23.9	22.0
Black	2.3	4.9	28.8	34.6	20.4	9.0
Hispanic[a]	3.0	13.2	26.8	23.5	18.9	14.6
Asian	0.7	2.4	10.3	13.6	22.7	50.3
Other[b]	2.8	10.7	43.8	15.7	12.6	14.3
Two or more races	3.1	8.1	30.8	25.1	17.8	15.1
SES[c]						
Lowest fifth	4.9	12.0	31.0	26.5	16.6	9.0
Middle three-fifths	3.2	8.2	26.5	25.1	20.9	16.2
Highest fifth	0.5	3.3	11.6	18.9	28.9	36.7

SES = socioeconomic status.

[a] Hispanic may be any race. Asian, black, white, and other races refer to individuals who are not of Hispanic origin.

[b] Other includes Alaska Native, American Indian, Native Hawaiian, Pacific Islander, and those having origins in a race not listed.

[c] SES is a composite variable derived from parental education level, parental occupation, and family income. The quintile measure divides the SES distribution into five equal quintile groups. Quintile 1 corresponds to the lowest one-fifth of the population, and quintile 5 corresponds to the highest. For this report, the middle three quintiles are combined into one category.

Note(s)

Trigonometry or other includes trigonometry, probability and statistics, and other advanced mathematics. Calculus or higher includes calculus, Advanced Placement or International Baccalaureate (AP/IB) calculus, and other AP/IB mathematics. Percentages may not add to total because of rounding.

Source(s)

National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2016) of High School Longitudinal Study of 2009 (HSLS:09), National Center for Education Statistics. See Appendix Table 1-22.

Science and Engineering Indicators 2018

Race or ethnicity. Asian students took advanced mathematics courses at a significantly higher rate than any other racial or ethnic group, with 50% taking calculus or higher, compared with 22% for white students, 15% for Hispanic students, and 9% for black students. Although 13% of Hispanic students stopped with geometry 1 as their highest mathematics course, just 2%–7% of white, black, and Asian students did so.

Sex. Approximately the same percentage of male and female students stopped with algebra 2, trigonometry, or calculus or higher as their highest mathematics course.

Socioeconomic status and sex by race or ethnicity. Virtually no sex differences were detected in mathematics coursetaking within each racial or ethnic group (Appendix Table 1-22). However, mathematics coursetaking gaps by SES persisted even after race or ethnicity was considered (Table 1-15). In all racial or ethnic groups, students in the highest SES quintile took advanced mathematics such as calculus at higher rates than low-SES students. Among Asian students, for example, 63% of those in the highest SES quintile took calculus compared with 30% of low-SES students. For white students, when comparing calculus coursetaking, it was 38% in the highest SES quintile versus 8% in the lowest SES quintile; for black students, it was 22% versus 3%; and for Hispanic students, it was 25% versus 12%. This pattern was reversed for lower-level mathematics coursetaking, with low-SES students in most racial or ethnic groups more likely than their high-SES peers to stop taking mathematics at the lower course levels. For example, 37% of low-SES white students took algebra 2 as their highest mathematics course, compared with 11% of high-SES white students.

TABLE 1-15

Highest-level mathematics course enrollment of high school completers, by socioeconomic status within race or ethnicity: 2013

(Percent)

Student and family characteristic	Algebra 1 or lower	Geometry	Algebra 2	Trigonometry or other	Pre-calculus	Calculus or higher
All students	2.9	7.8	24.4	23.8	21.8	19.3
White						
Lowest fifth SES	8.0	8.6	37.2	23.6	14.8	7.8
Middle three-fifths SES	3.6	8.0	25.4	23.7	22.3	17.1
Highest fifth SES	0.5	2.6	10.5	18.6	30.2	37.6
Black						
Lowest fifth SES	3.5	4.1	32.4	38.5	18.5	3.1
Middle three-fifths SES	2.3	5.4	27.3	34.7	21.0	9.4
Highest fifth SES	0.5	4.8	15.2	33.4	23.9	22.2
Hispanic[a]						
Lowest fifth SES	3.2	18.6	23.7	25.6	17.0	11.9
Middle three-fifths SES	3.1	11.2	29.0	23.8	18.5	14.5
Highest fifth SES	0.6	7.3	18.6	16.6	31.9	25.1
Asian						
Lowest fifth SES	0.0	8.0	19.2	16.9	25.8	30.0
Middle three-fifths SES	1.4	1.7	12.4	18.5	20.9	45.1
Highest fifth SES	0.0	1.9	4.8	6.3	24.3	62.7

SES = socioeconomic status.

[a] Hispanic may be any race. Asian, black, and white refer to individuals who are not of Hispanic origin.

Note(s)

Trigonometry or other includes trigonometry, probability and statistics, and other advanced mathematics. Calculus or higher includes calculus, Advanced Placement or International Baccalaureate (AP/IB) calculus, and other AP/IB mathematics. SES is a composite variable derived from parental education level, parental occupation, and family income. The quintile measure divides the SES distribution into five equal quintile groups. Quintile 1 corresponds to the lowest one-fifth of the population, and quintile 5 corresponds to the highest. For this report, the middle three quintiles are combined into one category.

Source(s)

National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2016) of High School Longitudinal Study of 2009 (HSLS:09), National Center for Education Statistics. See Appendix Table 1-23.

Science and Engineering Indicators 2018

Other characteristics. The highest level of mathematics coursetaking was also positively related to parents' highest education and students' mathematics achievement, mathematics coursetaking, and educational expectations in ninth grade (Appendix Table 1-23). In addition, students who attended private school took advanced courses at higher rates than students who attended public schools. For example, 33% of students at private schools took calculus or higher, compared with 18% of students at public schools.

Science Coursetaking by High School Completers

All ninth graders who began high school in 2009 and completed in 2013 took at least one science course, with 79% taking at least one general science course (but no advanced science) and 21% taking at least one advanced course (Table 1-16). Virtually all students (98%) took biology, 76% took chemistry, and fewer (41%) took physics.

Socioeconomic status. Although all students took at least one science course, students in the highest SES quintile were more than three times as likely to take at least one advanced science course compared with their peers in the lowest SES quintile (38% versus 11%). In addition, students in the highest SES quintile were more likely to take chemistry and physics courses than students in the lowest SES quintile.

Race or ethnicity. Among all racial or ethnic groups, Asian students were the most likely to take advanced science courses, by a large margin. For example, 25% of Asian students took advanced chemistry, compared with 9% of white students, 3% of black students, and 5% of Hispanic students. The percentage of students who took general physics was not significantly different among white, black, and Hispanic students.

Sex. Science coursetaking showed slight differences among male and female students. For example, 78% of female students took chemistry, compared with 73% of male students. The pattern reversed slightly for physics, with 40% of female students taking physics, compared with 43% of male students. In advanced coursetaking, female students were slightly more likely than male students to take advanced biology (13% versus 10%) and slightly less likely to take advanced physics (4% versus 7%).

Socioeconomic status and sex by race or ethnicity. Within each racial or ethnic group, students in the highest SES quintile were more likely to take at least one advanced science course compared with their counterparts in the lowest SES quintile (Table 1-17). Thirty-eight percent of high-SES white, 31% of high-SES black, and 31% of high-SES Hispanic students took at least one advanced science course, compared with approximately 10% of their peers in the lowest SES quintile.

Some sex differences in science coursetaking were observed when race or ethnicity was taken into account (Appendix Table 1-24). White female students were more likely than white male students to take chemistry (79% versus 73%), and white male students were more likely than white female students to take physics (45% versus 39%). Black female students were more likely to take at least one advanced science course than their male counterparts (18% versus 9%), specifically advanced biology (12% versus 5%).

Other characteristics. Science coursetaking also varied by parental education level, students' mathematics achievement and coursetaking, and educational expectations (Appendix Table 1-25). For example, students who enrolled in a course above algebra 1 in ninth grade took advanced biology, chemistry, and physics at higher rates, compared with students who enrolled in algebra 1 in ninth grade (19% versus 7% for biology, 14% versus 4% for chemistry, and 11% versus 2% for physics). About 85% of students at public and private schools took general biology, but students at private schools took general chemistry and physics at higher rates than their public school counterparts (81% versus 67% and 54% versus 35%, respectively).

TABLE 1-16

Science course enrollment of high school completers, by student and family characteristics: 2013

(Percent)

Student and family characteristic	General science	AP/IB or advanced science	No biology	General biology	AP/IB or advanced biology	No chemistry	General chemistry	AP/IB or advanced chemistry	No physics	General physics	AP/IB or advanced physics
All students	78.6	21.3	2.5	86.1	11.5	24.4	67.9	7.7	58.5	36.4	5.1
Sex											
Male	80.2	19.7	2.7	87.7	9.7	27.1	65.4	7.5	56.7	36.8	6.6
Female	77.1	22.8	2.2	84.5	13.2	21.9	70.2	7.9	60.3	36.0	3.7
Race or ethnicity											
White	76.6	23.3	2.4	85.3	12.4	23.9	67.3	8.8	58.3	36.3	5.4
Black	85.4	14.4	1.2	89.8	9.0	23.8	72.8	3.4	62.8	34.8	2.4
Hispanic[a]	84.0	15.9	2.9	89.2	7.9	27.1	68.1	4.8	59.6	36.9	3.5
Asian	48.5	51.5	3.8	66.1	30.1	10.1	65.2	24.7	32.9	47.4	19.8
Other[b]	91.5	7.7	2.7	91.2	6.1	33.0	63.2	3.7	74.5	25.1	0.4
Two or more races	81.1	18.9	2.9	86.9	10.3	28.1	65.6	6.4	62.0	33.2	4.7
SES[c]											
Lowest fifth	89.1	10.6	3.3	90.3	6.4	34.1	62.4	3.5	68.1	30.1	1.9
Middle three-fifths	81.2	18.6	2.1	87.5	10.4	25.8	68.0	6.2	60.8	35.2	4.0

Student and family characteristic	General science	AP/IB or advanced science	No biology	General biology	AP/IB or advanced biology	No chemistry	General chemistry	AP/IB or advanced chemistry	No physics	General physics	AP/IB or advanced physics
Highest fifth	62.0	38.0	2.4	78.6	19.0	11.9	72.8	15.4	43.6	45.9	10.5

AP/IB = Advanced Placement/International Baccalaureate; SES = socioeconomic status.

[a] Hispanic may be any race. Asian, black or African American, white, and other races refer to individuals who are not of Hispanic origin.

[b] Other includes Alaska Native, American Indian, Native Hawaiian, Pacific Islander, and those having origins in a race not listed.

[c] SES is a composite variable derived from parental education level, parental occupation, and family income. The quintile measure divides the SES distribution into five equal quintile groups. Quintile 1 corresponds to the lowest one-fifth of the population, and quintile 5 corresponds to the highest. For this report, the middle three quintiles are combined into one category.

Source(s)

National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2016) of High School Longitudinal Study of 2009 (HSLS:09), National Center for Education Statistics. See Appendix Table 1-24.

Science and Engineering Indicators 2018

TABLE 1-17

Science course enrollment of high school completers, by socioeconomic status within race or ethnicity: 2013

(Percent)

Student and family characteristic	General science	AP/IB or advanced science	No biology	General biology	AP/IB or advanced biology	No chemistry	General chemistry	AP/IB or advanced chemistry	No physics	General physics	AP/IB or advanced physics
All students	78.6	21.3	2.5	86.1	11.5	24.4	67.9	7.7	58.5	36.4	5.1
White											
Lowest fifth SES	89.7	10.1	2.7	91.9	5.5	40.3	55.4	4.4	72.3	26.7	1.0
Middle three-fifths SES	80.9	18.9	2.4	87.0	10.6	26.8	66.3	6.9	62.7	33.2	4.0
Highest fifth SES	62.3	37.8	2.2	79.2	18.6	11.4	73.8	14.7	44.0	46.2	9.8
Black											
Lowest fifth SES	89.2	10.2	2.3	90.9	6.9	25.0	69.9	5.1	66.6	28.9	4.5
Middle three-fifths SES	85.5	14.5	0.6	90.2	9.2	25.7	71.5	2.8	61.8	37.0	1.3
Highest fifth SES	69.3	30.7	1.9	80.8	17.3	14.9	80.6	4.5	51.5	43.5	5.0
Hispanic[a]											
Lowest fifth SES	89.0	10.7	4.3	88.6	7.2	32.5	65.3	2.2	65.8	33.1	1.1

Student and family characteristic	General science	AP/IB or advanced science	No biology	General biology	AP/IB or advanced biology	No chemistry	General chemistry	AP/IB or advanced chemistry	No physics	General physics	AP/IB or advanced physics
Middle three-fifths SES	83.4	16.6	1.9	90.5	7.7	24.8	70.6	4.7	56.8	39.9	3.4
Highest fifth SES	68.8	30.7	2.2	85.4	12.4	13.0	71.7	15.3	47.4	42.4	10.2
Asian											
Lowest fifth SES	69.3	30.7	5.8	79.5	14.7	18.8	72.0	9.2	50.5	38.2	11.3
Middle three-fifths SES	56.0	44.0	3.3	70.1	26.6	10.6	71.0	18.5	35.8	47.6	16.6
Highest fifth SES	32.3	67.7	4.0	56.5	39.5	7.3	55.7	37.0	23.0	51.5	25.5
Other[b]											
Lowest fifth SES	s	s	s	s	s	s	s	s	s	s	s
Middle three-fifths SES	88.6	10.2	3.7	88.2	8.1	29.6	64.9	5.5	76.0	23.7	0.3
Highest fifth SES	s	s	s	s	s	s	s	s	s	s	s
Two or more races											

Student and family characteristic	General science	AP/IB or advanced science	No biology	General biology	AP/IB or advanced biology	No chemistry	General chemistry	AP/IB or advanced chemistry	No physics	General physics	AP/IB or advanced physics
Lowest fifth SES	93.3	6.7	1.6	95.9	2.5	46.5	50.7	2.8	73.2	26.8	0.0
Middle three-fifths SES	81.8	18.2	2.5	87.2	10.2	27.1	67.4	5.5	63.5	31.9	4.6
Highest fifth SES	70.4	29.6	3.5	82.1	14.4	16.5	71.6	12.0	46.4	44.3	9.3

s = suppressed for reasons of confidentiality and/or reliability.

AP/IB = Advanced Placement/International Baccalaureate; SES = socioeconomic status.

[a] Hispanic may be any race. Asian, black, white, and other races refer to individuals who are not of Hispanic origin.

[b] Other includes Alaska Native, American Indian, Native Hawaiian, Pacific Islander, and those having origins in a race not listed.

Note(s)

SES is a composite variable derived from parental education level, parental occupation, and family income. The quintile measure divides the SES distribution into five equal quintile groups. Quintile 1 corresponds to the lowest one-fifth of the population, and quintile 5 corresponds to the highest. For this report, the middle three quintiles are combined into one category.

Source(s)

National Science Foundation, National Center for Science and Engineering Statistics, special tabulations (2016) of High School Longitudinal Study of 2009 (HSLS:09), National Center for Education Statistics.

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Computer Science and Technology Coursetaking

Computer science and coding skills are increasingly recognized as an asset in today's economy. The Bureau of Labor Statistics projects 23% growth from 2014 to 2024 in the computer systems design and related services industry—from 1,777,700 jobs in 2014 to 2,186,600 jobs in 2024 (U.S. Department of Labor 2015). In light of this projected growth, educators and policymakers, concerned that too few students are exposed to computer science instruction in school, are working to broaden access to computer science courses (Change the Equation 2016; Nager and Atkinson 2016). An analysis of data from NAEP's grade 12 student survey in 2015 showed that just 22% of students reported taking a course in computer programming while in high school (Change the Equation 2016). Several efforts related to computer science education are currently under way and these developments, detailed in the sidebar Focus on Computer Science, herald a new focus on computer science in K–12 education.

SIDEBAR

Focus on Computer Science

Recent years have seen a surge in new developments in computer science education, including a Presidential Memorandum from the Trump administration focused on expanding access to computer science education, the inclusion of computer science in the Every Student Succeeds Act, the launch of a new Advanced Placement computer science course, a growing number of states allowing computer science to count toward high school graduation, and the release of a computer science education framework.

A Presidential Memorandum, signed in September 2017, set a goal of devoting at least $200 million per year in grant funds toward expanding access to high-quality STEM and computer science education.* In conjunction with the Presidential Memorandum, several of the nation's largest technology companies pledged a total of $300 million to support computer science education over a five-year period.[†]

An earlier federal initiative, Computer Science for All, was announced by the Obama administration in early 2016. Although Congress did not approve the specific funding called for in the Computer Science for All initiative, other efforts related to it, such as investments by the National Science Foundation and the Corporation for National and Community Service to support and train computer science teachers, are moving forward.

The Every Student Succeeds Act specifically includes computer science as part of science, technology, engineering, and mathematics education subjects and includes computer science with other core subjects, such as English, reading, science, and mathematics, in its definition of a "well-rounded education."[‡]

The College Board's newest Advanced Placement course, Computer Science Principles, developed with the support of $9 million in funding from NSF, was offered for the first time during the 2016–17 school year. The course, designed to increase the number and diversity of high school students taking computer science, focuses on several topics in addition to programming, including working with data, computational thinking processes, algorithms, understanding the Internet, and cybersecurity.[§]

In 2017, 31 states and the District of Columbia allowed students to count a computer science course toward high school graduation requirements, up from 12 states in 2013.[‖]

The Association for Computing Machinery, Code.org, Computer Science Teachers Association, Cyber Innovation Center, and National Math and Science Initiative collaborated with states, districts, and the computer science education community to develop conceptual guidelines for computer science education. The K–12 Computer Science Framework outlines the essential computer science concepts and practices that students should know by the end of grades 2, 5, 8, and 12.[#]

[*] https://www.whitehouse.gov/the-press-office/2017/09/25/memorandum-secretary-education

[†] https://www.nytimes.com/2017/09/26/technology/computer-science-stem-education.html

[‡] https://www.gpo.gov/fdsys/pkg/BILLS-114s1177enr/pdf/BILLS-114s1177enr.pdf

[§] https://advancesinap.collegeboard.org/stem/computer-science-principles

[‖] https://code.org/action

#https://k12cs.org/

Longitudinal data from HSLS:09, a study that followed a cohort of ninth graders beginning high school in 2009 over 4 years of high school, indicate that 47% of 2013 high school graduates earned credit in computer and information sciences, and 15% earned credit in engineering and technology (Table 1-18; Appendix Table 1-26).[1] The average credits earned were 1.0 credit for computer and information sciences and 1.3 credits for engineering and technology. About two and a half times as many male students (21%) earned engineering and technology credits compared with female students (8%). No significant difference was detected in the percentage of male and female students earning credits for computer and information sciences. It is important to note that computer and information sciences credits reported above included credits earned for introductory courses as well as applied courses focused on learning and using specific software programs. These introductory courses do not fall under the more rigorous definition of computer science as "the study of computers and algorithmic processes, including their principles, design, implementation and impact on society" endorsed by the new K–12 Computer Science Framework (K-12 Computer Science Framework 2016).

TABLE 1-18

Average high school credits earned in technology-related courses and percentage of students earning any credit, for fall 2009 ninth graders, by sex: 2013

(Average number of credits and percentage of students)

Sex	Computer and information sciences		Engineering and technology	
	Average credits	Earned any credit	Average credits	Earned any credit
Total	1.0	47.1	1.3	14.7
Male	1.1	49.0	1.4	21.1
Female	1.0	45.1	1.0	8.3

Source(s)

Dalton B, Ingels SJ, Fritch L, *High School Longitudinal Study of 2009 (HSLS:09) 2013 Update and High School Transcript Study: A First Look at Fall 2009 Ninth-Graders in 2013,* NCES 2015-037rev (2016).

Science and Engineering Indicators 2018

Data collected as part of a multiyear research effort by Gallup and Google give further insight into the state of computer science education in the United States (Google Inc. and Gallup Inc. 2016). Gallup interviewed nationally representative samples of students, parents, teachers, principals, and superintendents in late 2015 and early 2016. Data from the survey of principals reveal the extent of student access to computer science courses. A total of 57% of principals reported that their school offered at least one computer science course, although, again, these could be applied courses in how to use software programs that do not meet the more rigorous definition of computer science advocated in the new K–12 Computer Science Framework (Table 1-19). Fewer principals reported offering computer science courses with advanced content, ranging from 40% reporting courses that included computer programming to 14% reporting courses that included data analytics or visualization (Google Inc. and Gallup Inc. 2016). Computer science courses were more likely to be offered at larger schools, with 78% of principals at schools with 1,000 or more students reporting offering at least one computer science course, compared with 47% of principals at schools with less than 500 students (Table 1-19). Computer science courses were also more available at high schools (75%) than at middle schools (51%) and elementary schools (39%). When principals at schools that offered no computer science were asked why such courses were not offered, 63% indicated that teachers with the necessary skills were not available, 55% responded that they did not have sufficient funds to train and hire a teacher, and 50% noted the lack of time in their class schedule for subjects other than those with testing requirements (Google Inc. and Gallup Inc. 2016).

TABLE 1-19

Percentage of principals reporting that their schools offer at least one computer science course, by grade level, size, and locale: 2016

(Percent)

Characteristic	At least one computer science course
Total	57
Grade level	
6th and lower	39
7th and 8th	51
9th and higher	75
Size	
Less than 500	47
500–999	51
1,000 or more	78
Locale	
City	44
Suburb	69
Town or rural	57

Source(s)

Google Inc. & Gallup Inc., *Trends in the State of Computer Science in U.S. K–12 Schools* (2016), figure B7, https://goo.gl/j291E0, accessed 16 March 2017.

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Participation and Performance in the Advanced Placement Program

The AP program is one of the largest and most well-known programs offering high school students the opportunity to earn college credits. Other such opportunities include the International Baccalaureate program, which also offers college credits to high school students, and dual enrollment, in which students enroll in college courses while still in high school.

Administered by the College Board, a nonprofit organization, the AP program offered college-level courses to high school students in 37 different subjects in 2016, enabling students to earn credits toward high school diplomas and college degrees simultaneously. The College Board also administers AP exams that test students' mastery of course material.[2] Students who earn a passing score of 3 or higher out of 5 on an AP exam may be eligible to earn college credits, placement into more advanced college courses, or both, depending on the policy of the postsecondary institution they attend.

AP Exam Taking and Performance

Among mathematics and science AP exams, calculus AB has been the most common, followed by biology; both remained so in 2016, when approximately 308,000 high school students took the calculus AB exam and 238,000 took the biology exam (Table 1-20). Fewer students took more advanced exams (e.g., about 125,000 students took calculus BC). Physics C: electricity and magnetism was the least common exam, taken by approximately 23,000 students in 2016.

The number of high school students who took at least one AP exam nearly doubled in the past decade, from 1,464,254 in 2006 to 2,611,172 in 2016 (Table 1-21). To provide context, the overall high school population increased by just 9% between 2001 and 2013 (U.S. Department of Education 2015). Similarly, the number of students who took an AP exam in mathematics or science rose consistently across all subjects from 2006 to 2016, ranging from an increase of 36% in the number of students taking the calculus AB exam to an increase of 75% in the number of students taking the computer science A exam. Calculus AB, statistics, biology, and environmental science all saw gains of more than 100,000 students taking those exams over the decade. Passing rates for the mathematics and science exams ranged from lows of 40% for physics 1 and 46% for environmental science to highs of 77% for physics C: mechanics and 81% for calculus BC (Table 1-20).

TABLE 1-20

Students who took or passed an AP exam in high school, by subject: 2016

(Number and percent)

Subject	Number who took exam	Percentage who passed exam[a]
AP mathematics exam		
Calculus AB	308,215	59.5
Calculus BC	124,931	81.1
Statistics	206,563	60.9
AP science exam		
Biology	238,080	61.1
Chemistry	153,465	53.6
Computer science A	57,937	64.5
Environmental science	149,096	45.6
Physics 1	169,304	39.8
Physics 2	26,385	61.3
Physics C: electricity/ magnetism	23,347	70.5
Physics C: mechanics	53,110	77.4

AP = Advanced Placement.

[a] Students scoring 3, 4, or 5 on a scale of 1–5 for an AP exam were considered to have passed.

Source(s)

The College Board (2016), https://secure-media.collegeboard.org/digitalServices/pdf/research/2016/Student-Score-Distributions-2016.xls, accessed 16 March 2017.

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TABLE 1-21

Students taking AP exams, by subject: 2006 and 2016

(Number)

Subject	2006	2016
Any AP exam	1,464,254	2,611,172
AP mathematics exam		
Calculus AB	197,181	308,215
Calculus BC	58,603	124,931
Statistics	88,237	206,563
AP science exam		
Biology	131,783	238,080
Chemistry	87,465	153,465
Computer science A	14,662	57,937
Environmental science	44,698	149,096
Physics 1	NA	169,304
Physics 2	NA	26,385
Physics C: electricity/ magnetism and mechanics[a]	34,961	76,457

NA = not available; physics 1 and 2 exams were first offered in 2015.

AP = Advanced Placement.

[a] Physics C electricity/magnetism and mechanics are two different exams but were reported as combined totals by the College Board.

Source(s)

The College Board, https://secure-media.collegeboard.org/digitalServices/pdf/research/2016/2016-Exam-Volume-Change.xls, accessed 16 March 2017.

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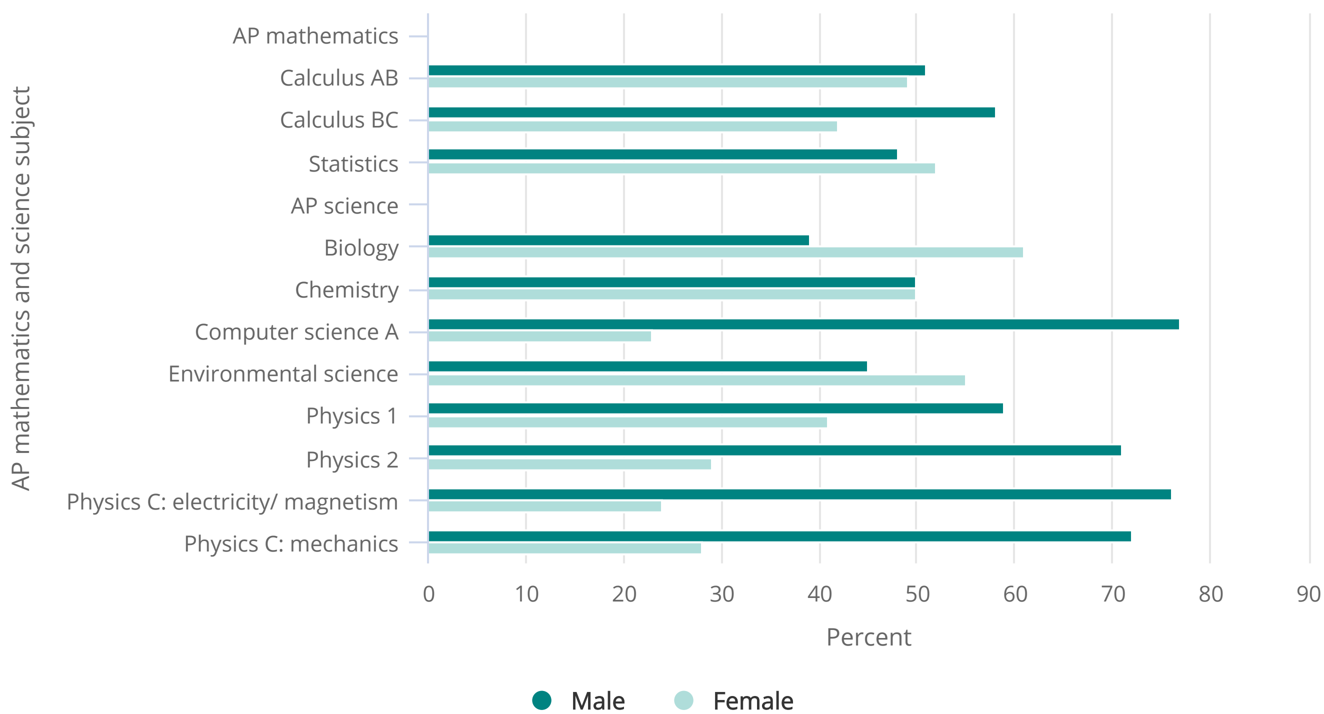
Sex. Mathematics and science AP exam taking varies by students' sex (Figure 1-6). Although the students who took calculus AB, statistics, and chemistry exams were about evenly split by sex in 2016, at advanced levels, male students predominated, representing 58% of all calculus BC takers, 71% of physics 2, 76% of physics C: electricity and magnetism, and 72% of physics C: mechanics. Male students also outnumbered their female counterparts in computer science, with 77% of computer science A exam takers being male students. In contrast, female students took a larger share of exams in biology (61%) and environmental science (55%).

FIGURE 1-6

Percentage distribution of high school students taking an AP exam in mathematics or science, by sex: 2016



AP = Advanced Placement.

Source(s)

The College Board, https://secure-media.collegeboard.org/digitalServices/misc/ap/national-summary-2016.xlsx, accessed 10 March 2017.

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Demographic Differences in Access to Advanced Mathematics and Science Courses: Civil Rights Data

The 2013–14 Civil Rights Data Collection (CRDC) is a survey of all public schools and school districts in the United States that is conducted by the Department of Education's Office for Civil Rights. The survey measures various factors that affect education equity and opportunity for students, including access to advanced mathematics and science courses (U.S. Department of Education 2016b). Overall, the CRDC shows that access to higher-level mathematics and science courses in the United States is not equal. Nationwide, 78% of high schools offer algebra 2, 48% offer calculus, 72% offer chemistry, and 60% offer physics (Table 1-22). In addition, these data show that schools with high black and Latino enrollment offer less access to high-level mathematics and science courses than schools with low black and Latino enrollment.[3] For example, 56% of high schools with low black and Latino student enrollment offer calculus, compared with 33% of high schools with high black and Latino enrollment.

TABLE 1-22

Access to high-level mathematics and sciences courses among students at low versus high black and Latino enrollment schools: 2013–14

(Percent)

Course	All schools	Low black and Latino enrollment[a]	High black and Latino enrollment
Algebra II	78	84	71
Calculus	48	56	33
Chemistry	72	78	65
Physics	60	67	48

[a] "High/low black and Latino enrollment" refers to schools with more than 75% and less than 25% black and Latino student enrollment, respectively, as defined and reported by the U.S. Department of Education's Office for Civil Rights.

Source(s)

U.S. Department of Education, Office for Civil Rights, *2013–2014 Civil Rights Data Collection: A first look* (2016). https://www2.ed.gov/about/offices/list/ocr/docs/2013-14-first-look.pdf, accessed 27 February 2017.

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[1] One credit is equivalent to a 1-year course of instruction.

[2]The cost of taking an AP exam was $93 per exam in 2017, a fee that might be prohibitive for low-income families and may affect equity of access to the exams. ESSA ended a federal grant program that had subsidized the cost of AP exams for students from low-income families for 17 years, adding to concerns about financial barriers to AP exam access. For more information, see https://www.edweek.org/ew/articles/2017/01/18/schools-grappling-with-fee-hikes-for-ap.html?r=1465832823.

[3] "High/low black and Latino enrollment" refers to schools with more than 75% and less than 25% black and Latino student enrollment, respectively, as defined and reported by the U.S. Department of Education's Office for Civil Rights.

Teachers of Mathematics and Science

Students' achievement in mathematics and science depends not only on the courses they take, but also, in large part, on their access to high-quality instruction. Many factors may affect teacher quality, including qualifications, subject-matter knowledge, years of experience, ongoing professional development, access to instructional coaches, instructional resources and leadership, and working conditions. Educators and policymakers continue to focus on attracting and retaining high-quality STEM teachers, as evidenced by the inclusion in ESSA of multiple provisions related to STEM teachers (see sidebar ESSA and STEM Teachers).

SIDEBAR

ESSA and STEM Teachers

The Every Student Succeeds Act (ESSA) includes several provisions designed to help states and districts prepare, train, and recruit high-quality science, technology, engineering, and mathematics (STEM) teachers.* These provisions include the following:

Alternative certification allows states "to establish, expand, or improve alternative routes for state certification of teachers especially for teachers of ... science, technology, engineering, mathematics, or other areas where the state experiences a shortage of educators."

Differential pay allows states and districts to "provide differential pay, or other incentives, to recruit and retain teachers in high need academic subjects" such as STEM.

Use of block grants for STEM professional development allows states and districts to use state block grants "to develop and provide professional development and other comprehensive systems of support for teachers, principals, or other school leaders to promote high-quality instruction and instructional leadership in science, technology, engineering, and mathematics subjects, including computer science."

STEM master teacher corps enables the Secretary of Education to award grants to states to "support the development of a state-wide STEM master teacher corps."

Professional development in technology for STEM teachers stipulates that school districts receiving grants of $30,000 or more "to improve the use of technology to improve the academic achievement, academic growth, and digital literacy of all students" must spend a portion of those funds on allowable uses, which include "professional development in the use of technology to enable teachers and instructional leaders to increase student achievement in the areas of science, technology, engineering, and mathematics, including computer science."

* See http://www.stemedcoalition.org/2015/12/01/coalition-analysis-of-key-stem-provisions-in-esea-act/ for additional information. The full text of ESSA is available at https://www2.ed.gov/documents/essa-act-of-1965.pdf.

Science and Engineering Indicators 2016 (NSB 2016) provided in-depth analysis of STEM teachers using data from the NCES 2011–12 Schools and Staffing Survey (SASS). New national data on STEM teachers have not become available since the publication of *Science and Engineering Indicators 2016*,[1] so this section provides a brief review of those findings followed by new data that provide insight into how U.S. teachers' salaries compare with those of their international counterparts.

As noted, the primary data source for STEM teacher information for *Science and Engineering Indicators 2016* was the 2011–12 SASS, a national survey conducted biennially by NCES from 1987 to 2011. NCES has redesigned SASS and launched it as a new survey, the National Teacher and Principal Survey (NTPS). Data collection began during the 2015–16 school year, and data will be available for analysis by 2018. NTPS was designed to be more flexible, timely, and integrated with other Department of Education surveys. It covers the same core topics as SASS while also including newer topics, such as teachers' use of information technology in the classroom. Core topics include teacher and principal preparation, school characteristics, demographics of the teacher and principal labor force, teacher professional development, and teacher compensation and retention.

Previous Findings

Science and Engineering Indicators 2016 provided various indicators of public school mathematics and science teachers' quality based on data collected during the 2011–12 school year, including educational attainment, professional certification, participation in student teaching, self-assessment of preparation, and years of experience. The section on mathematics and science teachers also examined school factors, such as salary and working conditions, that may affect teacher effectiveness. The section focused on middle and high school teachers because mathematics and science teachers are more common and more easily identified at these levels than at the elementary level.

In 2011, the vast majority of public middle and high school mathematics (91%) and science (92%) teachers were fully certified (i.e., held regular or advanced state certification). The percentage of mathematics and science teachers with full state certification increased by 6 percentage points and 9 percentage points, respectively, from 2003 to 2011. The increase in teachers with full certification was seen in many types of schools but was more apparent among science teachers in high-minority (from 79% in 2003 to 90% in 2011) and high-poverty schools (from 80% to 91%). Despite these increases, fully certified mathematics and science teachers were still less prevalent in high-minority and high-poverty schools when compared with low-minority and low-poverty schools. For example, 88% of mathematics teachers in high-poverty schools were fully certified, compared with 95% of those in low-poverty schools.

The prevalence of mathematics and science teachers with degrees in the subject they taught (i.e., in-field degrees) also varied by school poverty level. For example, 75% of middle school mathematics teachers in low-poverty schools had in-field degrees, compared with 63% of teachers at high-poverty schools. At the high school level, 95% of mathematics teachers at low-poverty schools had in-field degrees, compared with 87% at high-poverty schools.

Although the percentage of mathematics teachers with more than 20 years of experience decreased from 29% in 2003 to 23% in 2011, the percentage of teachers with 10–19 years of experience increased from 27% to 33%, and the percentage of teachers with fewer than 3 years of experience decreased from 19% to 15%. The pattern among science teachers was similar. Overall, in 2011, 85% of public middle and high school mathematics teachers and 90% of science teachers had more than 3 years of experience. The percentage of mathematics teachers with fewer than 3 years of experience was higher at high-poverty schools, however, compared with low-poverty schools (18% versus 10%). The pattern was similar for science teachers.

In 2011, the average base salary of middle and high school teachers was approximately $53,000 for mathematics teachers and $54,000 for science teachers, according to teachers' reports in SASS. When asked to rate their satisfaction with their salaries, slightly more than half of mathematics teachers, and just under half of science teachers, reported being satisfied. Teachers at high-poverty schools earned less than their counterparts at low-poverty schools, with mathematics teachers earning $10,000 less and science teachers earning $13,000 less on average.

International Comparisons of Teacher Salaries

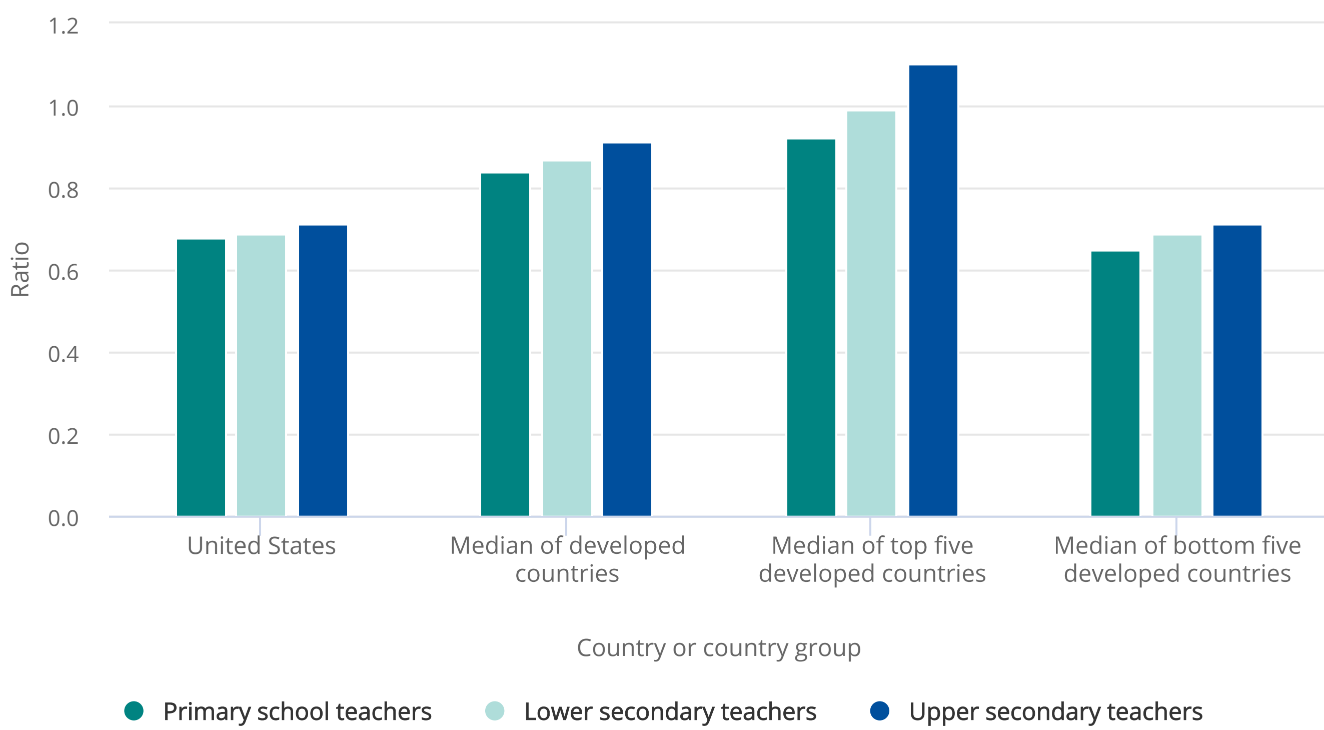
Teachers' salaries are associated with the attractiveness of teaching as a profession. The relative earnings in teaching and nonteaching professions correlate with career choices, and there is less attrition among teachers with higher salaries (Feng 2014; Gilpin 2012; James et al. 2011; OECD 2005).

The United States ranks low among developed countries with respect to the ratio of teachers' salaries to the salaries of other tertiary educated workers. For primary school teachers, the U.S. ranking is 20th of 23 countries. For lower and upper secondary school teachers, the United States is 21st of 23 countries.

Figure 1-7 examines the ratio of teachers' salaries to the salaries of other tertiary educated workers, comparing these ratios across developed countries. Primary teachers in the United States make 68% of the salary of other tertiary educated workers—that is, a 0.68 ratio. Lower secondary teachers (middle or junior high school) have a ratio of 0.69, whereas upper secondary teachers have a ratio of 0.71. The median relative salary ratio for all 23 developed countries for which data were available ranged from 0.84 to 0.91 for the three education levels. For the top five developed countries, the relative salary ratio ranged from 0.92 to 1.10.

FIGURE 1-7

Salaries of teachers in developed countries relative to earnings for tertiary educated workers: 2014



Note(s)

Education level defined by United Nations Educational, Scientific and Cultural Organization's *International Standard Classification of Education*, 2011. Lower secondary corresponds to junior high school or middle school in the United States. Thirty-two Organisation for Economic Co-operation and Development countries are defined as developed according to the International Monetary Fund's "advanced economy" classification. Of these, the data here reflect 23 developed countries for which data were available.

Source(s)

Organisation for Economic Co-operation and Development, *Education at a Glance: OECD Indicators*, 2016.

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A shortcoming of these data is that they are not adjusted for the level of tertiary education teachers and nonteachers received. For example, if U.S. teachers received fewer years of tertiary education than teachers in other countries, this may help account for some of the salary differences between countries. The OECD, however, provides some data that address this potential shortcoming. Ratios adjusted for amount of tertiary education are available for 11 developed countries, including the United States (OECD 2016). The United States, however, fares worse once the amount of tertiary education is considered: the gap between the U.S. ratio and the average ratio for other countries grows. In short, the ratio of teacher salaries to those of other educated workers is not lower in the United States than in other countries because U.S. teachers receive fewer years of tertiary education.

Another shortcoming of these data is that they do not focus specifically on science and mathematics teachers. However, salaries in the United States for K–12 teachers whose primary focus in teaching is mathematics or science were only 1.7% higher than salaries for other teachers.[2] This suggests that gaps in relative salaries for mathematics and science teachers might be similar to those observed for other teachers.

In summary, U.S. K–12 teachers have lower salaries than other U.S. workers with tertiary education, and the ratio of U.S. K–12 teacher salaries to that of other U.S. tertiary educated workers is smaller than for that of the median OECD country. Although U.S. K–12 teachers make 68% to 71%—depending on grade level—of the salary of other workers with tertiary education, the median for OECD countries ranges from 84% to 91%.

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[1] The Teachers of Mathematics and Science section from *Science and Engineering Indicators 2016* can be accessed at https://www.nsf.gov/statistics/2016/nsb20161/#/report/chapter-1/teachers-of-mathematics-and-science.

[2] Special tabulations (2016) using Schools and Staffing Survey PowerStats tool are available at https://nces.ed.gov/datalab/sass/.

Instructional Technology and Digital Learning

Over the years, policymakers and researchers have suggested that modern technology may have the potential to transform education (Duffey and Fox 2012; Johnson et al. 2014; U.S. Department of Education 2016a). Recognizing the potential value of technology, the U.S. federal government has launched a series of initiatives in recent years urging school leaders and educators across the nation to adopt a 21st-century model of education that encompasses technology. In 2013, then-President Obama announced the ConnectED initiative, pledging to connect 99% of American students to next-generation broadband and high-speed wireless in their schools and libraries by 2018. The country has made significant progress in reaching this goal, with the percentage of school districts with high-speed broadband increasing from 30% in 2013 to 88% in 2016 (Education Superhighway 2017). Many states have also joined the federal efforts, taking an active role in building a technology-rich learning environment in their states (Education Superhighway 2017; Watson et al. 2014).

Technology integration in schools not only provides access to the Internet but also encompasses the use of technological tools and practices, including online courses, use of various devices and hardware in classrooms, computer-based assessment, and adaptive software for students with special needs. Collectively referred to as instructional technology, this wide range of tools and practices involves using and creating appropriate technological processes and resources to facilitate teaching, engage students, and improve learning outcomes (Alliance for Excellent Education 2011; Richey 2008).

Data and research about instructional technology are presented in two sections. The first section focuses on the availability or use of various technological devices in classrooms and other topics such as Internet access. The second section focuses on online learning, providing data about its prevalence and the different types of online learning available to students. Each section concludes with a review of the research on the effectiveness of the technology discussed and its impact on student learning outcomes.

Technology as a K–12 Instructional Tool

The use of instructional technology—computers, the Internet, mobile devices, interactive whiteboards, and other emerging technologies—in K−12 classrooms has been growing rapidly. However, national data available to address the quality and effectiveness of the technologies remain limited, and research has generally shown only modest positive effects of technology on learning (Snyder and Dillow 2013; U.S. Department of Education 2016a).

Computers and Other Technology Devices

Computers are universally available in U.S. elementary and secondary schools (NSB 2014); however, as discussed later in this section, some K–12 teachers do not consider the current availability of instructional technology to be adequate, particularly in science classes. As of 2008, all U.S. public K–12 schools had one or more computers for instructional purposes on campus (Gray, Thomas, and Lewis 2010a). Computers are also commonly available in classrooms. In 2009, for example, 97% of K–12 public school teachers reported that they had one or more computers in their classroom, and 69% said that they or their students often or sometimes used computers during class time (Gray, Thomas, and Lewis 2010b). In addition to computers, the majority of teachers reported having the following technology devices available as needed or in the classroom every day: liquid crystal display or digital light processing projectors (84%), digital cameras (78%), and interactive whiteboards (51%). Furthermore, increasing numbers of schools and districts have initiated one-to-one computing programs, giving each student a laptop, tablet computer, or other mobile computing device to connect to the Internet, access digital course materials and textbooks, and complete school assignments (Gemin et al. 2015).

Despite the availability of computers and other devices in classrooms, many teachers still believe they lack technology resources. According to a 2012 national survey conducted by Project Tomorrow, 55% of K–12 teachers reported that there were not enough computers for student use in their classes, highlighting this deficiency as one of the major obstacles in their use of technology for teaching (Project Tomorrow 2013).

The lack of technology resources in classrooms may be more common in science classes than in mathematics classes. The 2012 National Survey of Science and Mathematics Education sponsored by the National Science Foundation found that, although 69% of elementary, middle, and high school mathematics teachers indicated that their instructional technology resources were adequate, just 34% to 48% of elementary, middle, and high school science teachers indicated so (Banilower et al. 2013).

Internet Access

Access to the Internet is universal in public K–12 schools in the United States. As of 2008, all public schools had instructional computers with an Internet connection (Gray, Thomas, and Lewis 2010a). Although Internet access at schools is universal, access with adequate bandwidth and connection speeds remains an area of concern. However, substantial progress is being made (Consortium for School Networking [CoSN] 2016; Education Superhighway 2017). In a 2016 national survey of school district technology administrators, more than two-thirds (68%) indicated that all the schools in their system fully met the Federal Communication Commission's short-term minimum Internet bandwidth recommendations for public schools,[1] up from 19% in 4 years (CoSN 2016). Affordability, network speed, capacity, reliability, and competition continue to affect Internet connectivity. Survey results suggest that increased bandwidth continues to be needed because schools expect dramatic increases in the number of students using multiple devices for classwork while at school. In 2016, 21% of schools reported that their students were using two or more devices per day; 65% of respondents expect use of two or more devices per student per day within the next 3 years (CoSN 2016).

Despite the progress that has been made in connectivity, access to high-speed Internet connections continue to vary by student demographics. One study reported that students in high-minority schools were half as likely to have high-speed Internet as students in low-minority schools, and students in low-income schools or remote rural areas were twice as likely as students in affluent schools or their urban and suburban peers to have slow Internet access at their schools (Horrigan 2014).

Mobile Devices

In addition to computers, mobile devices such as laptops, smartphones, and tablets are enhancing students' access to the Internet. Even though these Internet-connected devices have become one of the primary means with which youth interact and learn from each other, few national data are available to describe how and with what frequency these devices are used in day-to-day learning in and out of school. One extensive, although not nationally representative survey conducted by Project Tomorrow (2015),[2] found that 47% of K–12 teachers reported that their students had regular access to mobile devices in their classrooms. In terms of which types of devices students used for schoolwork during the school day, the survey found that 58% of students used their own device, followed by school laptops (32%), school Chromebooks (16%), and school tablets (14%) (Project Tomorrow 2015). Overall, 13% of high school and 21% of middle school students reported no access to computers or mobile devices at school (Project Tomorrow 2015).

Digital Conversion

With the advent of Internet-connected mobile devices, schools and districts are also initiating what is called a digital conversion within their classrooms, replacing traditional hard-copy textbooks with interactive, multimedia digital textbooks or e-textbooks that are accessible to students through the Internet. Forty-six percent of students in grades 9–12 who responded to Project Tomorrow's 2015 survey reported that they were using online textbooks, compared with 30% in 2005 (Project Tomorrow 2016). Educators are also supplementing traditional resources with videos, games, simulations, and other Internet-based resources. The use of academic-content videos from such services as YouTube, Khan Academy, and the National Aeronautics and Space Administration, among others, is growing as well. In the Project Tomorrow 2015 survey, 68% of teachers (up from 47% in 2012) reported that they regularly use videos from the Internet to augment their class lessons and stimulate class discussion (Project Tomorrow 2016). Students also report accessing Internet videos for support with homework, research projects, and other learning, with science (66%) and mathematics (59%) topping the list of content accessed. The use of computer games to supplement classroom learning is also on the rise, with 48% of teachers in 2015 reporting that they used them in their classrooms, up from 30% in 2012.

Research on Effectiveness of K–12 Instructional Technology

Effects of Instructional Technology

Existing research studies about the effects of instructional technology on student learning are not comprehensive enough to address the general question of whether technology improves student outcomes (Tamim et al. 2011). Few national studies are available; many of the existing studies are of brief duration or are based on specific products with small and geographically narrow samples or weak research designs. Nevertheless, some meta-analyses—studies that seek to combine data from nonrepresentative studies into a rigorous statistical design to provide limited but more rigorous findings—have yielded findings that suggest modest positive effects of technology on student learning.

One recent meta-analysis explored the effect of one-to-one laptop computing programs on elementary and secondary student achievement (Zheng et al. 2016). Drawing on articles published between 2001 and 2015, this study reviewed 96 articles but only found 10 suitable for inclusion in the statistical analysis, suggesting that rigorous research about the effects of one-to-one computing remains limited. The study found that one-to-one laptop programs had a modest effect on students' overall academic achievement in mathematics and science (Zheng et al. 2016). These findings are aligned with the findings from an earlier large-scale meta-analysis of all types of computer use in classrooms, which summarized 1,055 primary studies from 1967 to 2008 and concluded that the use of computer technologies in classrooms had modest effects on student achievement (Tamim et al. 2011).

Three meta-analyses that specifically focused on mathematics learning compared the mathematics achievement of students taught in elementary and secondary classes using technology-assisted mathematics programs with that of students in control classes using alternative programs or standard methods (Cheung and Slavin 2011; Li and Ma 2010; Rakes et al. 2010). All three studies found small, positive effects on student achievement when technology was incorporated into mathematics classes. A randomized impact evaluation found that a computer-aided application improved elementary students' mathematics test scores (Carrillo, Onofa, and Ponce 2010). A more recent randomized field trial of seventh grade mathematics students also found that an online mathematics homework tool combined with teacher training led to higher mathematics achievement scores for participating students compared with those of a control group that did not have access to the program (Roschelle et al. 2016).

Some studies also suggest that technology's potential to improve student achievement may depend on how it is incorporated into instruction (Cennamo, Ross, and Ertmer 2013; Ross, Morrison, and Lowther 2010; Tamim et al. 2011). One study found that, when computing devices were used as tools to supplement the traditional curriculum, no increase in achievement was observed; when computing devices were used as the main teaching tools in class, however, student achievement increased (Norris, Hossain, and Soloway 2012).

K–12 Online Learning

In addition to its potential for enhancing learning in the classroom, technology can also enable students to access instruction remotely via the Internet. Online learning at the K–12 level ranges from programs that are fully online with all instruction occurring via the Internet to hybrid or blended learning programs that combine face-to-face teacher instruction with online components (Gemin et al. 2015; Watson et al. 2014). Online learning discussed in this section focuses on fully online schools and stand-alone online courses that do not incorporate face-to-face instruction.

In the 2014–15 school year, 24 states operated virtual schools that offered supplemental online courses for students. These schools served more than 462,000 students, who took a total of 815,000 online semester-long courses (Gemin et al. 2015). Although still a small fraction of the approximately 50 million students enrolled in K–12 public schools, this was a significant increase since 2012–13, when 721,149 semester course enrollments were recorded. High school students took most of these courses (85%). Math courses made up nearly 23% of the courses taken, and science courses made up 14% (Gemin et al. 2015). Full-time virtual charter schools are another online option for students; these schools served about 275,000 students during the 2014–15 school year (Gemin et al. 2015).

A nationally representative survey of public school districts conducted by NCES in 2009 found that the top reasons for offering online learning opportunities were to provide courses not otherwise available at their schools (64%) and to give students opportunities to recover course credits from classes missed or failed (57%) (Queen and Lewis 2011). The survey also found that credit recovery was especially important in urban areas, where 81% of school districts indicated that this was a very important reason for making online learning opportunities available. Other reasons school districts gave for providing online learning options included offering AP or college-level courses (40%), reducing scheduling conflicts for students (30%), and providing opportunities for homebound students and those with special needs (25%).

Research on Effectiveness of Online Learning

Effects of Online Learning

Policymakers and researchers cite many potential benefits of online learning, which include increasing access to resources, personalizing learning, and assisting struggling students (Bakia et al. 2012; Watson et al. 2013). Despite these potential benefits, few rigorous national studies have addressed the effectiveness of online learning compared with that of traditional teaching models at the K–12 level. One rigorous, large-scale national study of virtual charter schools was conducted by the Center for Research on Education Outcomes (CREDO), housed at Stanford University (CREDO 2015). Researchers contrasted the annual academic growth of students attending full-time online charter schools with that of a comparison group of students from traditional schools who were similar in terms of grade level, sex, race or ethnicity, poverty, prior test scores, and other attributes. The study found that students attending the online schools in the 2012–13 school year had significantly weaker academic growth when compared with their counterparts at traditional schools (CREDO 2015). These results, however, were specific to online charter schools and do not apply to full-time online schools operated by states and districts or to individual online course enrollments or blended learning school models.

A common use of online learning courses is to allow students to recover credits from courses they have failed. One large study comparing achievement outcomes for students taking an algebra credit recovery course online with students taking a face-to-face course found weaker achievement outcomes for students taking the online course (Heppen et al. 2017). Other recent studies have observed some positive effects for online learning, but researchers stress that teacher training and the way in which online components are integrated into the curriculum are important variables that could affect outcomes and that need to be the subject of more rigorous research (Barbour 2015). Although the latest research suggests that online schools may be meeting the needs of students who do not have access to adequate physical school and course options, research on the effectiveness of online learning is still in a nascent state (Watson et al. 2014).

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[1] The Federal Communication Commission short-term goal is 100 Mbps per 1,000 students. The long-term goal is 1 Gbps per 1,000 students.

[2] The global education nonprofit, Project Tomorrow, conducts the annual Speak Up Research Project, which polls K–12 students, parents, and educators about the role of technology in learning in and out of school. In fall 2014, Project Tomorrow surveyed 431,231 K–12 students, 35,337 parents, 41,805 teachers, 680 district administrators, and 3,207 school administrators representing 8,216 public and private schools from 2,676 districts. Schools from urban (30%), suburban (30%), and rural (40%) communities were represented. Just over one-half of the schools (56%) that participated in Speak Up 2014 were Title I eligible schools (an indicator of student population poverty). In fall 2015, Project Tomorrow surveyed 415,686 K–12 students, 38,613 teachers and librarians, 4,536 administrators, and 40,218 parents representing more than 7,600 public and private schools and 2,600 districts. Schools from urban (25%), suburban (40%), and rural (35%) communities were represented. Just over one-half of the schools (58%) that participated in Speak Up 2015 were Title I–eligible schools.

Transition to Higher Education

One of the most important education goals in the United States is to educate every student to graduate from high school ready for college and a career (Achieve Inc. 2016; NCEE 2013; Pellegrino and Hilton 2012). Over the past decades, U.S. high school graduation rates have been rising steadily, reaching 83% in 2015 (McFarland, Stark, and Cui 2016). Although high school completion represents a major milestone for adolescents, most of today's fastest-growing, well-paying jobs require at least some postsecondary education (Carnevale, Smith, and Strohl 2010; Hout 2012). Young people who do not pursue education beyond high school face fewer job opportunities, lower earnings, and a greater likelihood of being unemployed and underemployed than their college-educated peers (Baum, Ma, and Payea 2013; Pew Research Center 2014).

Within this context, this section focuses on indicators related to U.S. students' transitions from high school to postsecondary education. It presents national data on on-time high school graduation rates, trends in immediate college enrollment after high school, choice of STEM majors at the postsecondary level, and academic preparation for college. This section also examines U.S. students' high school graduation rates relative to those of their peers in other countries. Together, these indicators present a broad picture of the transition of U.S. students from high school to postsecondary education. (Higher education in S&E is the topic of Chapter 2.)

Completion of High School

Estimates of U.S. high school completion rates vary, depending on the definitions, data sources, and calculation methods (Heckman and LaFontaine 2007; Seastrom et al. 2006). Based on a relatively inclusive definition—receiving a regular high school diploma or earning an equivalency credential, such as a GED certificate—about 92% of the U.S. population ages 18–24 in 2013 had completed a high school education (McFarland, Stark, and Cui 2016). This is largely consistent with the experience of a nationally representative cohort of 2002 high school sophomores; 96% of the cohort members had earned a high school diploma or an equivalency credential by 2012 (Lauff and Ingels 2014).

Beginning with the 2010–11 school year, the Department of Education required all states to use a more restrictive definition of high school graduation, emphasizing on-time completion and considering only recipients of regular high school diplomas (Chapman et al. 2011). Using this definition, NCES releases two annual measures of high school completion: the Adjusted Cohort Graduation Rate (ACGR) and the Averaged Freshman Graduation Rate (AFGR).[1] Both measures provide the percentage of public school students who attain a regular high school diploma within 4 years of starting ninth grade, but the ACGR is the more accurate measure because it relies on longitudinal data that track each student over time (McFarland, Stark, and Cui 2016). The U.S. high school graduation rates discussed below are ACGRs.[2]

On-Time Graduation Rates from 2011 to 2015

The on-time graduation rate among U.S. public high school students has increased steadily since 2011 (Table 1-23). In 2011, 79% of public high school students graduated on time with a regular diploma; by 2015, the percentage had climbed to 83%.

Socioeconomic status. In addition to reporting graduation rates by race or ethnicity to the federal government, states also report rates by students who are economically disadvantaged.[3] Although on-time graduation rates for economically disadvantaged students have improved by 6 percentage points since 2011, these students continue to graduate at lower rates than the general population (76% versus 83%).

Race or ethnicity. Black students made the largest gain during this period, an improvement of 8 percentage points, from 67% in 2011 to 75% in 2015. Hispanic students made a gain of 7 percentage points, from 71% in 2011 to 78% in 2015, as did

American Indian or Alaska Native students, from 65% in 2011 to 72% in 2015. White students gained 4 percentage points, and Asian or Pacific Islander students gained 3 percentage points during this period. Despite this improvement, substantial differences among racial and ethnic groups persisted: in 2015, the on-time high school graduation rates for Asian or Pacific Islander and white students were 90% and 88%, respectively; and both rates surpassed those of black, Hispanic, and American Indian or Alaska Native students (72%–78%) by at least 16 percentage points.

TABLE 1-23

On-time graduation rates of U.S. public high school students, by student characteristics: 2011–15

(Percent)

Characteristic	2011	2012	2013	2014	2015
All students	79	80	81	82	83
Race or ethnicity[a]					
White	84	86	87	87	88
Black	67	69	71	73	75
Hispanic	71	73	75	76	78
Asian or Pacific Islander	87	88	89	89	90
American Indian or Alaska Native	65	67	70	70	72
Economically disadvantaged[b]	70	72	73	75	76
Limited English proficiency[c]	57	59	61	63	65
Students with disabilities[d]	59	61	62	63	65

[a] Hispanic may be any race. American Indian or Alaska Native, Asian or Pacific Islander, black, and white refer to individuals who are not of Hispanic origin.

[b] This refers to students who met the reporting states' criteria for classification as economically disadvantaged.

[c] This refers to students who met the definition of limited English proficient as outlined in the ED*Facts* Workbook. For more information, see appendix B in https://www2.ed.gov/about/inits/ed/edfacts/eden/16-17-workbook-13-0.pdf.

[d] These students were identified as children with disabilities under the Individuals with Disabilities Education Act.

Source(s)

McFarland J, Stark P, Cui J, *Trends in High School Dropout and Completion Rates in the United States: 2013,* NCES 2016 117 (2016); U.S. Department of Education, National Center for Education Statistics, Common Core of Data data tables, https://nces.ed.gov/ccd/tables/ACGR_RE_and_characteristics_2013-14.asp and https://nces.ed.gov/ccd/tables/ACGR_RE_and_characteristics_2014-15.asp, accessed 27 February 2017.

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High School Graduation Rates in the United States and Other OECD Nations

The OECD estimates upper secondary graduation rates for its members and selected nonmember countries by dividing the number of graduates in a country in a specific year by the number of people at the typical graduation age (OECD 2016).[4] These estimates enable a broad, albeit imperfect, comparison between the United States and other countries.[5] Based on 2014 data, U.S. graduation rates are lower than those of many OECD countries. Among the 25 OECD nations with available data on graduation rates in 2014, the United States ranked 19th, with a graduation rate of 82%, compared with the OECD average of 85% (Table 1-24). The top-ranked countries, listed in order of rank, are Finland, Japan, New Zealand, Netherlands, South Korea, Denmark, Italy, Germany, and Slovenia—all of which had graduation rates of 90% or higher.

Furthermore, the relative standing of U.S. high school graduation rates has stayed largely the same from 2008 to 2014. Among the 18 OECD countries for which graduation rate data were available in 2008, 2010, 2012, and 2014, the United States ranked 13th in 2008, 14th in 2010 and 2012, and 12th in 2014 (Table 1-25).

TABLE 1-24

High school graduation rates, by OECD country: 2014

(Percent)

Country	High school graduation rate
OECD average[a]	85.4
Finland	96.9
Japan	96.7
New Zealand	95.5
Netherlands	94.8
South Korea	94.6
Denmark	94.0
Italy	93.0
Germany	90.7
Slovenia	90.0
Austria	89.7
Israel	89.6
Iceland	89.3
Canada[b]	88.7
Hungary	87.8
Chile	87.7
Norway	84.3
Slovakia	82.6
Poland	82.5
United States	81.9
Spain	74.4
Czech Republic	74.0
Luxembourg	73.9
Sweden	68.7
Turkey	67.6

Country	High school graduation rate
Mexico	51.3

OECD = Organisation for Economic Co-operation and Development.

[a] OECD average is based on all OECD countries with available data.

[b] Graduation rate is for 2013.

Note(s)

To generate estimates that are comparable across countries, OECD calculated high school graduation rates by dividing the number of first-time graduates (of any age) completing upper secondary education programs in the country by the population of the typical graduation age, which OECD refers to as the age of the students at the beginning of the school year (e.g., 17 years old in the United States). Countries are ordered by 2014 high school graduation rate.

Source(s)

OECD, *Education at a Glance: OECD Indicators 2016* (2016).

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TABLE 1-25

Relative standing of U.S. high school graduation rates among OECD countries: 2008, 2010, 2012, and 2014

(Percent)

Year	OECD country	High school graduation rate
2008	Germany	97
	Japan	95
	Finland	93
	South Korea	93
	Norway	91
	Iceland	89
	Czech Republic	87
	Italy	85
	Denmark	83
	Poland	83
	Slovakia	81
	Hungary	78
	United States	77
	Sweden	76
	Luxembourg	73
	Spain	73
	Mexico	44
	Turkey	26
2010	Japan	96
	South Korea	94
	Finland	93
	Iceland	88
	Germany	87
	Norway	87

Year	OECD country	High school graduation rate
	Denmark	86
	Hungary	86
	Slovakia	86
	Poland	84
	Italy	83
	Spain	80
	Czech Republic	79
	United States	77
	Sweden	75
	Luxembourg	70
	Turkey	54
	Mexico	47
2012	Germany	95
	Iceland	95
	Hungary	94
	Finland	93
	Japan	93
	Spain	93
	Denmark	92
	South Korea	92
	Norway	88
	Slovakia	86
	Poland	85
	Italy	84
	Czech Republic	82
	United States	79
	Sweden	77

Year	OECD country	High school graduation rate
	Luxembourg	69
	Turkey	55
	Mexico	47
2014	Finland	97
	Japan	97
	South Korea	95
	Denmark	94
	Italy	93
	Germany	91
	Iceland	89
	Hungary	88
	Norway	84
	Poland	83
	Slovakia	83
	United States	82
	Czech Republic	74
	Luxembourg	74
	Spain	74
	Sweden	69
	Turkey	68
	Mexico	51

OECD = Organisation for Economic Co-operation and Development.

Note(s)

Data include only OECD countries with available data in all 4 years. Countries whose percentages are tied are listed alphabetically.

Source(s)

Organisation for Economic Co-operation and Development, *Education at a Glance: OECD Indicators 2008* (2008), *Education at a Glance: OECD Indicators 2010* (2010), *Education at a Glance: OECD Indicators 2012* (2012), and *Education at a Glance: OECD Indicators 2014* (2014).

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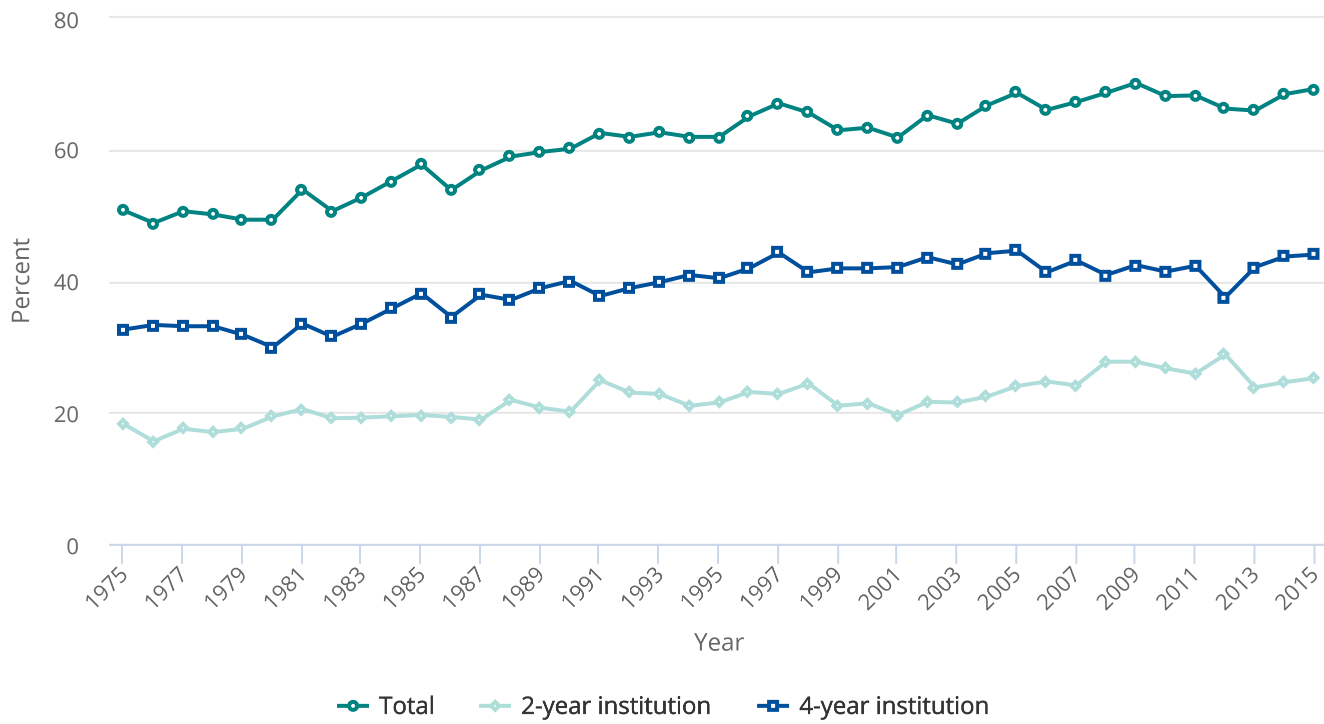
Enrollment in Postsecondary Education

After completing high school, some students immediately enter the workforce, join the military, or start families, but the majority go directly into postsecondary education (Ingels et al. 2012). Of the 3 million students who completed high school or a GED in 2015, some 2.1 million (69%) enrolled in a 2- or 4-year college the following fall (Kena et al. 2016). This rate, known as the immediate college enrollment rate, is defined as the annual percentage of high school completers aged 16 to 24, including GED recipients, who enroll in 2- or 4-year colleges by the October after high school completion.

Between 1975 and 2015, the percentage of high school graduates making an immediate transition to college increased from 51% to 69% (Figure 1-8). In each year, more students enrolled in 4-year institutions than in 2-year institutions. Immediate enrollment rates between 1975 and 2015 increased from 33% to 44% for 4-year institutions and from 18% to 25% for 2-year institutions.

FIGURE 1-8

Immediate college enrollment rates among high school graduates, by institution type: 1975–2015



Note(s)

The figure includes students ages 16 to 24 who completed high school in each survey year. Immediate college enrollment rates are defined as rates of high school graduates enrolled in college in October after completing high school. Before 1992, high school graduates referred to those who had completed 12 years of schooling. As of 1992, high school graduates are those who have received a high school diploma or equivalency certificate. Detail may not sum to total due to rounding.

Source(s)

The Condition of Education, tables 302.10, 302.20, 302.30, https://nces.ed.gov/programs/coe/indicator_cpa.asp, accessed 3 May 2017. See Appendix Table 1-27.

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Socioeconomic status. Enrollment gaps, however, persisted among students of different socioeconomic backgrounds (Appendix Table 1-27): in 2015, the immediate college enrollment rate of students from low-income families was lower than the rate of those from high-income families (69% versus 83%).

Race or ethnicity. Since 1975, the immediate college enrollment rate has increased from 49% to 70% for white students, 45% to 63% for black students, and 53% to 67% for Hispanic students. Asians or Pacific Islanders enrolled at consistently higher rates than all other groups since 2003, when data on Asian and Pacific Islander students were first available.

Sex. The immediate college enrollment rate in 2015 was higher for female students (73%) than for male students (66%).

Other characteristics. Enrollment rates also varied widely with parental education, ranging in 2015 from 56% for students whose parents had less than a high school education to 82% for students whose parents had a bachelor's or higher degree.

Preparation for College

Although the majority of U.S. students attend college after high school, high rates of remedial coursetaking and low rates of college completion indicate that many of them are not well prepared during their high school years for college (Chen 2016). Research indicates that many college students arrive on campus lacking the necessary academic skills to perform at the college level. Postsecondary institutions address this problem by offering remedial courses designed to strengthen students' basic skills. Students must pass these remedial courses before they can begin taking credit-bearing courses that count toward their degree. In 2011–12, about 29% of students at public 4-year institutions and 41% at public 2-year institutions reported having ever taken remedial courses (Skomsvold 2014).

In 2016, Achieve Inc., an independent, nonprofit education reform organization, conducted the first state-by-state analysis of student performance on college- and career-ready measures (including performance on assessments, completion of a rigorous course of study, and earning college credit while in high school) and determined that "too few high school graduates are prepared to succeed in postsecondary education" (Achieve Inc. 2016: 1). Student scores on such assessments as NAEP and ACT also suggest that a majority of high school students are not academically prepared for college-level mathematics and science coursework (see sidebar Measuring College Readiness in Mathematics and Science).

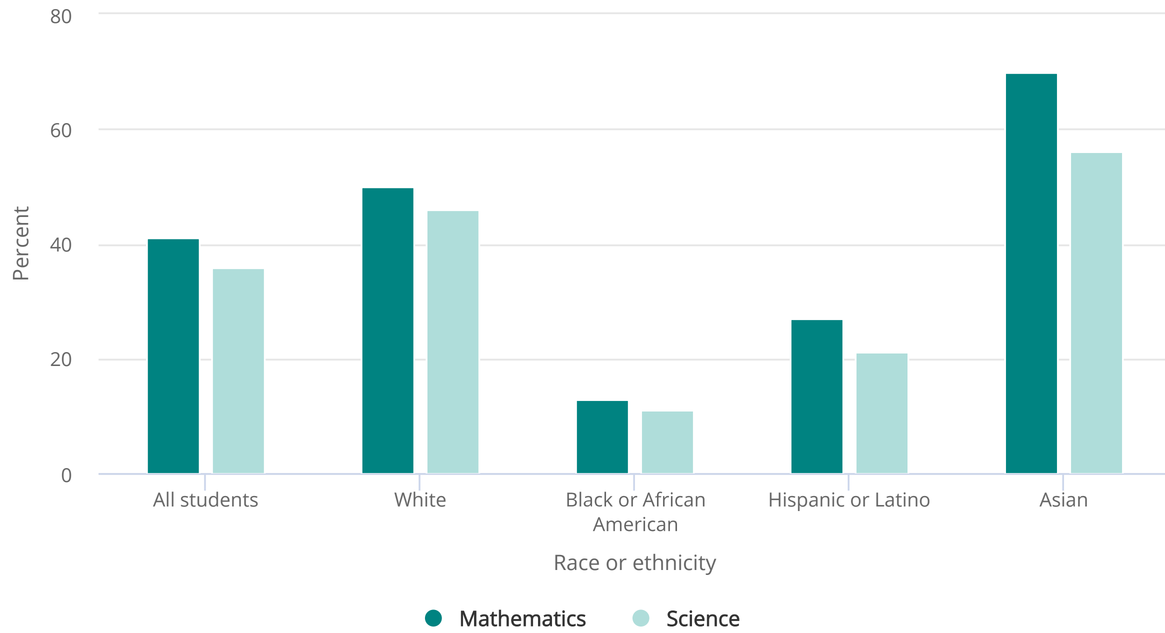
SIDEBAR

Measuring College Readiness in Mathematics and Science

The ACT is a national college admissions examination that consists of subject-area tests in English, mathematics, reading, and science. In 2016, 64% of the high school graduating class took the ACT (ACT 2016). The ACT organization has established College Readiness Benchmarks, which are the minimum scores students need to have a high probability of success in the credit-bearing college courses most commonly taken by first-year college students.* ACT drew on college performance data from 214 institutions and 230,000 students to establish its benchmarks. Although not representative of the entire high school population, performance on these benchmarks gives insight into how well prepared a majority of the nation's students are to succeed in college-level mathematics and science. In 2016, ACT reported that 41% of ACT takers met the college readiness benchmark in mathematics, and 36% met the college readiness benchmark in science (Figure 1-A). These percentages varied substantially by race or ethnicity, with 70% of Asian ACT takers meeting the mathematics benchmark, compared with 50% of white students, 27% of Hispanic students, and 13% of black students. Similar disparities were seen in the percentages of students meeting the science benchmark, with 56% of Asian students meeting the benchmark, compared with 46% of white students, 21% of Hispanic students, and 11% of black students.

FIGURE 1-A

ACT-tested 2016 high school graduates meeting ACT college readiness benchmarks in mathematics and science



Source(s)

ACT, 2016. *The Condition of College and Career Readiness 2016*. Iowa City, IA, https://www.act.org/content/dam/act/unsecured/documents/CCCR_National_2016.pdf. Accessed 27 February 2017.

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Other measures of college readiness support the ACT findings. National Association of Educational Progress (NAEP) college-ready indicators provide readiness estimates based on a nationally representative sample of students. The National Assessment Governing Board (NAGB), which sets policy for NAEP, began using NAEP in 2013 to estimate the percentage of grade 12 students who possess the knowledge and skills in reading and mathematics that would make them academically prepared for first-year college coursework. NAGB conducted a decade of research to determine the NAEP scores students need to earn to demonstrate college readiness. According to results from the 2015 NAEP, an estimated 37% of twelfth graders were prepared for college-level coursework in mathematics (Kena et al. 2016), a finding similar to that of ACT and one that is echoed in Achieve Inc.'s 50-state analysis of student performance on college readiness indicators. Achieve found that, even in the highest performing state, only 42% of students were ready for college-level work in mathematics (Achieve Inc. 2016).

* Students who meet the mathematics or science benchmark on the ACT have approximately a 75% chance of earning a C or better in the credit-bearing college-level mathematics or science courses most commonly taken by college students (e.g., college algebra and biology).

High School Completers Planning to Pursue a STEM Major in College

With the goals of maintaining global competitiveness and enhancing capacity for innovation, U.S. policymakers have called for increasing the number and diversity of students pursuing degrees and careers in STEM fields. Data from HSLS:09 gave insight into the percentage of high school students planning to major in STEM fields in college. Among respondents who reported plans to pursue a bachelor's degree, 32% indicated plans to pursue a STEM major (Appendix Table 1-28). Asian students were the most likely to identify a STEM major, with 53% of bachelor's degree program respondents identifying a STEM major, compared with 32% of white students, 28% of Hispanic students, and 23% of black students. A higher percentage of male (41%) than female (24%) bachelor's degree program respondents identified a STEM major.

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[1] To calculate the ACGR, states identify the "cohort" of first-time ninth graders in a particular school year and adjust this number by adding any students who transfer into the cohort after ninth grade and subtracting any students who transfer out, emigrate to another country, or die. The ACGR is the percentage of the students in this cohort who graduate with a high school diploma within 4 years. The AFGR uses aggregate student enrollment data to estimate the size of an incoming freshman class, which is the sum of eighth grade enrollment in the first year, ninth grade enrollment for the next year, and tenth grade enrollment for the year after, and then dividing by three. The AFGR is the number of high school diplomas awarded 4 years later divided by the estimated incoming freshman class size.

[2] The earlier editions of *Science and Engineering Indicators* reported U.S. high school graduation rates based on AFGR because the student-level records needed to calculate the ACGR were not available at a state level until recent years.

[3] See https://nces.ed.gov/pubs2016/2016117rev.pdf for a definition of *economically disadvantaged*.

[4] Upper secondary education, as defined by the OECD, corresponds to high school education in the United States. In calculating the U.S. graduation rates, the OECD included only students who earned a regular diploma and excluded those who completed a GED certificate program or other alternative forms of upper secondary education. The OECD defines the typical graduation age as the age of the students at the beginning of the school year: when they graduate at the end of the school year, students will generally be 1 year older than the age indicated. According to the OECD, the typical graduation age in the United States is 17 years old. The U.S. high school graduation rates calculated by the OECD cannot be directly compared with U.S. on-time graduation rates because of the different population bases and calculation methods for the two measures.

[5] International comparisons are often difficult because of differences among education systems, types of degrees awarded across countries, and definitions used in different countries. Some researchers have pinpointed various problems and limitations of international comparisons and warned readers to interpret data, including those published by the OECD, with caution (Adelman 2008; Wellman 2007).

Conclusion

Raising overall student achievement, reducing performance gaps among different groups, increasing advanced coursetaking, recruiting more STEM teachers, and improving college readiness in mathematics and science are high priorities for education reform across the United States. How well does this country perform in these areas? The indicators in this chapter present a mixed picture of the status and progress of elementary and secondary mathematics and science education in the United States. Table 1-26 provides an overall summary of the data presented in this chapter. It shows that despite efforts at reform, there are substantial disparities in STEM performance and opportunity based on students' race or ethnicity and SES. Some disparities persist between male and female students, though the differences are small relative to the disparities by race or ethnicity and SES. In the international arena, the United States performs in the middle of the pack among developed countries on the TIMSS assessments but at the bottom on PISA. Table 1-27 shows that U.S. performance overall in STEM has mostly improved over the long term, though short-term trends show some plateaus and downturns. Following is a summary of the chapter findings by major indicators.

TABLE 1-26

Chapter summary of U.S. performance on K–12 STEM indicators

(Score, percentile, and gaps between groups)

Data year	Assessment	Scale	Average score or percentage	10th percentile	90th percentile	Point range 10th to 90th	Gaps between											
							High and low SES[a]			White and black and Hispanic[b]					Male and female		
							High	Low	Gap	White	Black	Gap	Hispanic	Gap	Male	Female	Gap
2015	NAEP Mathematics Grade 4	0 to 500	240	202	277	75	253	229	24	248	224	24	230	18	241	239	2
2015	NAEP Mathematics Grade 8	0 to 500	282	235	329	94	296	268	28	292	260	32	270	22	282	282	0
2015	NAEP Mathematics Grade 12	0 to 300	152	107	196	89	160	137	23	160	130	30	139	21	153	150	3
2015	NAEP Science Grade 4	0 to 300	154	108	196	88	169	140	29	166	133	33	139	27	154	154	0
2015	NAEP Science Grade 8	0 to 300	154	109	195	86	167	140	27	166	132	34	140	26	155	152	3
2015	NAEP Science Grade 12	0 to 300	150	103	196	93	160	134	26	160	125	35	136	24	153	148	5
2014	NAEP TEL Grade 8	0 to 300	150	104	193	89	163	135	28	160	128	32	138	22	149	151	2
2014	ECLS-K:2011 Mathematics Grade 3	0 to 135	99	NA	NA	NA	103	93	10	103	90	13	94	9	101	97	4
2014	ECLS-K:2011 Science Grade 3	0 to 87	56	NA	NA	NA	59	51	8	59	50	9	52	7	56	55	1
2015	TIMSS Mathematics Grade 4	0 to 1,000	535	432	640	208	600	499	101	541	462	79	492	49	543	536	7
2015	TIMSS Mathematics Grade 8	0 to 1,000	518	408	624	216	573	477	96	559	495	64	515	44	519	517	2
2015	TIMSS Science Grade 4	0 to 1,000	546	439	644	205	603	502	101	570	501	69	518	52	548	544	4
2015	TIMSS Science Grade 8	0 to 1,000	530	421	631	210	579	489	90	557	469	88	502	55	533	527	6
2015	TIMSS Advanced Mathematics	0 to 1,000	485	352	608	256	534	425	109	495	400	95	440	55	500	470	30

Data year	Assessment	Scale	Average score or percentage	10th percentile	90th percentile	Point range 10th to 90th	Gaps between										
							High and low SES[a]			White and black and Hispanic[b]					Male and female		
							High	Low	Gap	White	Black	Gap	Hispanic	Gap	Male	Female	Gap
2015	TIMSS Advanced Physics	0 to 1,000	437	283	589	306	506	363	143	463	334	129	390	73	455	409	46
2015	PISA Mathematics (age 15)	0 to 1,000	470	355	585	230	517	431	86	499	419	80	446	53	474	465	9
2015	PISA Science (age 15)	0 to 1,000	496	368	626	258	546	457	89	531	433	98	470	61	500	493	7
Highest course enrollment[c] (%)																	
2013	Calculus or higher	na	19	na	na	na	37	9	28	22	9	13	15	7	19	19	0
2013	AP/ IB or advanced science	na	21	na	na	na	38	11	27	23	14	9	16	7	20	23	3
Transition to postsecondary (%)																	
2015	On-time high school graduation[d]	na	83	na	na	na	NA	NA	NA	88	75	13	78	10	NA	NA	NA
2015	Immediate college enrollment[e]	na	69	na	na	na	83	69	14	70	63	7	67	2	66	73	7
2016	College ready in mathematics[f]	na	41	na	na	na	NA	NA	NA	50	13	37	27	23	NA	NA	NA
2016	College ready in science	na	36	na	na	na	NA	NA	NA	46	11	35	21	25	NA	NA	NA

NA = not available; na = not applicable.

AP = Advanced Placement/International Baccalaureate; ECLS-K:2011 = Early Childhood Longitudinal Study, Kindergarten Class of 2010–11 (see Appendix Table 1-14 and Appendix Table 1-15); NAEP = National Assessment of Educational Progress (see Appendix Table 1-1 and Appendix Table 1-3); NAEP TEL = National Assessment of Educational Progress, technology and engineering literacy (see Appendix Table 1-5); PISA = Program for International Student Assessment (see Table 1-11); SES = socioeconomic status; STEM = science, technology, engineering, and mathematics; TIMSS = Trends in International Mathematics and Science Study (see Table 1-6 and Table 1-8).

[a] SES is a composite variable derived from parental education level, parental occupation, and family income.

[b] Hispanic may be any race. Black and white refer to individuals who are not of Hispanic origin.

[c] Highest mathematics and science course enrollment of high school completers from High School Longitudinal Study of 2009. See Appendix Tables 1-23 and 1-25.

[d] See Table 1-23.

[e] See Appendix Table 1-27.

[f] See Figure 1-9.

Note(s)

Scales are different for each assessment and are not comparable across grades or assessments. Please use caution when interpreting results.

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TABLE 1-27

Summary of long- and short-term trends in U.S. performance on K–12 STEM indicators

(Trend)

Assessment	Long-term trend		Short-term trend	
	Date span	Trend	Date span	Trend
NAEP Mathematics Grade 4	1990–2015	^	2013–15	v
NAEP Mathematics Grade 8	1990–2015	^	2013–15	v
NAEP Mathematics Grade 12	2005–15	≈	2013–15	v
NAEP Science Grade 4	2009–15	^	na	na
NAEP Science Grade 8	2009–15	^	2011–15	^
NAEP Science Grade 12	2009–12	≈	na	na
TIMSS Mathematics Grade 4	1995–2015	^	2011–15	≈
TIMSS Mathematics Grade 8	1995–2015	^	2011–15	^
TIMSS Science Grade 4	1995–2015	≈	2011–15	≈
TIMSS Science Grade 8	1995–2015	^	2011–15	≈
TIMSS Advanced Mathematics	1995–2015	≈	na	na
TIMSS Advanced Physics	1995–2015	≈	na	na
PISA Mathematics (age 15)	2003–15	≈	2012–15	v
PISA Science (age 15)	2006–15	≈	2012–15	≈
On-time high school graduation[a]	2011–15	^	2014–15	^
Immediate college enrollment[b]	1990–2014	^	2013–14	^

≈ = indicates no significant change; ^ = upward trend in scores; v = downward trend in scores; na = not applicable because data are available for only two time points, so long term is the only trend.

NAEP = National Assessment of Educational Progress (see Appendix Table 1-1 and Appendix Table 1-3); PISA = Program for International Student Assessment (see Figure 1-5); STEM = science, technology, engineering, and mathematics; TIMSS = Trends in International Mathematics and Science Study (see Figure 1-3 and Figure 1-4).

[a] See Table 1-23.

[b] See Appendix Table 1-27.

Science and Engineering Indicators 2018

NAEP mathematics assessment results show that average mathematics scores for fourth, eighth, and twelfth graders remained relatively flat over the past decade and then declined slightly from 2013 to 2015. These declines are the first since 1990 for fourth and eighth graders and since 2005 for twelfth graders. NAEP science results for fourth and eighth graders were more encouraging, with increases of 4 points in average scores since 2009, although average scores for twelfth graders did not change during the same period. NAEP data indicate that achievement gaps persisted in the United States: low-SES, black, and Hispanic students trailed their peers by large margins, and male students slightly outperformed female students on most NAEP exams. Data from ECLS-K:2011 showed patterns similar to those from NAEP with respect to performance by different subgroups: high-SES students outscored low-SES students, Asian and white students outscored black and Hispanic students, and male students slightly outscored female students. Gaps that were evident between disadvantaged and advantaged groups in kindergarten and first grade remained through the end of third grade.

In the international arena, the nation's fourth graders scored in the top quarter of all participating education systems in mathematics and science on the 2015 TIMSS assessments, although their scores in either subject did not improve since the last administration in 2011. U.S. eighth graders also performed in the top quarter of participating education systems in 2015 and improved in mathematics but not in science since 2011. U.S. 15-year-olds' performance on PISA in 2015 declined in mathematics and did not change significantly in science when compared with the last administration in 2012. The United States scored lower than 36 education systems in mathematics and 18 in science.

Efforts to improve student achievement include raising high school graduation requirements and increasing advanced coursetaking. These efforts are meeting with some success. Most high school completers are taking mathematics courses through at least algebra 2 and science courses through chemistry by the time they finish high school. The number of students taking mathematics and science AP exams continues to grow, with the number of students taking at least one of these exams nearly doubling in the past decade. Despite these gains, significant demographic gaps persist. Black and Hispanic students and students from disadvantaged economic backgrounds take fewer advanced courses and are more likely to attend schools that do not offer advanced courses. Although male and female students have reached parity in many areas, female students lag behind their male counterparts in taking advanced courses in specific fields of science such as AP physics.

Attracting and retaining high-quality STEM teachers continues to be a focus of educators and policymakers, as evidenced by the inclusion in ESSA of multiple provisions related to STEM teachers. The law allows states to use differential pay to attract STEM teachers and provides grants to create STEM master teacher corps, among other incentives. A recent international analysis suggests that the United States ranks low among developed countries with respect to the ratio of teachers' salaries to the salaries of other educated workers, which may play a role in STEM teacher recruitment and retention.

Recent federal and state policies encourage greater use of technology throughout the education system to improve students' learning experiences. The use of instructional technology in K−12 classrooms has been growing rapidly. Many school districts have invested in technology such as computers and mobile devices, and more than two-thirds of school district technology administrators indicated that all the schools in their system fully met Internet bandwidth recommendations for public schools in 2016. Rigorous research on the effects of instructional technology and online learning shows some modest positive effects on student mathematics learning, but more research is needed to determine which technologies are effective and under what conditions.

Ensuring that students graduate from high school and are ready for college or the labor market is an important goal of high school education in the United States. U.S. on-time high school graduation rates have shown steady improvement, reaching 83% by 2015. In the broad international context, the United States ranked 19th in graduation rates among 25 OECD countries with available data in 2014. The vast majority of high school seniors expect to attend college after completing high school, and many do so directly after high school graduation. Achievement data suggest, however, that the majority of college-bound students are not academically prepared for success in mathematics and science coursework at the college level.

Glossary

Definitions

Advanced Placement (AP): Courses that teach college-level material and skills to high school students who can earn college credits by demonstrating advanced proficiency on a final course exam. The College Board develops curricula and exams for AP courses, available for a wide range of academic subjects.

Blended learning: Any time a student learns at least in part at a supervised, traditional school location away from home and at least in part through online delivery with some element of student control over time, place, path, and/or pace; often used synonymously with "hybrid learning."

Distance education: A mode of delivering education and instruction to students who are not physically present in a traditional setting such as a classroom. Also known as "distance learning," it provides access to learning when the source of information and the learners are separated by time and/or distance.

Elementary school: A school that has no grades higher than 8.

Eligibility for National School Lunch Program: Student eligibility for this program, which provides free or reduced-price lunches, is a commonly used indicator of family poverty. Eligibility information is part of the administrative data schools keep and is based on parent-reported family income and family size.

English language learner: An individual who, because of any of the following reasons, has sufficient difficulty speaking, reading, writing, or understanding the English language to be denied the opportunity to learn successfully in classrooms where the language of instruction is English or to participate fully in the larger U.S. society. Such an individual (1) was not born in the United States or has a native language other than English, (2) comes from environments where a language other than English is dominant, or (3) is an American Indian or Alaska Native and comes from an environment where a language other than English has had a significant effect on the individual's level of English language proficiency.

GED certificate: This award is received after successfully completing the General Educational Development (GED) test. The GED program, sponsored by the American Council on Education, enables individuals to demonstrate that they have acquired a level of learning comparable with that of high school graduates.

High school: A school that has at least one grade higher than 8 and no grade in K–6.

High school completer: An individual who has been awarded a high school diploma or an equivalent credential, including a GED certificate.

High school diploma: A formal document regulated by the state certifying the successful completion of a prescribed secondary school program of studies. In some states or communities, high school diplomas are differentiated by type, such as an academic diploma, a general diploma, or a vocational diploma.

Middle school: A school that has any of grades 5–8, no grade lower than 5, and no grade higher than 8.

Online learning: Education in which instruction and content are delivered primarily over the Internet.

Organisation for Economic Co-operation and Development (OECD): An international organization of 34 countries headquartered in Paris, France. The member countries are Australia, Austria, Belgium, Canada, Chile, Czech Republic, Estonia, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, South Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States. Among its many activities, the OECD compiles social, economic, and science and technology statistics for all member and selected nonmember countries.

Postsecondary education: The provision of a formal instructional program with a curriculum designed primarily for students who have completed the requirements for a high school diploma or its equivalent. These programs include those with an academic, vocational, or continuing professional education purpose and exclude vocational and adult basic education programs.

Remedial courses: Courses taught within postsecondary education that cover content below the college level.

Repeating cross-sectional studies: This type of research focuses on how a specific group of students performs in a particular year, then looks at the performance of a similar group of students at a later point. An example would be comparing fourth graders in 1990 with fourth graders in 2011 in NAEP.

Scale score: Scale scores place students on a continuous achievement scale based on their overall performance on the assessment. Each assessment program develops its own scales.

Key to Acronyms and Abbreviations

ACGR: adjusted cohort graduation rate

AFGR: averaged freshman graduation rate

AP: Advanced Placement

CRDC: Civil Rights Data Collection

CREDO: Center for Research on Education Outcomes

ECLS-K: Early Childhood Longitudinal Study-Kindergarten

ESSA: Every Student Succeeds Act

GED: General Educational Development

HSLS: High School Longitudinal Study

IB: International Baccalaureate

IEA: International Association for the Evaluation of Educational Achievement

K–12: kindergarten through 12th grade

NAEP: National Assessment of Educational Progress

NAGB: National Assessment Governing Board

NCES: National Center for Education Statistics

NRC: National Research Council

NSF: National Science Foundation

NSLP: National School Lunch Program

NTPS: National Teacher and Principal Survey

OECD: Organisation for Economic Co-operation and Development

PISA: Program for International Student Assessment

SASS: Schools and Staffing Survey

SES: socioeconomic status

STEM: science, technology, engineering, and mathematics

TEL: technology and engineering literacy

TIMSS: Trends in International Mathematics and Science Study

UK: United Kingdom

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