K–12 Education

Elementary and Secondary STEM Education

NSB-2021-1

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Executive Summary

Key takeaways:

- Internationally, the United States ranks higher in science (7th of 37 Organisation for Economic Co-operation and Development [OECD] countries) and computer information literacy (5th of 14 participating education systems) than it does in mathematics literacy (25th of 37 OECD countries).

- Average scores for U.S. fourth and eighth graders on a national assessment of mathematics improved from 1990 to 2007, but there was no overall measurable improvement in mathematics scores from 2007 to 2019.

- Differences persist in U.S. science, technology, engineering, and mathematics (STEM) achievement scores by socioeconomic status (SES) and race or ethnicity.

- Differences in U.S. STEM achievement scores by sex are smaller than those by SES or race or ethnicity but are present; male students slightly outscored female students on some national assessments, although female students substantially outscored male students on a computer information literacy exam.

- Less experienced STEM teachers (as measured by years of teaching) are more prevalent in schools with high-minority enrollment or high-poverty enrollment.

- Data collected on U.S. remote learning in spring 2020 (during the COVID-19 pandemic) revealed differences in access to technology based on household income: 57% of households with income below $25,000 always had a computer available for educational purposes, whereas 90% of households with an income of $200,000 or more did so.

Elementary and secondary education in mathematics and science is the foundation for student entry into postsecondary STEM majors as well as a wide variety of STEM-related occupations. Federal and state policymakers, legislators, and educators are working to broaden and strengthen STEM education at the K–12 level. These efforts include promoting elementary grade participation in STEM, raising overall student achievement, increasing advanced high school coursetaking, reducing performance gaps among demographic groups, and improving college and career readiness in mathematics and science.

The indicators in this report present a mixed picture of the status and progress of elementary and secondary STEM education in the United States. Internationally, the United States ranks low among OECD nations in mathematics literacy (25th out of 37) but does better in science literacy (7th out of 37). In computer and information literacy, the United States ranks 5th among the 14 education systems that participated in that assessment. Within the United States, students' achievement in mathematics has been essentially stagnant for more than a decade after showing steady improvement in the prior two decades.

The data presented in this report show persistent performance gaps by students' SES and race or ethnicity. For example, on an assessment with a scale of 0–500, mathematics scores for low-SES students in a national cohort of eighth graders were 30 points lower than scores for high-SES students, and Asian and White students posted scores that were up to 53 points higher than scores by Black, Hispanic, American Indian or Alaska Native, and Native Hawaiian or Pacific Islander students. Similar patterns were seen for student performance in computer and information literacy.

Differences by sex on national assessments were small on average. Male students slightly outscored female students by 3 points in fourth grade in 2019 on a national math assessment, but there was no difference in scores between males and females in eighth grade. Female students outscored male students by 23 points on an assessment of computer and information literacy.

The data also reveal that student access to well-qualified mathematics and science teachers varies. A recent national study showed that virtually all middle and high school science and mathematics teachers have a bachelor's degree and a regular or an advanced teaching certification; however, access to highly qualified teachers varies by school demographics. Schools with higher concentrations of low-SES and minority students had comparatively fewer highly qualified teachers (i.e., those with 3 years or more of teaching experience and with a degree in the subject taught).

High school STEM achievement and coursetaking frequently facilitate STEM-related postsecondary education and employment. Students who have positive perceptions of their mathematics and science abilities in high school are more inclined to declare a postsecondary STEM major. The majority of U.S. high school students enroll in either 2-year or 4-year postsecondary institutions immediately after graduation from high school; enrollment patterns, however, differ by demographic group. For example, Black students and students from low-income families enroll at lower rates than their peers. Among students who enter the workforce directly after high school, those who take STEM-related career and technical education courses are more likely than others to enter skilled technical jobs.

Finally, the United States faced an unprecedented situation in spring 2020 with the COVID-19 pandemic when most elementary and secondary schools across the country abruptly shifted to a distance-learning model. Researchers estimated that students on average suffered some mathematics learning losses as a result, with low-SES students suffering disproportionately larger losses, in part due to their lack of access to the technology required for distance learning.

Collectively, the findings in this report suggest that the United States has yet to achieve the goal of ensuring equal educational opportunities in STEM for all students regardless of socioeconomic and demographic background. As noted in the National Science Board's *Vision 2030* report (NSB 2020), K–12 STEM education and high achievement for all students plays a critical role in ensuring that the United States is meeting the needs of the modern workforce and maintaining America's position internationally. Given these needs and the importance of K–12 STEM preparation and the opportunities available to students who excel in STEM subjects, it is important to continue to focus on efforts that will increase the number and diversity of students interested in STEM and broaden opportunities for all students to succeed and thrive in STEM.

Introduction

Elementary and secondary science, technology, engineering, and mathematics (STEM) education is the foundation for students' entry into postsecondary STEM majors as well as a wide variety of STEM occupations.[1] Proficiency in STEM fields is vital to economic growth and international competitiveness and important for all citizens in an increasingly technology-driven society (OSTP 2019). A skilled and diverse STEM workforce is essential for the United States to remain preeminent in science and engineering (S&E) and continue to be at the forefront of innovation. (See the forthcoming *Indicators 2022* report, "[2022] The STEM Labor Force of Today: Scientists, Engineers, and Skilled Technical Workers," for information on the STEM labor force). Improving K−12 STEM education and nurturing the talents of all Americans—including women and underrepresented minorities in STEM—is key to maintaining U.S. competitiveness and strengthening and diversifying its STEM workforce (Committee on STEM Education 2018; NSB 2020). An increasingly complex technological society and such events as the COVID-19 pandemic underscore the important role that K−12 STEM education has to play in building public understanding of science and creating a scientifically literate citizenry (NASEM 2019).

This report provides the most recent available indicators of the state of U.S. K−12 STEM education. It presents data about student performance in mathematics in fourth and eighth grades; computer science performance in eighth grade; U.S. mathematics, science, and computer science performance compared with that of other nations; U.S. mathematics and science teachers' qualifications and how they compare internationally; and high school students' preparation for postsecondary education and the workforce.

These data indicate that K−12 STEM education in the United States continues to face many challenges. U.S. students' scores on a standardized national assessment have remained essentially stagnant since 2007, and U.S. students rank below those of many other developed nations on international mathematics and science assessments. Black, Hispanic, American Indian or Alaska Native, Native Hawaiian or Pacific Islander students, and students living in poverty continue to score well below White, Asian, and high-SES students on STEM assessments and have done so for decades. Research literature suggests that structural and systemic educational and societal inequities contribute to these achievement disparities. For example, research has shown that a variety of academic, health, and social factors (e.g., exposure to trauma, inadequate medical care, disproportionate school disciplinary practices, lack of a social safety net, or attending schools with inadequate resources or with less-qualified teachers) contribute to the persistently lower achievement scores observed from these students (Bowman, Comer, and Johns 2018; Carnevale et al. 2019; Hanushek et al. 2020; Pearman 2020; Reardon, Kalogrides, and Shores 2019).

There are four main sections in this report. The first section presents indicators of U.S. students' performance in mathematics and science subjects in elementary and secondary school, both nationally and internationally. The second section examines U.S. middle and high school mathematics and science teachers' qualifications and how they vary by U.S. school characteristics, including minority enrollment and students' socioeconomic status (SES), and among nations in the Organisation for Economic Co-operation and Development (OECD). The third section focuses on students' transitions from high school to postsecondary education or to the workforce. It examines Advanced Placement (AP) coursetaking and dual enrollment (simultaneous enrollment in high school and college), immediate college enrollment after high school, and how high school students' perceptions of their mathematics and science identity and ability relate to their choice of postsecondary STEM major. The final section addresses the impact of the COVID-19 pandemic on the U.S. education system beginning in spring 2020, when the pandemic led to a shift to distance learning for most students across the country. This section highlights the potential impact of distance education and access to technology on student learning.

Data sources are described in each section of the report. When a comparative statistic is cited, it is statistically significant at the 0.05 probability level, unless otherwise noted. The term *no measurable difference* indicates that a score difference was not statistically significant. When countries are ranked internationally, countries that have average scores that are not significantly different from those of the United States are given the same rank as the United States.[2]

Student Learning in Mathematics and Science

Policymakers, legislators, and educators in the United States continue to strive to improve K−12 STEM education. Access to high-quality STEM education for all students and students' strong performance in STEM subjects are necessary for achieving and maintaining the STEM proficiency needed for economic growth, international competitiveness, and scientific literacy (Bush 2019; Committee on STEM Education 2018; NSB 2020). This section presents indicators of U.S. students' performance in STEM subjects in elementary and secondary school, beginning with performance in mathematics in fourth and eighth grades. Next, it examines mathematics and science performance of U.S. 15-year-olds in an international context. Finally, it examines U.S. performance in computer science, both nationally and internationally.

National Trends in K−12 Student Achievement

Although average scores for the nation's fourth and eighth graders on a national assessment of mathematics improved from 1990 to 2007 (by 27 points for fourth graders and 18 points for eighth graders), scores have remained essentially stagnant since 2007 (**Figure K12-1**). There were no statistically significant changes in the 2019 mathematics scores on the National Assessment of Educational Progress (NAEP) relative to scores 12 years ago (2007).[3] Furthermore, the gap between high- and low-performing students has increased. The lowest-performing students at each grade level (those scoring within the 10th percentile) posted scores in 2019 that were lower than their scores a decade earlier, whereas the highest-performing students in the fourth and eighth grades (those scoring within the 90th percentile) had improved their scores since 2009 (Table SK12-1).

Figure K12-1

Average scores of students in grades 4 and 8 on the NAEP mathematics assessment: 1990−2019

NAEP = National Assessment of Educational Progress.

Note(s):
The scale for NAEP mathematics assessment scores is 0−500 for grades 4 and 8.

The NAEP 2019 mathematics data show that scores for Black, Hispanic, Native Hawaiian or Pacific Islander, and American Indian or Alaska Native students persistently lag behind the scores of their White and Asian peers. There are potentially many contributing factors to this persistent lag, including lack of access to high-quality STEM instruction and structural and systemic educational and societal inequities that affect students' educational experiences and performance (Bowman, Comer, and Johns 2018; Hanushek et al. 2020; Pearman 2020; Reardon, Kalogrides, and Shores 2019). In 2019, Black, Hispanic, Native Hawaiian or Pacific Islander, and American Indian or Alaska Native students scored 18−25 points lower than White students in fourth grade and 24−32 points lower in eighth grade (**Figure K12-2**). Asian students have consistently outperformed all other groups, posting 2019 scores that were 14 points and 21 points higher than those of White students among fourth and eighth graders, respectively.

Figure K12-2

Average scores of students in grades 4 and 8 on the NAEP mathematics assessment, by race or ethnicity: 2011−19

Grade 4

Grade 8

NAEP = National Assessment of Educational Progress.

Note(s):
The scale for NAEP mathematics assessment scores is 0−500 for grades 4 and 8. Hispanic may be any race; race categories exclude Hispanic origin.

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the 2011, 2013, 2015, 2017, and 2019 NAEP mathematics assessments, National Center for Education Statistics.

Science and Engineering Indicators

Score gaps of 23−42 points also exist at both grade levels between students from low- and high-SES families,[4] students with and without disabilities, and students who are and are not English language learners (**Figure K12-3**). Male students slightly outscored female students by 3 points in fourth grade in 2019, but there was no difference in scores between males and females in eighth grade. Gaps up to 10 points appear in comparisons by region and school type, with fourth- and eighth-grade students in the Northeast scoring higher than students in the South and West, and students in suburban schools scoring higher than students in city, town, and rural schools (**Figure K12-4**).[5]

Figure K12-3

Average scores of students in grades 4 and 8 on the NAEP mathematics assessment, by sex, socioeconomic status, disability status, and English language learner status: 2019
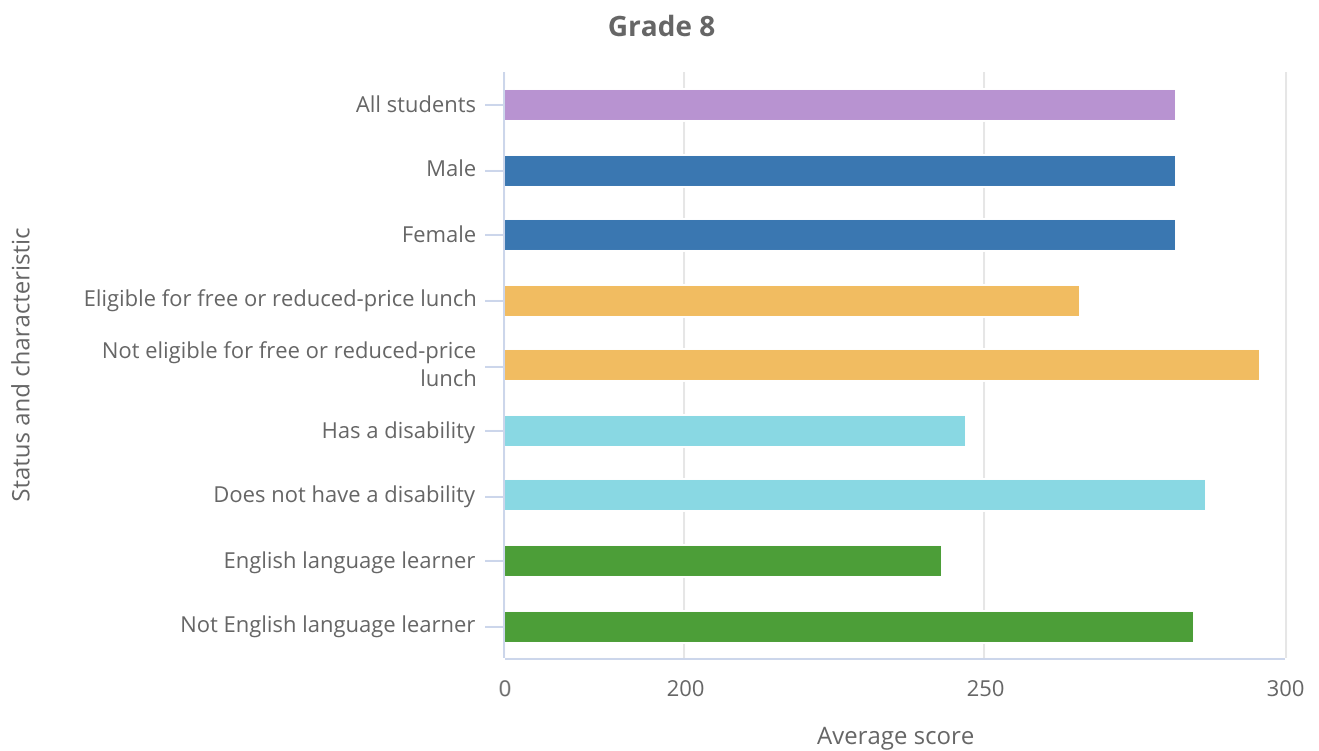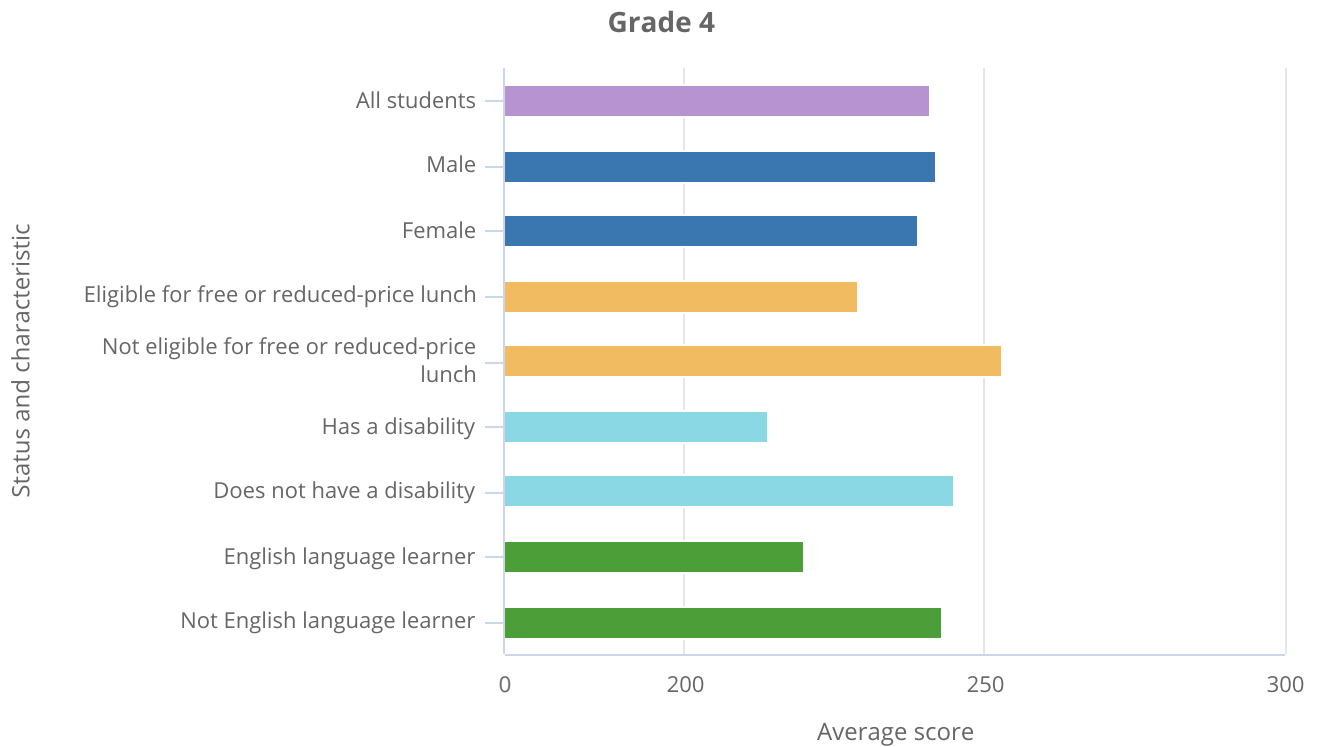
Grade 4

Grade 8

NAEP = National Assessment of Educational Progress.

Note(s):
The scale for NAEP mathematics assessment scores is 0–500 for grades 4 and 8. 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.

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the 2019 NAEP mathematics assessments, National Center for Education Statistics.

Science and Engineering Indicators

Figure K12-4

Average scores of students in grades 4 and 8 on the NAEP mathematics assessment, by region of country and school location: 2019

Grade 8

NAEP = National Assessment of Educational Progress.

Note(s):
The scale for NAEP mathematics assessment scores is 0–500 for grades 4 and 8.

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the 2019 NAEP mathematics assessments, National Center for Education Statistics.

Science and Engineering Indicators

Looking more deeply into gender differences, the only statistically significant difference between male and female eighth graders' scores was among Black students, with females outscoring males by 5 points (**Table K12-1**). Among fourth graders, however, Black male students and Black female students had similar scores, whereas male students outscored female students among White, Asian, and Hispanic students. High-SES students had higher scores than low-SES students within all racial and ethnic groups at both grade levels, with score differences ranging from 15 points to 29 points.

Table K12-1

Average scores of students in grades 4 and 8 on the NAEP mathematics assessment and score differences, by socioeconomic status and sex within race or ethnicity: 2019

(Average score)

Student grade and race or ethnicity	Socioeconomic status[a]				Sex		
	Eligible for free or reduced-price lunch	Not eligible for free or reduced-price lunch	Score difference between not eligible and eligible		Male	Female	Score difference between male and female
All students in grade 4	229	253	24	*	242	239	-3	*
Race or ethnicity[b]							

Table K12-1

Average scores of students in grades 4 and 8 on the NAEP mathematics assessment and score differences, by socioeconomic status and sex within race or ethnicity: 2019

(Average score)

Student grade and race or ethnicity	Socioeconomic status[a]		Score difference between not eligible and eligible		Sex		Score difference between male and female	
	Eligible for free or reduced-price lunch	Not eligible for free or reduced-price lunch			Male	Female		
White	237	255	18	*	251	247	-4	*
Black	220	237	17	*	224	225	1	
Hispanic[c]	227	242	15	*	232	230	-2	*
Asian	246	272	26	*	266	259	-7	*
American Indian or Alaska Native	221	246	25	*	227	227	0	
Native Hawaiian or Pacific Islander	219	247	28	*	222	229	7	
Two or more races	233	254	21	*	247	240	-7	*
All students in grade 8	266	296	30	*	282	282	0	
Race or ethnicity[b]								
White	275	299	24	*	293	292	-1	
Black	254	273	19	*	257	262	5	*
Hispanic[c]	264	280	16	*	268	268	0	
Asian	294	323	29	*	314	311	-3	
American Indian or Alaska Native	256	277	21	*	261	263	2	
Native Hawaiian or Pacific Islander	254	280	26	*	263	268	5	
Two or more races	270	298	28	*	286	286	0	

* $p < 0.05$. Score difference is significantly different at the 0.05 level of statistical significance.

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] Other racial and ethnic groups are included in the rows for All students in grade 4 and All students in grade 8 but are not shown separately in the table.

[c] Hispanic may be any race; race categories exclude Hispanic origin.

Note(s):
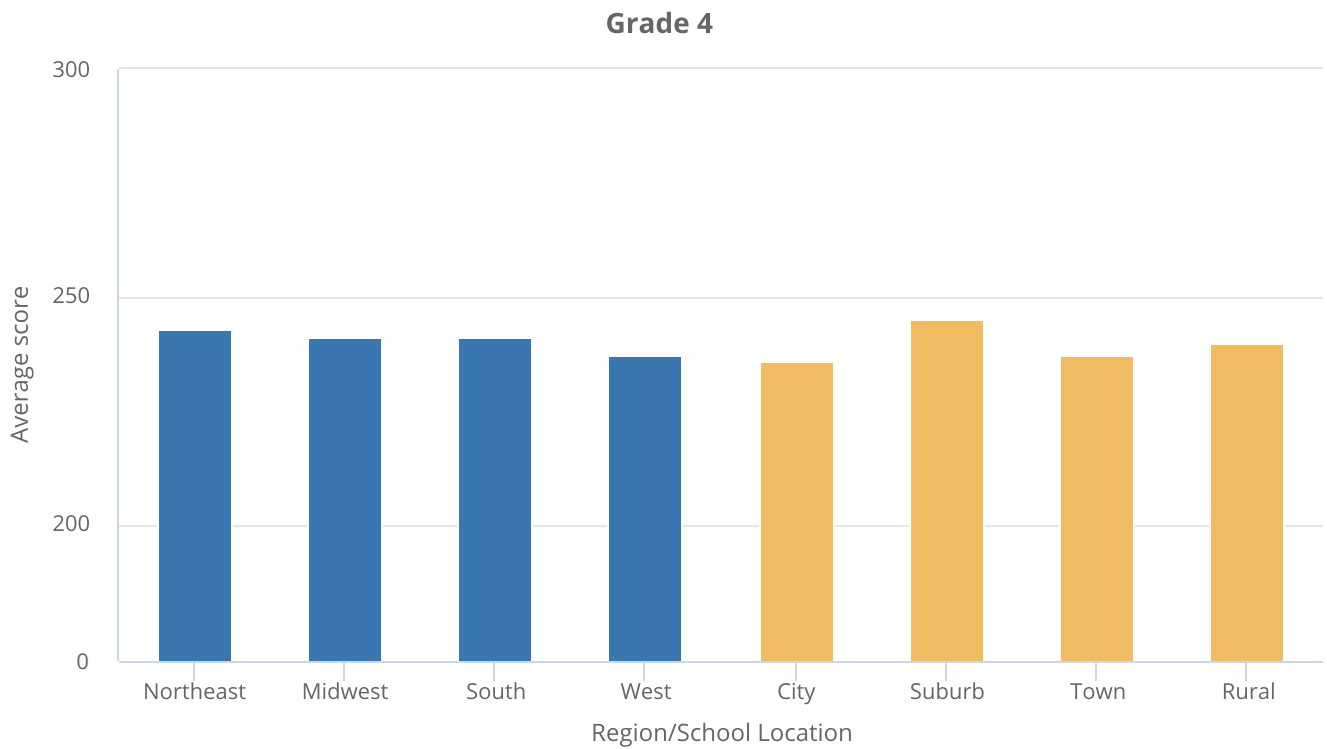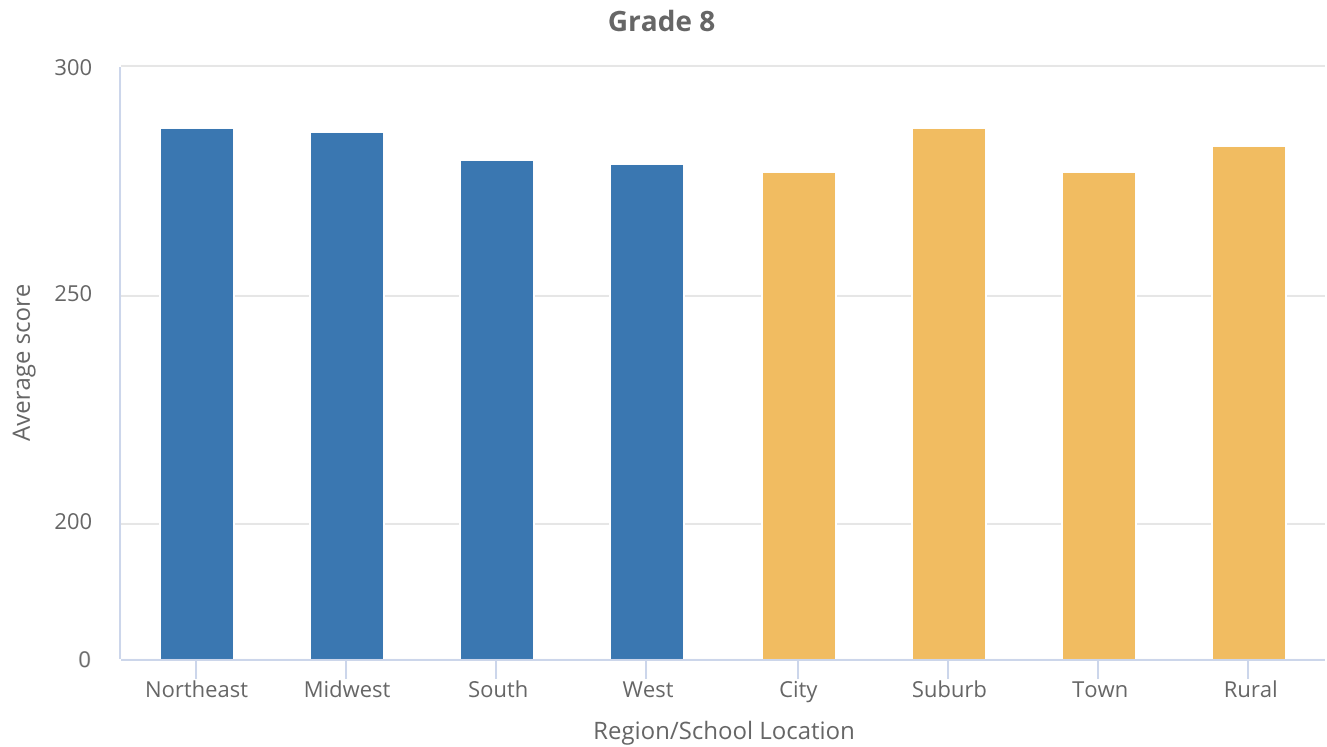The scale for NAEP mathematics assessment scores is 0–500 for grades 4 and 8.

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the 2019 NAEP mathematics assessment, National Center for Education Statistics.

Science and Engineering Indicators

NAEP mathematics assessment results were recently released for students in 12th grade. These results show similar patterns as the results for fourth and eighth graders. The average score in 2019 was not significantly different from the score when the assessment was last administered in 2015 nor from the score in 2005, and scores for Black, Hispanic, and American Indian or Alaska Native students were lower than scores for White and Asian or Pacific Islander students (Table SK12-1).

The NAEP science assessment was administered to fourth, eighth, and 12th graders in 2019, but results were not available in time for inclusion in this volume of *Indicators*. The results for the 2015 NAEP science assessment showed that the average NAEP science scores for the nation increased 4 points between 2009 and 2015 in both fourth and eighth grades but did not change significantly in 12th grade. More detailed analysis of the 2015 NAEP science scores can be found in *Indicators 2018*. State-level data on mathematics and science achievement can be found in *State Indicators*.

International Comparisons of Mathematics and Science Performance

U.S. 15-year-olds rank higher internationally in science literacy than they do in mathematics literacy,[6] as shown by their performance on the 2018 Program for International Student Assessment (PISA).[7] In mathematics, U.S. 15-year-olds in 2018 ranked 25th among 37 OECD countries; compared to the 36 other OECD members, the U.S. average in mathematics literacy for 15-year-olds was lower than the average in 24 education systems, higher than in 6, and not measurably different than in 6 (**Figure K12-5**). The average score in 2018 was lower than the OECD average and did not measurably change since 2003 (**Figure K12-6**). In comparison, U.S. students fared better in science, ranking in the 7th position out of 37; compared to the 36 other OECD members, the U.S. average score in science literacy was lower than the average in 6 education systems, higher than in 19, and not measurably different than in 11. The U.S. average science score was higher than the OECD average in 2018 and improved by 13 points between 2006 and 2018.[8]

Figure K12-5

Average scores of 15-year-old students on the PISA mathematics and science literacy scales, by OECD education system: 2018

Mathematics

Science

* *p* < 0.05. Significantly different from the U.S. estimate at the 0.05 level of statistical significance.

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

Note(s):
The score of mathematics and science scores is 0−1,000. The OECD average is the average of the national averages of the OECD member countries, with each country weighted equally. For Colombia, Mexico, and Turkey, at least 50% but less than 75% of the 15-year-old population is covered by the PISA sample.

Source(s):
OECD, PISA, 2018. https://nces.ed.gov/surveys/pisa/pisa2018/index.asp#/math/intlcompare.

Science and Engineering Indicators

Figure K12-6

Average scores of U.S. 15-year-old students on the PISA mathematics and science literacy scales: 2003−18

PISA = Program for International Student Assessment.

Note(s):
The score of mathematics and science scores is 0−1,000. The PISA science framework was revised in 2006. Because of changes in the framework, it is not possible to compare science learning outcomes from PISA 2003 with those from PISA 2006, 2009, 2012, 2015, and 2018.

Source(s):
Organisation for Economic Co-operation and Development (OECD), PISA, 2003, 2006, 2009, 2012, 2015, and 2018. https://nces.ed.gov/surveys/pisa/pisa2018/index.asp#/math/intlcompare.

Science and Engineering Indicators

Japan, South Korea, Estonia, and the Netherlands were the highest-scoring OECD countries in mathematics in 2018, and Estonia and Japan were the highest scoring in science. PISA also tests students in several city-based and non-OECD-country education systems (**Figure K12-7**). Among these entities, Beijing, Shanghai, Jiangsu, and Zhejiang (B-S-J-Z) in China, Singapore, and Macau (China) were the highest scorers in both mathematics and science. The scores for cities and small countries in **Figure K12-7** are not directly comparable to those of the United States, which has a much larger and more heterogenous education system. These scores are presented to provide context for U.S. performance compared to that of some of its global competitors in science and technology businesses and innovation.

Figure K12-7

Average scores of 15-year-old students on the PISA mathematics and science literacy scales in the United States and top-scoring non-OECD education systems: 2018
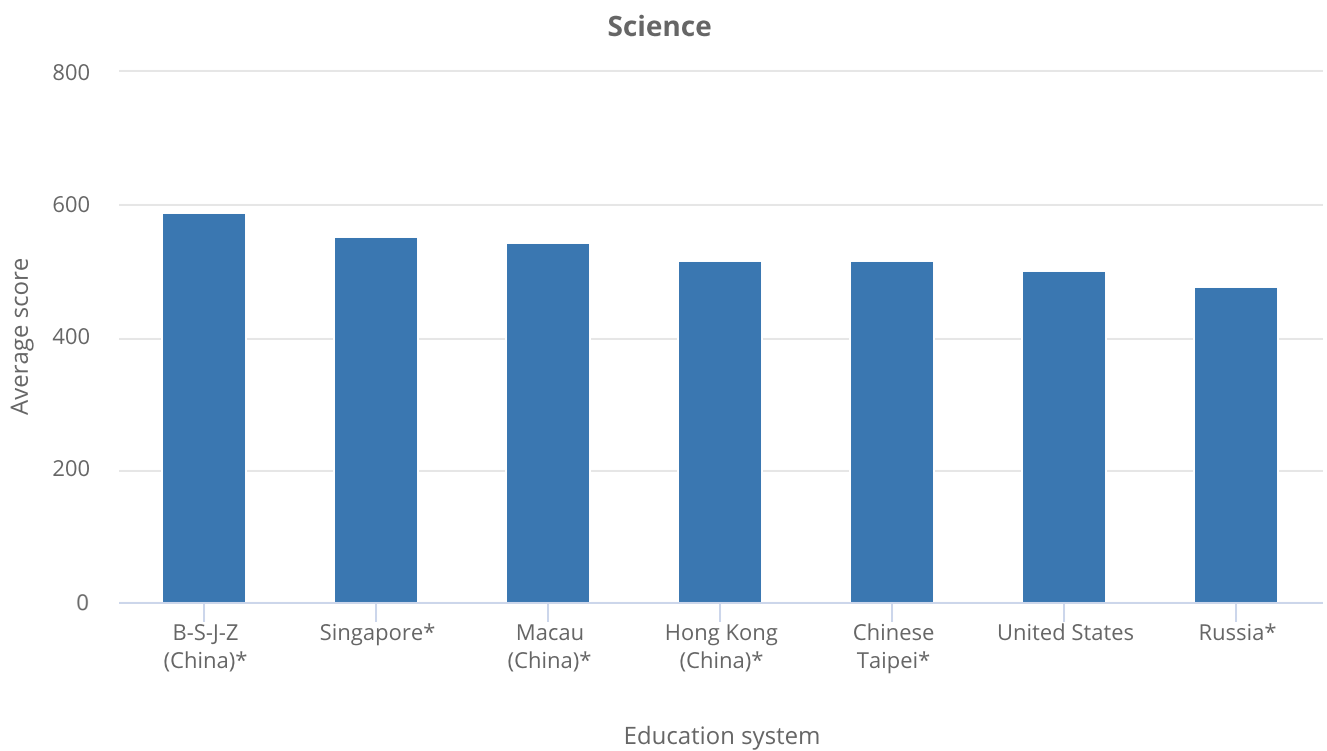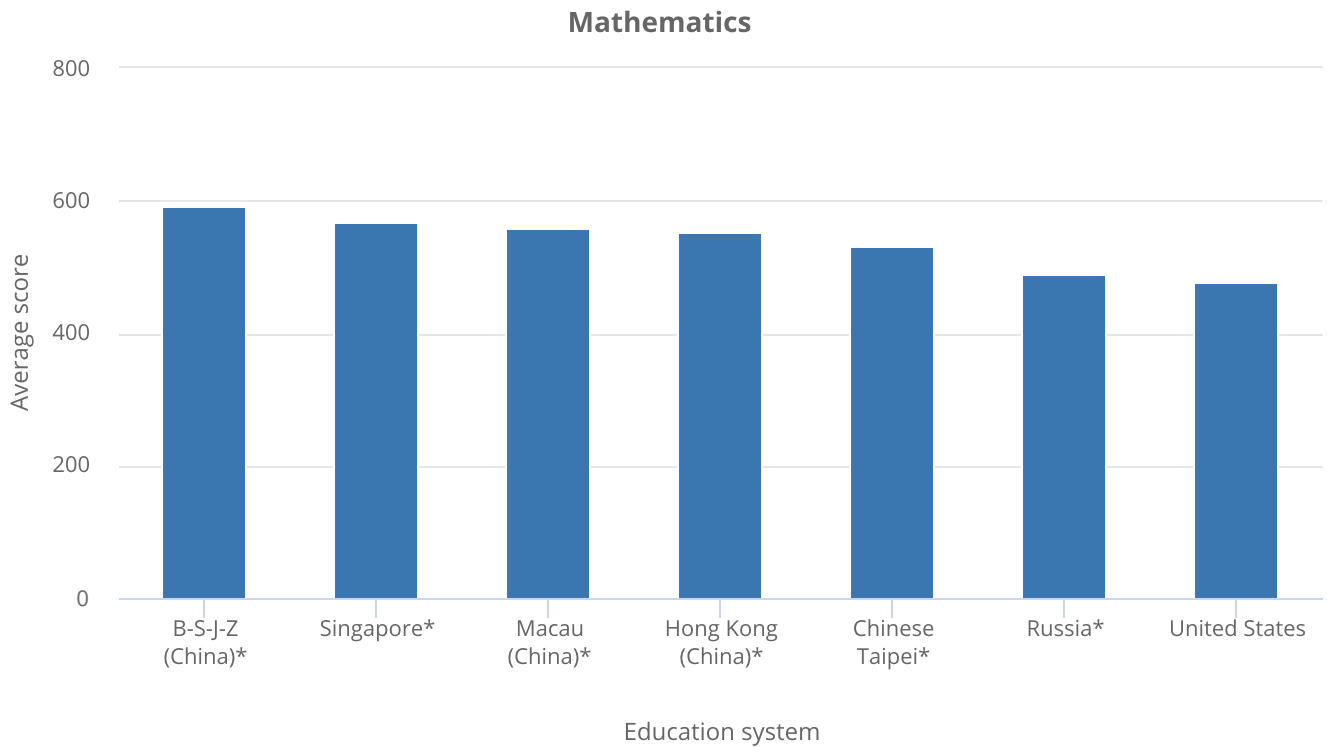
* *p* < 0.05. Significantly different from the U.S. estimate at the 0.05 level of statistical significance.

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

Note(s):
The scale of mathematics and science scores is 0–1,000. B-S-J-Z (China) refers to the four PISA-participating China provinces: Beijing, Shanghai, Jiangsu, and Zhejiang.

Source(s):
OECD, PISA, 2018. https://nces.ed.gov/surveys/pisa/pisa2018/index.asp#/math/intlcompare.

Science and Engineering Indicators

Average PISA scores indicate score gaps between male and female students in many countries, including the United States (**Figure K12-8**). In the United States, male students outperformed female students in mathematics literacy by 9 points, but there was no measurable difference between male and female students' scores in science. Among OECD countries, on average, male students outscored female students by 5 points in mathematics, and female students outscored male students by 2 points in science. In such countries as Finland, Norway, Iceland, and Israel, female students outscored male students by substantial margins in both mathematics and science.

Figure K12-8

Male-female score gaps of 15-year-old students on the PISA mathematics and science literacy scales, by OECD education system: 2018

Mathematics

Science
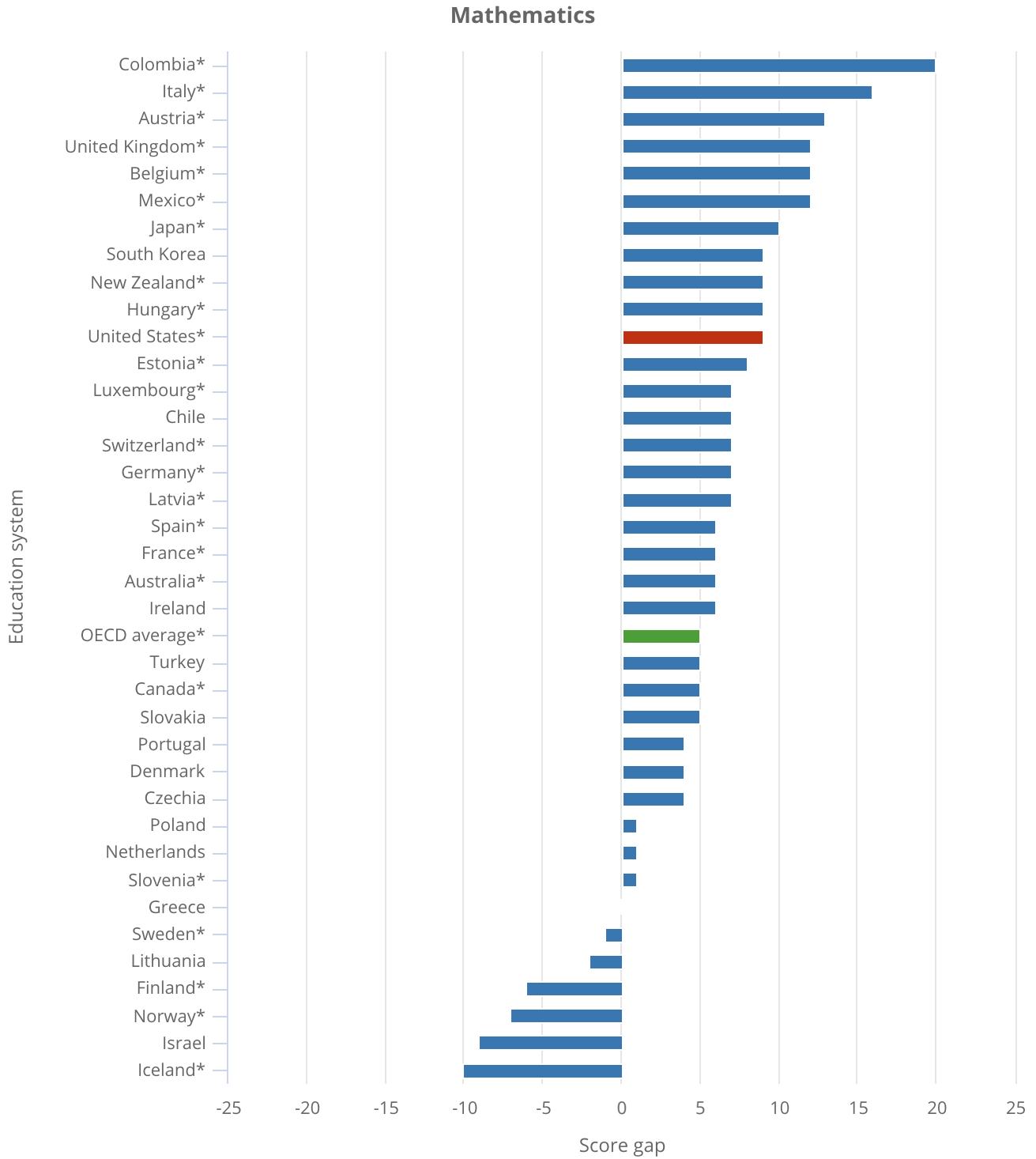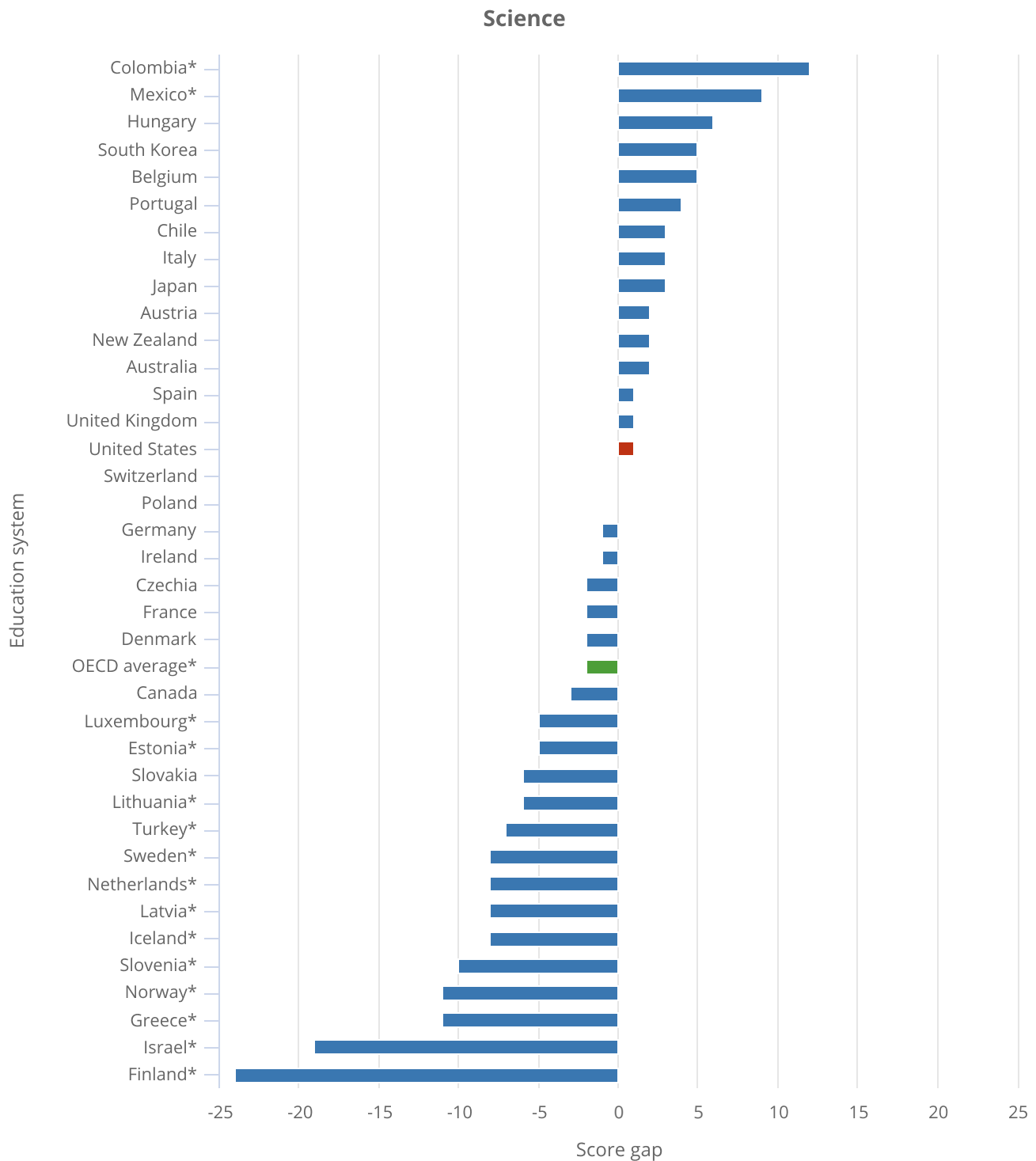
* *p* < 0.05. Difference between male and female scores at the country level is significantly different at the 0.05 level of statistical significance.

OECD = Organisation for Economic Co-operation and Development; PISA = Program for International Student Assessment.
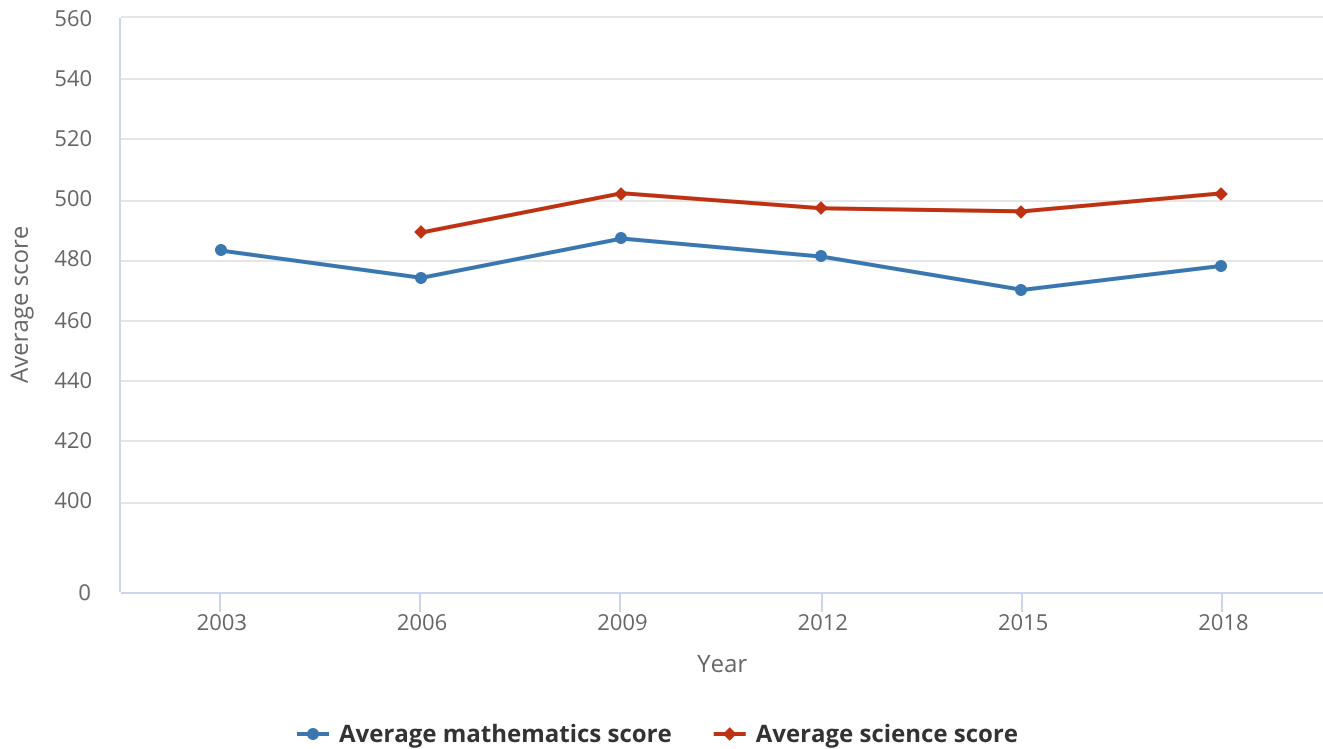
Note(s):
The scale of mathematics and science scores is 0–1,000. The OECD average is the average of the national averages of the OECD member countries, with each country weighted equally. For Colombia, Mexico, and Turkey, at least 50% but less than 75% of the 15-year-old population is covered by the PISA sample. A positive score gap indicates that male students outperform female students on PISA scales.

Source(s):
OECD, PISA, 2018. https://nces.ed.gov/surveys/pisa/pisa2018/index.asp#/math/intlcompare.

The Trends in International Mathematics and Science Study (TIMSS) is another international comparative study that measures trends in mathematics and science achievement in fourth and eighth grades every 4 years. TIMSS is designed to align broadly with mathematics and science curricula in the participating education systems and, therefore, to reflect students' school-based learning. The United States has participated in every administration of TIMSS since its inception in 1995, including the most recent administration in 2019. TIMSS 2019 data were released too late for inclusion in this edition of *Indicators*; data on U.S performance in 2019 are available here: **TIMSS 2019 U.S. Results**.

International Comparisons of Computer Science Performance

In the 2018 International Computer and Information Literacy Study (ICILS),[9] U.S. eighth-grade students' average score was higher than the international average on computer and information literacy and was not measurably different from the international average on computational thinking (**Figure K12-9**).[10] *Computer and information literacy refers* to the ability to use computers effectively in everyday life at home, work, and school, whereas *computational thinking* refers to the use of computers to solve problems and includes such skills as programming. The United States scored 5th among the 14 education systems that participated in the computer and information literacy assessment and 4th among the 9 education systems that participated in the computational thinking assessment. Internationally, Denmark and South Korea were the highest-scoring countries on both assessments. The city of Moscow had the second-highest score in computer and information literacy. U.S. students outperformed their counterparts in France, Luxembourg, Chile, Italy, Uruguay, and Kazakhstan in computer and information literacy and Germany, Portugal, and Luxembourg in computational thinking.

Figure K12-9

Average CIL and CT scores of students in grade 8, by education system: 2018
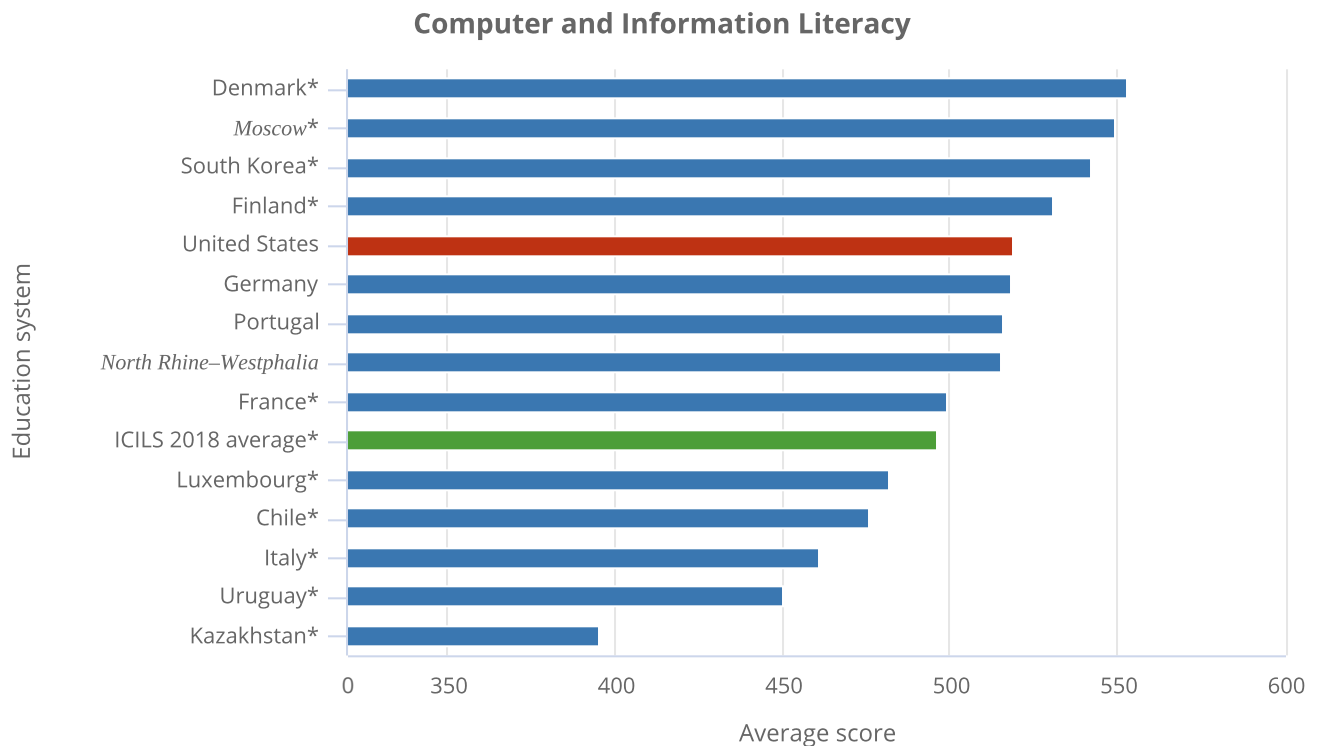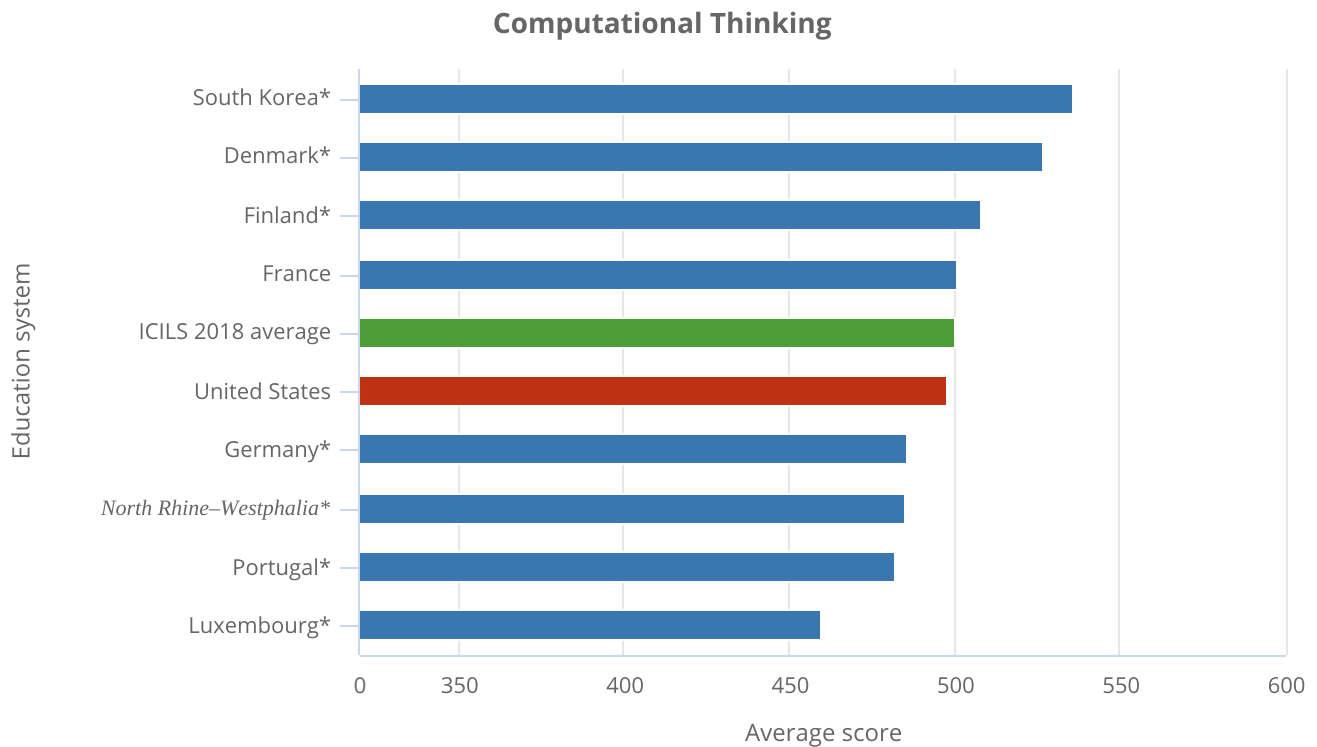
Computer and Information Literacy

Computational Thinking

* *p* < 0.05. Significantly different from the U.S. estimate at the 0.05 level of statistical significance.

CIL = computer and information literacy; CT = computational thinking.

Note(s):
The scale of CIL and CT scores is 100−700. The International Computer and Information Literacy Study (ICILS) 2018 average is the average of all participating education systems meeting international technical standards, with each education system weighted equally. The United States did not meet the guidelines for a sample participation rate of 85% and was not included in the international average. Moscow and North Rhine−Westphalia are included as benchmarking participants.

Source(s):
International Association for the Evaluation of Educational Achievement (IEA), ICILS, 2018. https://nces.ed.gov/surveys/icils/icils2018/theme1.asp?tabontop.

Science and Engineering Indicators

ICILS also provides information about U.S. eighth-grade student scores by sex, race or ethnicity, and school poverty level. Female students outperformed male students in computer and information literacy by 23 points (531 compared to 508); there was no measurable difference in scores between male students and female students in computational thinking (**Figure K12-10**). Scores differed far more substantially by school poverty level. U.S. eighth-grade students in schools with less than 10% of students eligible for free or reduced-price lunch outscored students in schools with 75% or more students eligible by 88 points in computer and information literacy (564 compared to 476) and 112 points (557 compared to 444) in computational thinking (**Figure K12-11**).[11]

Figure K12-10

Average CIL and CT scores of U.S. students in grade 8, by sex: 2018
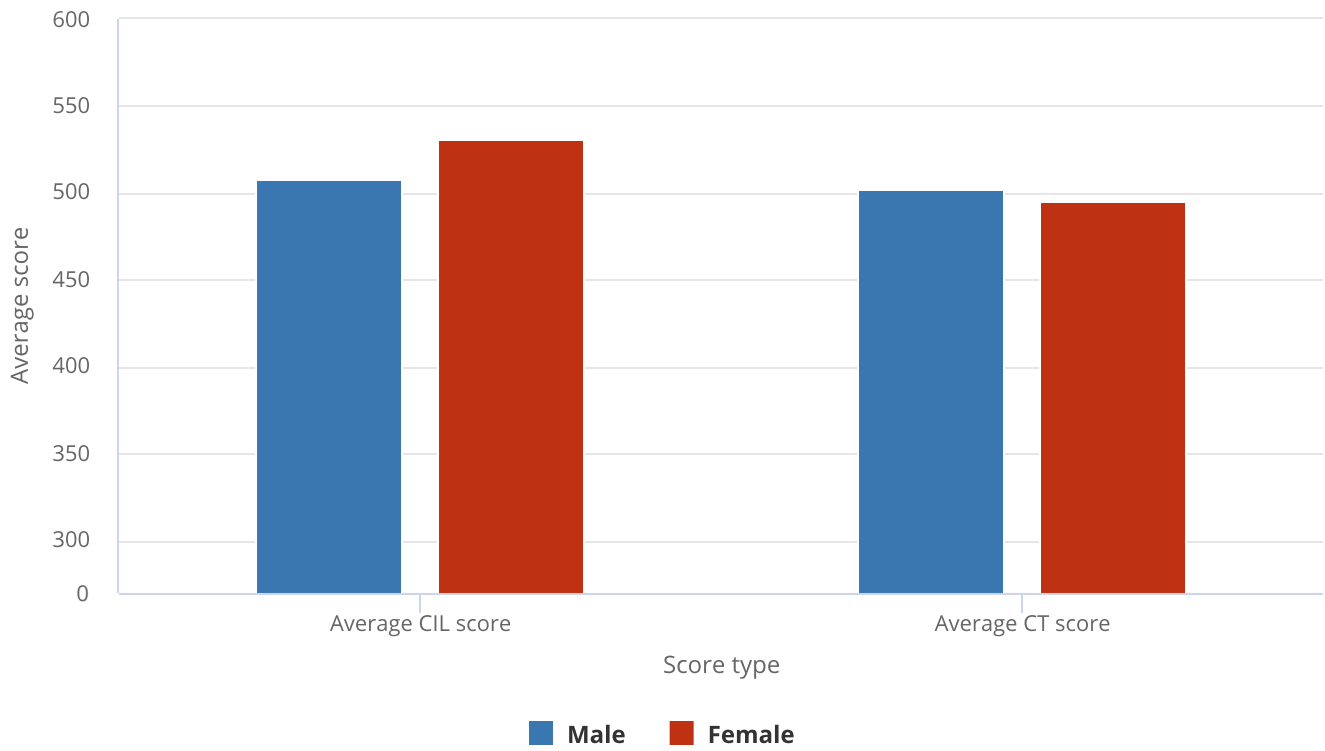
CIL = computer and information literacy; CT = computational thinking.

Note(s):
The scale of CIL and CT scores is 100–700.

Source(s):
International Association for the Evaluation of Educational Achievement (IEA), International Computer and Information Literacy Study (ICILS), 2018. https://nces.ed.gov/surveys/icils/icils2018/theme1.asp?tabontop.

Science and Engineering Indicators

Figure K12-11

Average CIL and CT scores of U.S. students in grade 8, by school poverty level: 2018

Computer and Information Literacy

Computational Thinking

CIL = computer and information literacy; CT = computational thinking.

Note(s):
The scale of CIL and CT scores is 100–700. School poverty level is the percentage of students eligible for free or reduced-price lunch.

Source(s):
International Association for the Evaluation of Educational Achievement (IEA), International Computer and Information Literacy Study (ICILS), 2018. https://nces.ed.gov/surveys/icils/icils2018/theme1.asp?tabontop.

Science and Engineering Indicators

As with NAEP scores, ICILS scores by race or ethnicity indicate that U.S. Black, Hispanic, Native Hawaiian or Pacific Islander, and American Indian or Alaska Native students posted scores that lag behind those of their White and Asian counterparts in both computer and information literacy and computational thinking (**Figure K12-12**). Researchers suggest that contributors to these persistent differences include inequitable access to high-quality computer science instruction and to computer or wireless technology, lack of a culturally relevant curriculum, and societal narratives about who is good at computer science (IEA 2020; Margolis et al. 2017; Vakil 2018). ICILS scores ranged from 563 for Asian students to 470 for American Indian or Alaska Native students.

Figure K12-12

Average CIL and CT scores of U.S. students in grade 8, by race or ethnicity: 2018
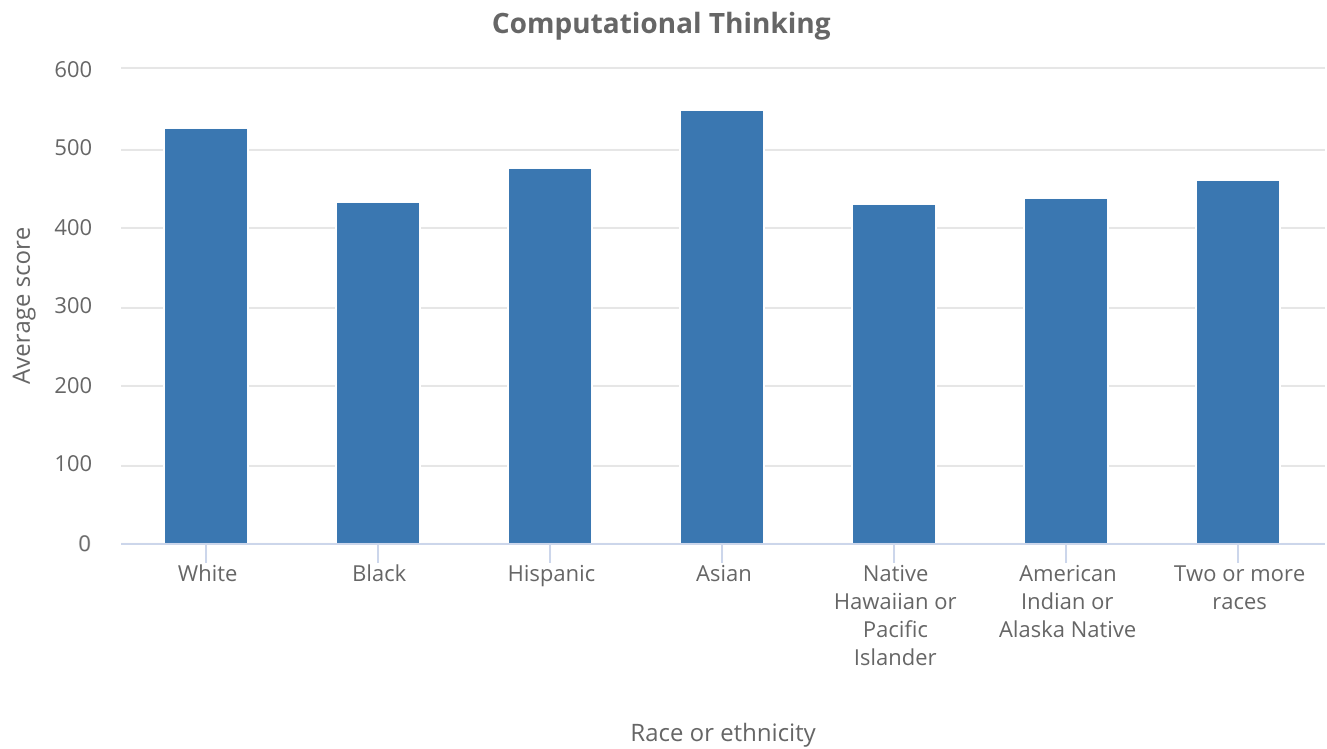
Computer and Information Literacy

Computational Thinking

CIL = computer and information literacy; CT = computational thinking.

Note(s):
The scale of CIL and CT scores is 100–700. Hispanic may be any race; race categories exclude Hispanic origin.
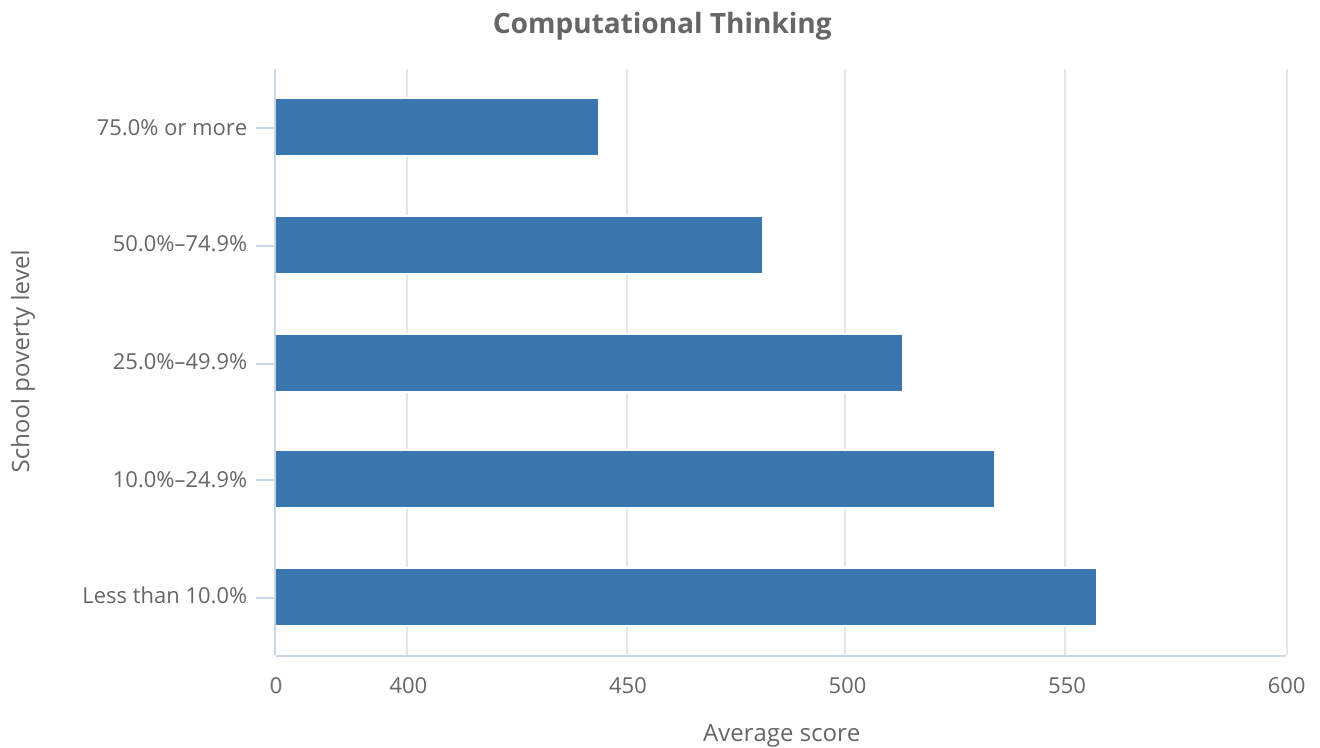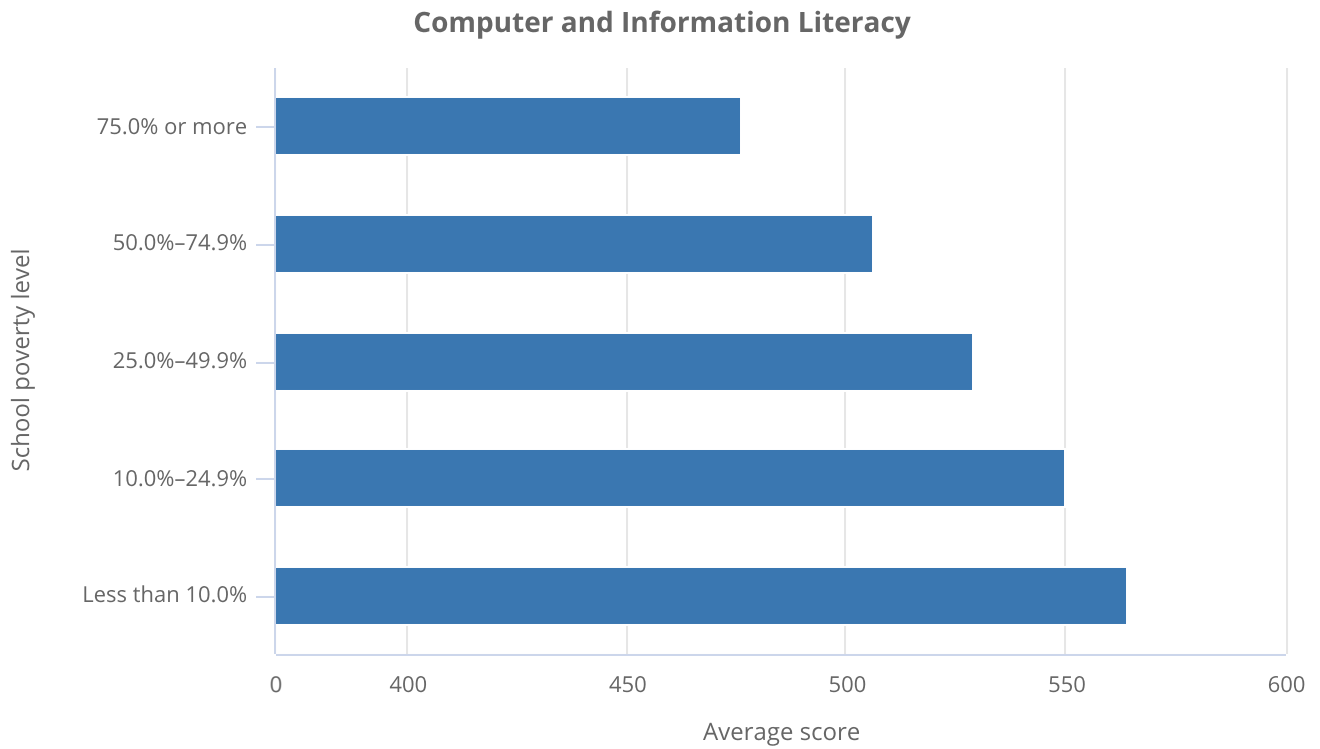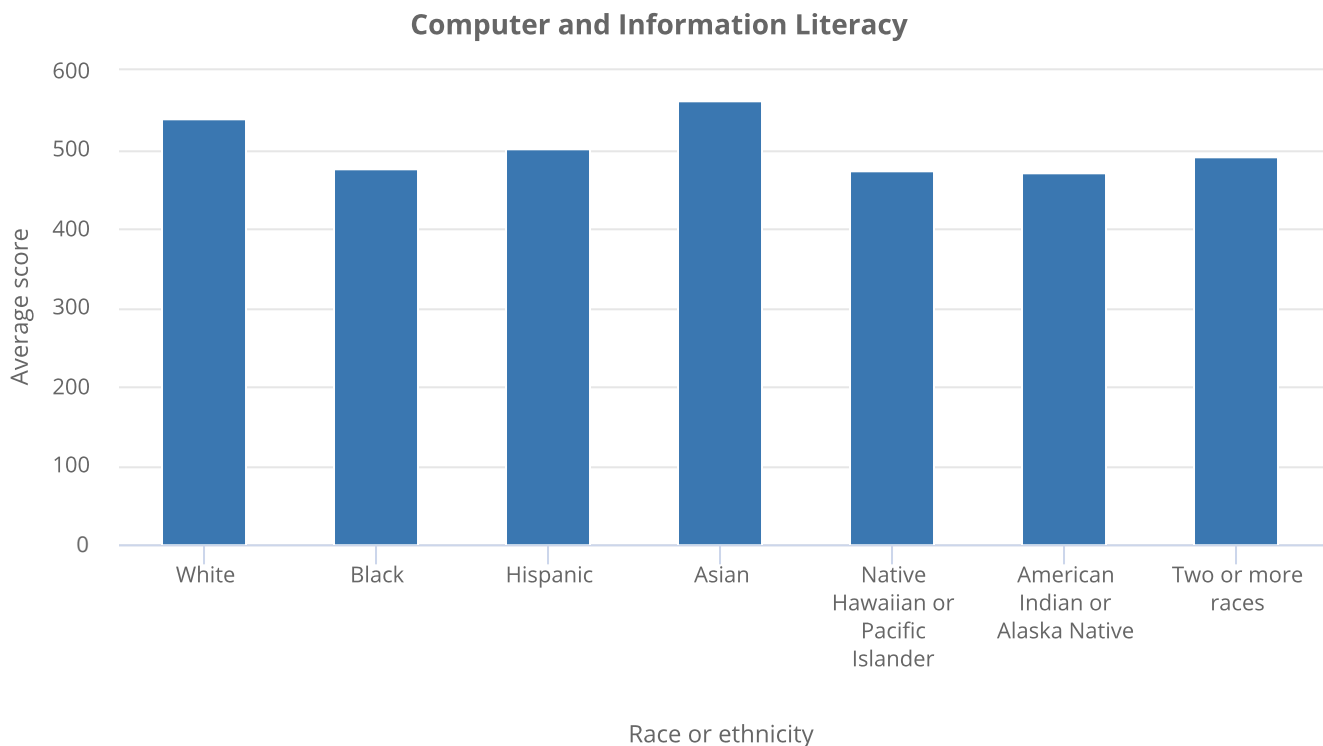
Source(s):
International Association for the Evaluation of Educational Achievement (IEA), International Computer and Information Literacy Study (ICILS), 2018. https://nces.ed.gov/surveys/icils/icils2018/theme1.asp?tabontop.

Science and Engineering Indicators

Teachers of Mathematics and Science

Teachers play an essential role in student learning, and it is important that all students have access to qualified and effective teachers (NASEM 2020). As noted in the National Academies of Sciences, Engineering, and Medicine (NASEM) report *Changing Expectations for the K−12 Teacher Workforce*, "there is no uniformly agreed upon means of determining the 'quality' of teachers, but there is long-standing evidence from a variety of settings that teacher *qualifications* are inequitably distributed with students of color and students living in poverty tending to be assigned to less experienced and less credentialed teachers" (NASEM 2020:76). Some indicators of teacher qualifications—such as teacher certification, years of teaching experience, and a degree in the subject taught—vary widely across student demographic groups, and highly qualified teachers are less prevalent at schools with high-minority or high-poverty populations (Goldhaber, Quince, and Theobald 2018; NASEM 2020; Rahman et al. 2017).

This section uses data from the 2017−18 National Teacher and Principal Survey (NTPS)[12] and the 2018 Teaching and Learning International Survey (TALIS)[13] to report on characteristics of public middle and high school mathematics and science teachers in the United States and internationally.

U.S. Mathematics and Science Teachers

More than 90% of the nation's public middle and high school mathematics and science teachers held a regular or advanced teaching certification, and nearly all held a bachelor's degree or higher (**Table K12-2**). Their average annual salary was approximately $60,000 in 2017−18. A key aspect of teacher preparation is whether teachers have an academic degree or certification in the specific subject that they teach, referred to as an *in-field* degree. Research suggests that subject matter teachers with an in-field degree or certification are more effective (Shah et al. 2019). At the middle school level, 69% of mathematics teachers and 76% of science teachers held an in-field degree or certification (in mathematics or mathematics education, and science or science education, respectively) (**Figure K12-13**). At the high school level, about 90% of mathematics teachers and biology or life sciences teachers held in-field degrees or certifications, and 76% of physical sciences teachers did so.

Table K12-2

Public middle and high school teachers with selected characteristics and average annual salaries of teachers, by teaching field: 2017−18

(Percent and dollars)

Characteristic	Mathematics teachers	Science teachers	Other teachers[a]
Had a bachelor's or higher degree (percent)	98	97	96
Had a regular or advanced certification (percent)	92	90	90
Average annual salary (dollars)	59,600	60,500	59,300

[a] Other teachers include those who teach any subject other than mathematics or science.

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the 2017−18 National Teacher and Principal Survey, National Center for Education Statistics.

Science and Engineering Indicators

Figure K12-13

Public middle and high school mathematics and science teachers with in-field subject-matter preparation: 2017−18
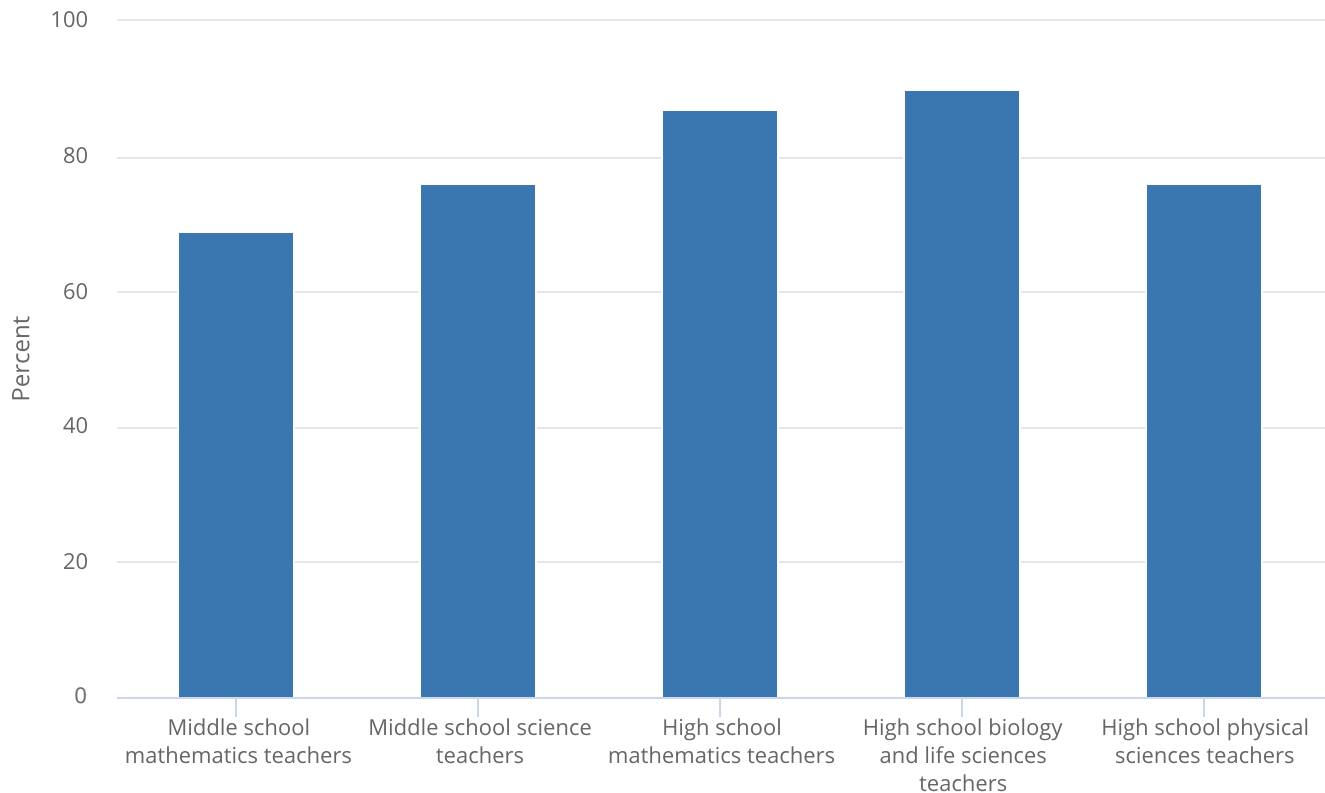
Note(s):
In-field subject-matter preparation refers to mathematics teachers with a degree and/or full certification in mathematics or mathematics education and science teachers with a degree and/or full certification in science or science education.

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the 2017−18 National Teacher and Principal Survey, National Center for Education Statistics.

Science and Engineering Indicators

The percentage of teachers with in-field degrees or certifications varied by minority enrollment, school poverty level, and region. Middle school mathematics teachers with in-field degrees were less prevalent at high-minority-enrollment schools, and both middle school mathematics and science teachers with in-field degrees were less prevalent at high-poverty schools (**Table K12-3**). For example, 75% of middle school mathematics teachers at schools with less than 25% minority enrollment had an in-field degree or certification, compared with 61% of teachers at schools with 75% or more minority enrollment. Similarly, 76% and 80% of middle school science and mathematics teachers at schools with less than 35% of students eligible for free or reduced-price lunch had an in-field degree, compared with 62% and 68%, respectively, of teachers at schools with 75% or more students eligible. At the U.S. regional level, high school physical sciences and biology or life sciences teachers with in-field degrees were least prevalent in the South compared with other regions of the country: 60% of high school physical sciences teachers in the South had an in-field degree, compared with at least 79% of these teachers in the Northeast, Midwest, and West.

Table K12-3

Public middle and high school mathematics and science teachers with in-field subject-matter preparation, by teaching field and selected school characteristics: 2017−18

(Percent)

School level and teaching field	Minority enrollment (percent)[a]				School poverty level (percent)[b]				Region			
	0−24	25−49	50−74	75 or more	0−34	35−49	50−74	75 or more	Northeast	Midwest	South	West
Middle school mathematics	75	75	63	61	76	73	67	62	75	72	65	71
Middle school science	77	74	79	76	80	78	77	68	82	79	72	77
High school mathematics	88	91	87	83	88	87	91	83	85	91	87	86
High school biology and life sciences	92	87	93	85	92	93	87	87	96	94	81	95
High school physical science	80	78	69	73	84	70	71	71	91	79	60	80

[a] Minority enrollment includes students who are Black, Hispanic, Asian, Native Hawaiian or Pacific Islander, American Indian or Alaska Native, and Two or more races.

[b] School poverty level is the percentage of students in school eligible for free or reduced-price lunch.

Note(s):
In-field subject-matter preparation refers to mathematics teachers with a degree and/or full certification in mathematics or mathematics education and science teachers with a degree and/or full certification in science or science education.

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the 2017−18 National Teacher and Principal Survey, National Center for Education Statistics.

Science and Engineering Indicators

Another aspect of teacher qualification is the route that teachers take to earn their certification, either a traditional or alternative route.[14] In a traditional certification program, prospective mathematics and science teachers typically complete coursework and spend time as a student teacher with a mentor teacher before earning their credential and teaching in their own classroom. Alternative routes to certification vary by state but typically allow candidates to begin teaching in their own classroom while simultaneously taking coursework needed to earn a credential (Carver-Thomas and Darling-Hammond 2017; Whitford, Zhang, and Katsiyannis 2018). Nationally, 24% of mathematics teachers and 30% of science teachers entered teaching through an alternative route to certification; however, greater proportions of teachers at high-minority-enrollment and high-poverty-enrollment schools entered through an alternative route to certification (Table SK12-15). In schools with a minority enrollment of 75% or more, 37% of mathematics teachers and 41% of science teachers entered teaching through an alternative route, compared with 14% of mathematics teachers and 23% of science teachers at schools with less than 25% minority enrollment (**Figure K12-14**). Patterns were similar at schools with high- and low-poverty enrollment. Entry into teaching through an alternative route also varied widely by region of the country, with mathematics and science teachers in the South entering teaching through alternative programs at higher rates than teachers in the Northeast, Midwest, or West.

Public middle and high school mathematics and science teachers who entered teaching through an alternative certification program, by school minority enrollment: 2017–18

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the 2017–18 National Teacher and Principal Survey, National Center for Education Statistics.

Science and Engineering Indicators

Less experienced mathematics and science teachers (as measured by years of teaching experience) were more prevalent at schools with high-minority and high-poverty enrollment (Table SK12-15). For example, 23% of teachers at high-poverty-enrollment schools had 3 years or fewer of teaching experience, compared with 14% of teachers at low-poverty-enrollment schools (**Figure K12-15**). There was also regional variation, particularly among science teachers, with 20% of science teachers in the South having 3 years or fewer of teaching experience, compared with 10% in the Northeast, 14% in the Midwest, and 15% in the West (Table SK12-16).

Figure K12-15

Public middle and high school mathematics and science teachers with 3 years or fewer of teaching experience, by school poverty level: 2017–18

Note(s):
School poverty level is the percentage of students eligible for free or reduced-price lunch.
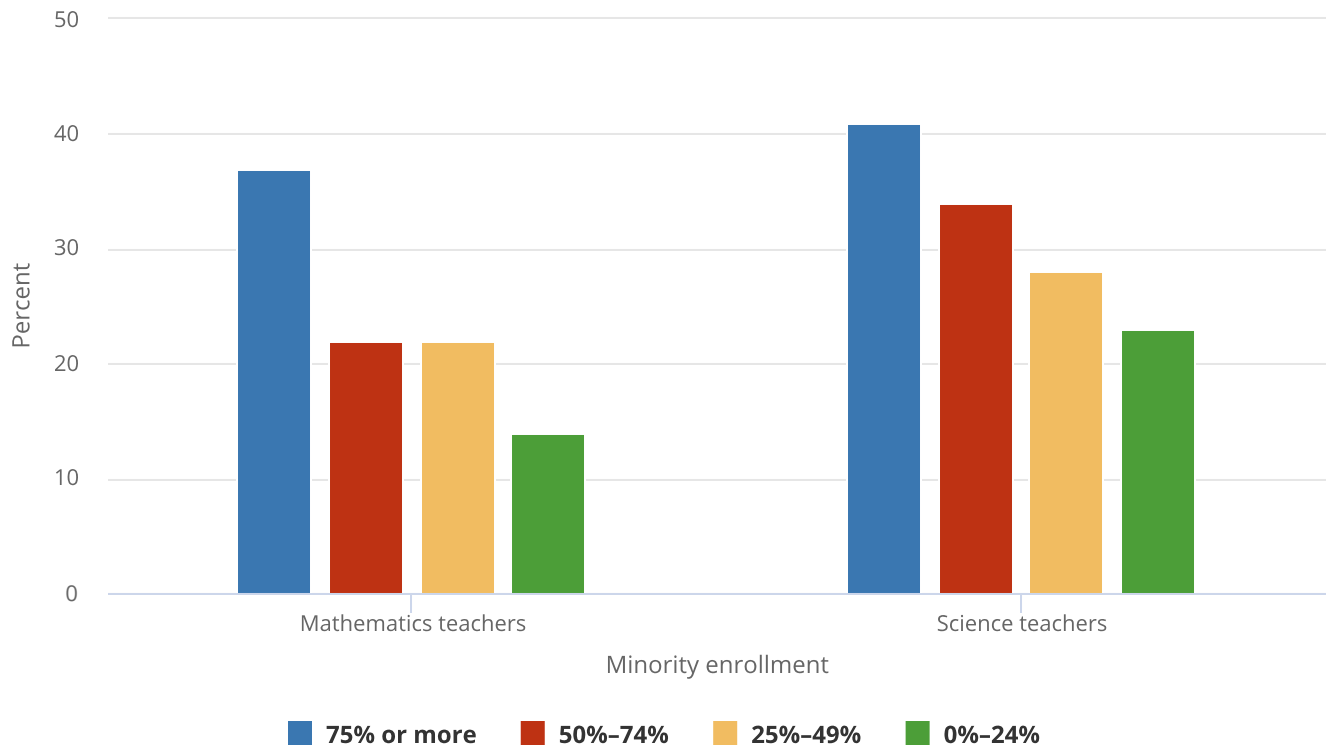
Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the 2017–18 National Teacher and Principal Survey, National Center for Education Statistics.

Science and Engineering Indicators

The available data also provide information on the extent to which Black and Hispanic students are taught by teachers of the same race or ethnicity. Research indicates that Black, Hispanic, Native Hawaiian or Pacific Islander, and American Indian or Alaska Native students in general post higher scores on achievement tests and have higher levels of attendance and fewer suspensions when they have at least one same-race teacher (Egalite and Kisida 2018; Gershenson et al. 2018; NASEM 2020). Additionally, policymakers and educators want to increase the number of students from historically underrepresented minorities in STEM fields, and research suggests that having same-race STEM instructors encourages more underrepresented students to participate in STEM (Price 2010). Overall, in 2017–18, the population of middle and high school mathematics and science teachers was less racially and ethnically diverse than the U.S. student population. Approximately 80% of mathematics and science teachers were White, about 7% were Black, and 8% were Hispanic (**Table K12-4**). In contrast, the U.S. public school student population in 2019 was 48% White, 15% Black, and 27% Hispanic (Hussar et al. 2020).

Table K12-4

Public middle and high school mathematics and science teachers who are White, Black, or Hispanic, by teaching field and minority enrollment in school: 2017−18

(Percent)

Teaching field and minority enrollment in school	White	Black	Hispanic[a]
All public middle and high school teachers	80	7	8
Mathematics	80	7	7
Minority enrollment in school			
More than 50% White	93	2	2
More than 50% minority	62	13	15
More than 50% Black	51	41	s
More than 50% Hispanic[a]	53	6	27
No single race or ethnicity more than 50%	75	9	8
Science	80	6	7
Minority enrollment in school			
More than 50% White	93	1	2
More than 50% minority	63	13	15
More than 50% Black	54	36	5
More than 50% Hispanic[a]	54	4	31
No single race or ethnicity more than 50%	76	10	5

[a] Hispanic may be any race; race categories exclude Hispanic origin.
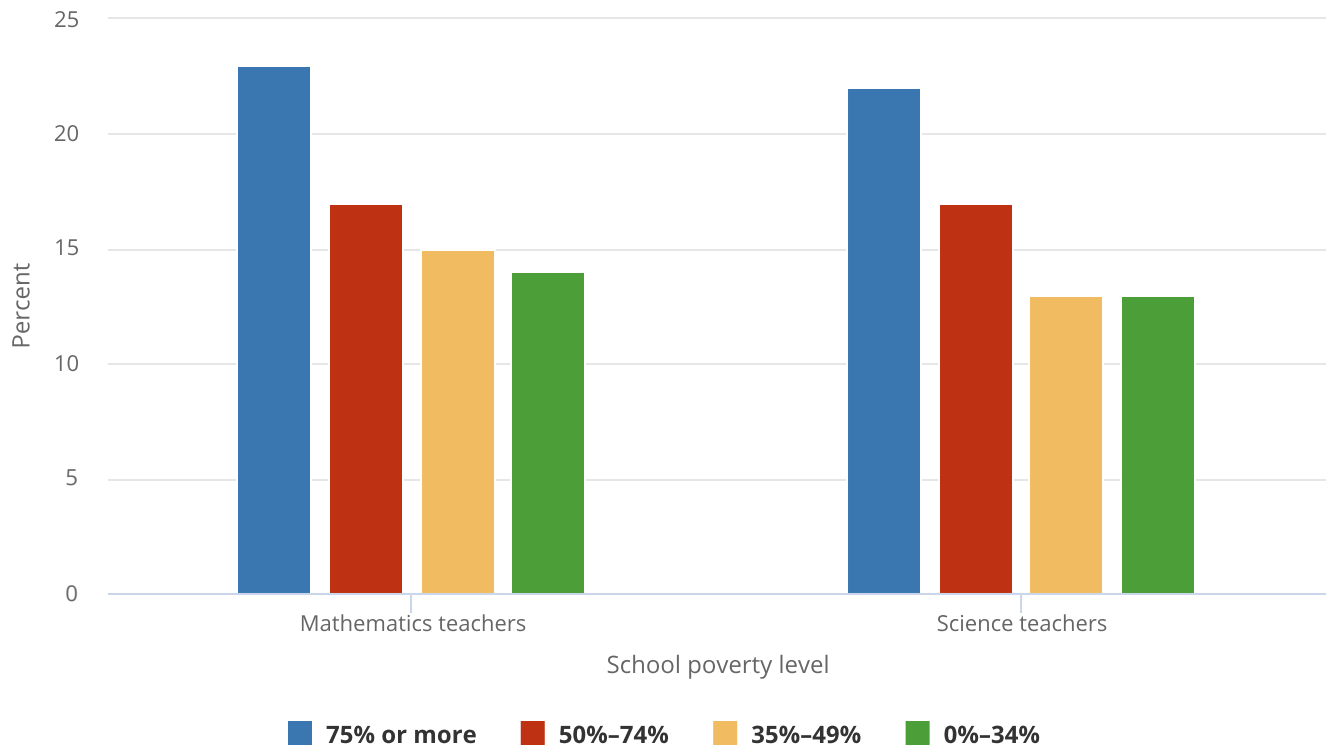
Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the 2017−18 National Teacher and Principal Survey, National Center for Education Statistics.

Science and Engineering Indicators

The findings from the 2017−18 NTPS data are consistent with this discrepancy. At schools with predominantly Black or Hispanic populations, the percentage of Black and Hispanic mathematics and science teachers was higher than at other schools, although still not as high as the percentage of Black or Hispanic students. At schools with more than 50% Black students, 41% of the mathematics teachers and 36% of the science teachers were Black; and at schools with more than 50% Hispanic students, 27% of the mathematics teachers and 31% of the science teachers were Hispanic (**Table K12-4**).

International Comparisons of Mathematics and Science Teachers

TALIS provides cross-country information on teacher attributes at the lower secondary level (grades 7−9). These data enable a comparison of U.S. mathematics and science teachers with their international peers on a variety of dimensions, although it is important to bear in mind that these dimensions are not measures of teacher quality or effectiveness. On average, a greater proportion of U.S. lower secondary mathematics teachers had a master's degree or higher (64%), compared with teachers in OECD member countries (47%). The percentage of U.S. lower secondary science teachers with a master's degree or higher (58%) was not significantly different from the average for teachers in OECD member countries (52%) (**Figure K12-16**). More than 90% of lower secondary mathematics and science teachers in Slovakia, Czechia, Italy, Portugal, and Finland had a master's degree or higher, compared to less than 10% of lower secondary mathematics and science teachers in Belgium, Denmark, and Turkey.[15]

Figure K12-16

Lower secondary mathematics and science teachers with a master's or higher degree, by OECD education system: 2018

Mathematics teachers

Science teachers

* *p* < 0.05. Significantly different from the U.S. estimate at the 0.05 level of statistical significance.

OECD = Organisation for Economic Co-operation and Development.

Note(s):
Lower secondary education in the United States includes grades 7–9. Mathematics and science teachers are identified through teacher reports of the subject taught in their *target class*, which is defined as the first class that teachers taught in their school after 11 a.m. Tuesday in the week before the interview. If a teacher did not teach on Tuesday, the target class can be a class taught on a day following the last Tuesday. Teachers whose target class consisted of entirely or mainly special needs students were not asked about the subject taught in their target class and were, therefore, excluded in the table. Teachers' education is based on the 2011 International Standard Classification of Education (ISCED), which defines nine education levels: level 0 = early childhood education, level 1 = primary education, level 2 = lower secondary education, level 3 = upper secondary education, level 4 = postsecondary non-tertiary education, level 5 = short-cycle tertiary education, level 6 = bachelor's degree or equivalent education, level 7 = master's degree or equivalent education, and level 8 = doctoral degree or equivalent education. More information about ISCED 2011 is available at http://uis.unesco.org/sites/default/files/documents/international-standard-classification-of-education-isced-2011-en.pdf.

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the OECD, Teaching and Learning International Survey (TALIS), 2018.

Science and Engineering Indicators

About 14% of U.S. lower secondary mathematics and science teachers had 3 years or fewer of teaching experience (**Figure K12-17**), which was not significantly different from most of the other OECD countries. Among science teachers, Austria (23%) and Chile (19%) had the highest percentage of teachers with 3 years or fewer of teaching experience, and Lithuania (4%) and Portugal (1%) had the least. In the United States, two-thirds of lower secondary mathematics teachers (68%) and more than half of lower secondary science teachers (56%) were women (**Figure K12-18**). Among OECD countries, Latvia had the highest concentration of female lower secondary mathematics (97%) and science (88%) teachers, whereas Japan had the lowest, with 22% female mathematics teachers and 28% female science teachers.

Figure K12-17

Lower secondary mathematics and science teachers with 3 years or fewer of teaching experience, by OECD education system: 2018

Mathematics teachers

Science teachers

* *p* < 0.05. Significantly different from the U.S. estimate at the 0.05 level of statistical significance.

OECD = Organisation for Economic Co-operation and Development.

Note(s):
Lower secondary education in the United States includes grades 7–9. Mathematics and science teachers are identified through teacher reports of the subject taught in their *target class,* which is defined as the first class that teachers taught in their school after 11 a.m. Tuesday in the week before the interview. If a teacher did not teach on Tuesday, the target class can be a class taught on a day following the last Tuesday. Teachers whose target class consisted of entirely or mainly special needs students were not asked about the subject taught in their target class and were, therefore, excluded in the table.

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the OECD, Teaching and Learning International Survey (TALIS), 2018.

Science and Engineering Indicators

Figure K12-18

Lower secondary mathematics and science teachers who were women, by OECD education system: 2018

Mathematics teachers

Science teachers

* *p* < 0.05. Significantly different from the U.S. estimate at the 0.05 level of statistical significance.

OECD = Organisation for Economic Co-operation and Development.

Note(s):
Lower secondary education in the United States includes grades 7–9. Mathematics and science teachers are identified through teacher reports of the subject taught in their *target class*, which is defined as the first class that teachers taught in their school after 11 a.m. Tuesday in the week before the interview. If a teacher did not teach on Tuesday, the target class can be a class taught on a day following the last Tuesday. Teachers whose target class consisted of entirely or mainly special needs students were not asked about the subject taught in their target class and were, therefore, excluded in the table.
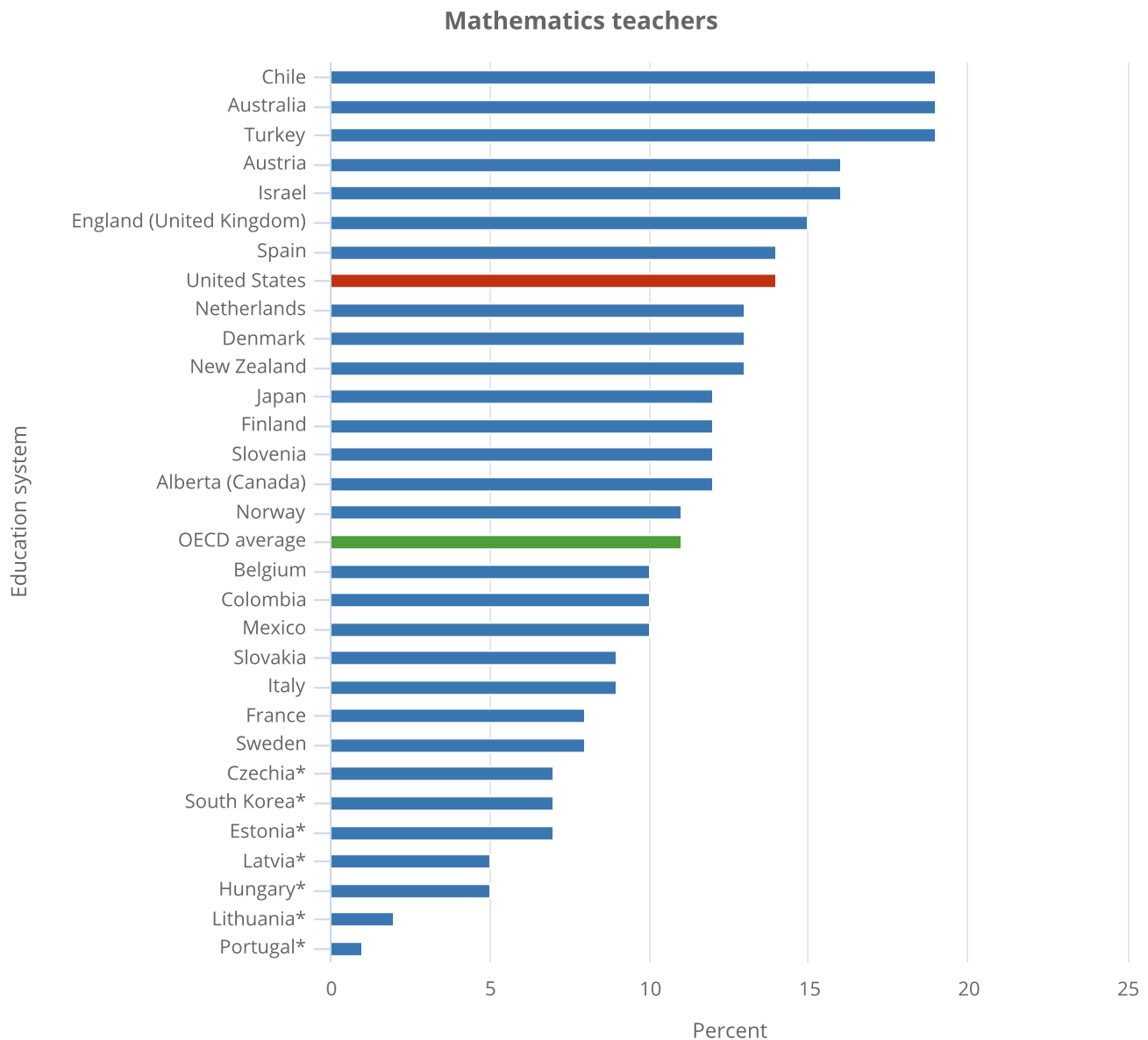
Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the OECD, Teaching and Learning International Survey (TALIS), 2018.

Science and Engineering Indicators

About one-third of U.S. lower secondary mathematics (31%) and science (35%) teachers agreed that the teaching profession is valued in U.S. society (**Figure K12-19**). This differs from other OECD countries; for example, in South Korea and Finland, 56% or more of lower secondary mathematics and science teachers believed that teaching is valued by society. In France and Slovakia, however, fewer than 7% of mathematics and science teachers believed so.

Figure K12-19

Lower secondary mathematics and science teachers who agreed that the teaching profession is valued in their society, by OECD education system: 2018

Mathematics teachers

Science teachers

* *p* < 0.05. Significantly different from the U.S. estimate at the 0.05 level of statistical significance.

OECD = Organisation for Economic Co-operation and Development.

Note(s):
Lower secondary education in the United States includes grades 7–9. Mathematics and science teachers are identified through teacher reports of the subject taught in their *target class*, which is defined as the first class that teachers taught in their school after 11 a.m. Tuesday in the week before the interview. If a teacher did not teach on Tuesday, the target class can be a class taught on a day following the last Tuesday. Teachers whose target class consisted of entirely or mainly special needs students were not asked about the subject taught in their target class and were, therefore, excluded in the table.
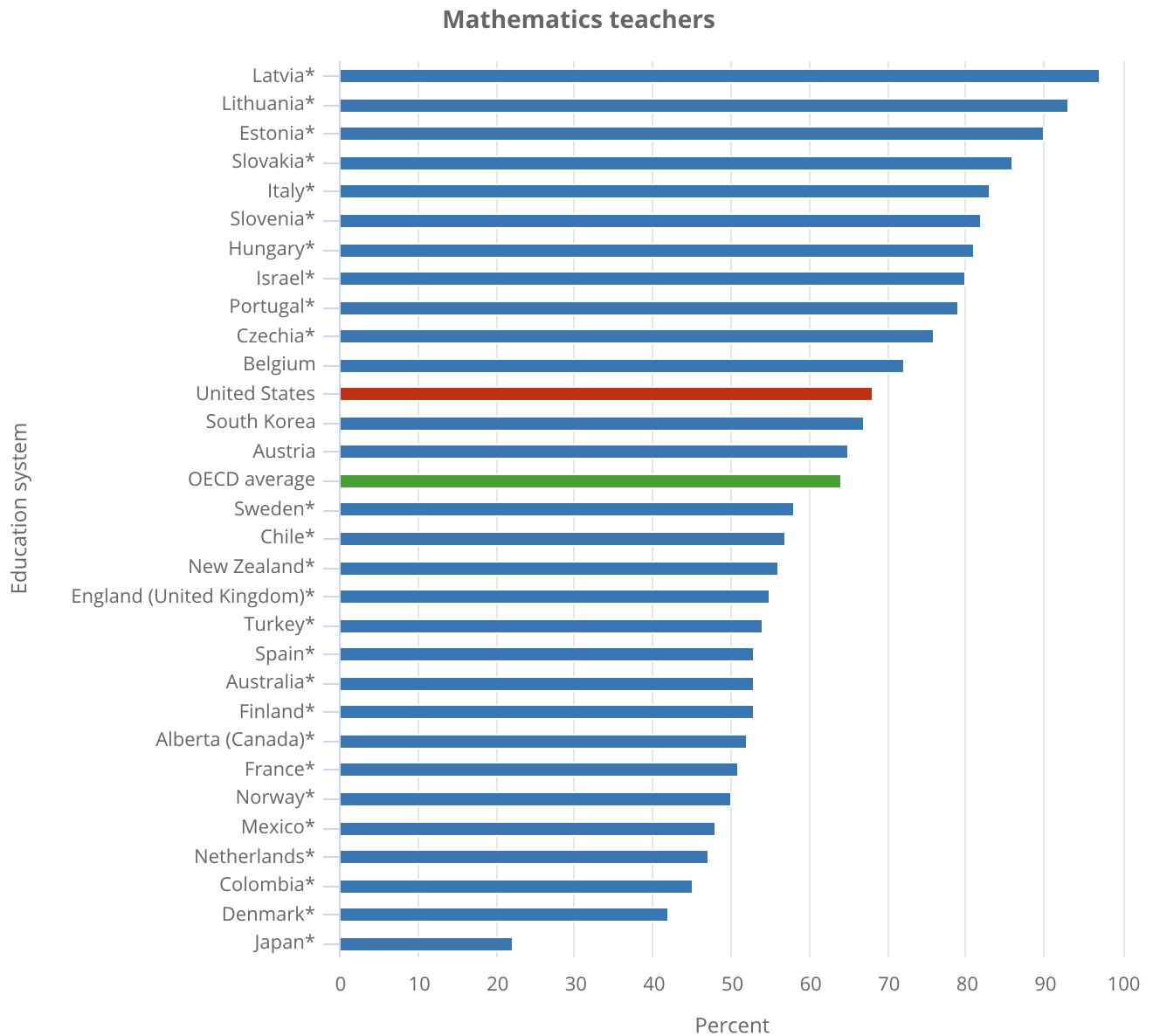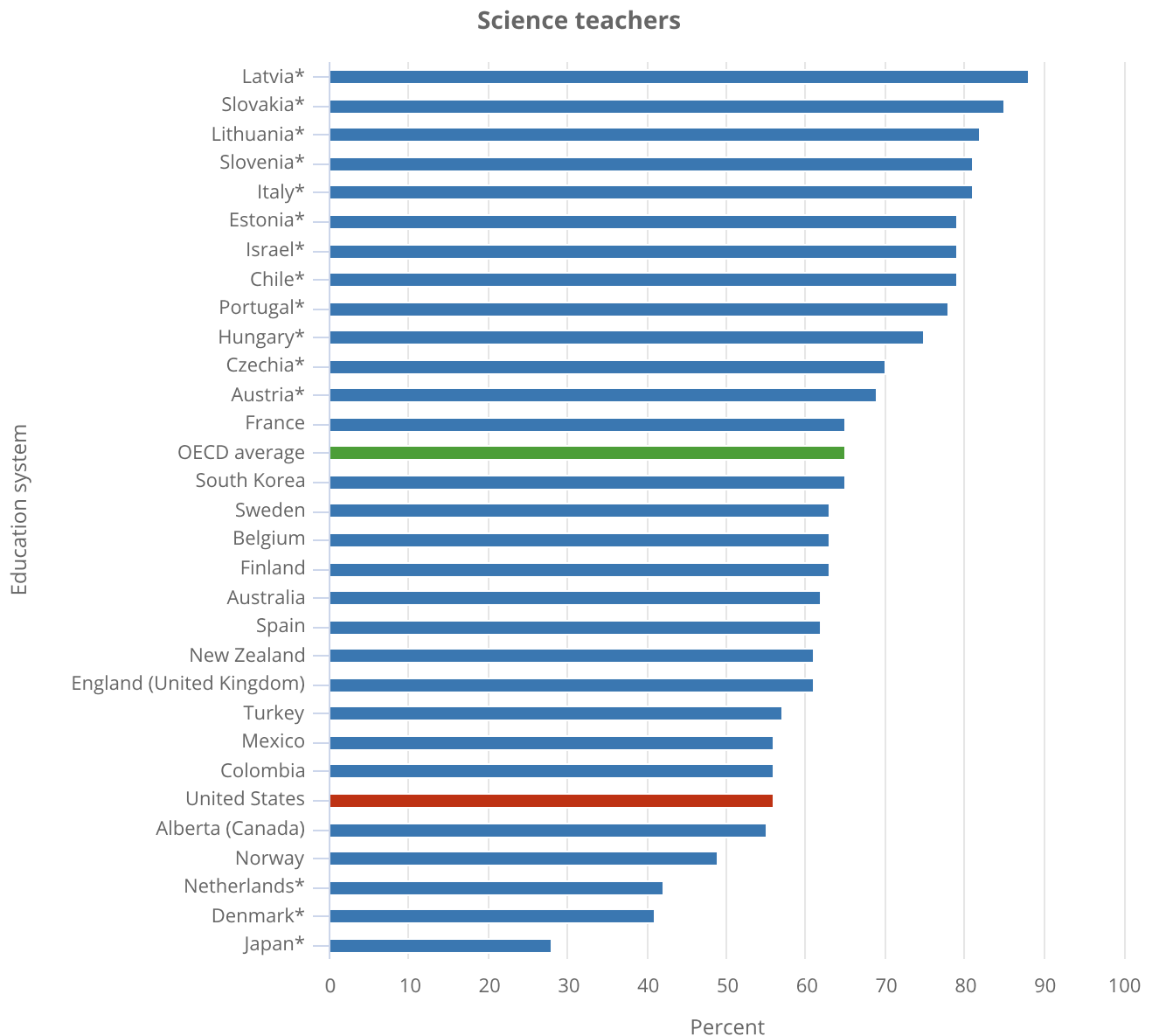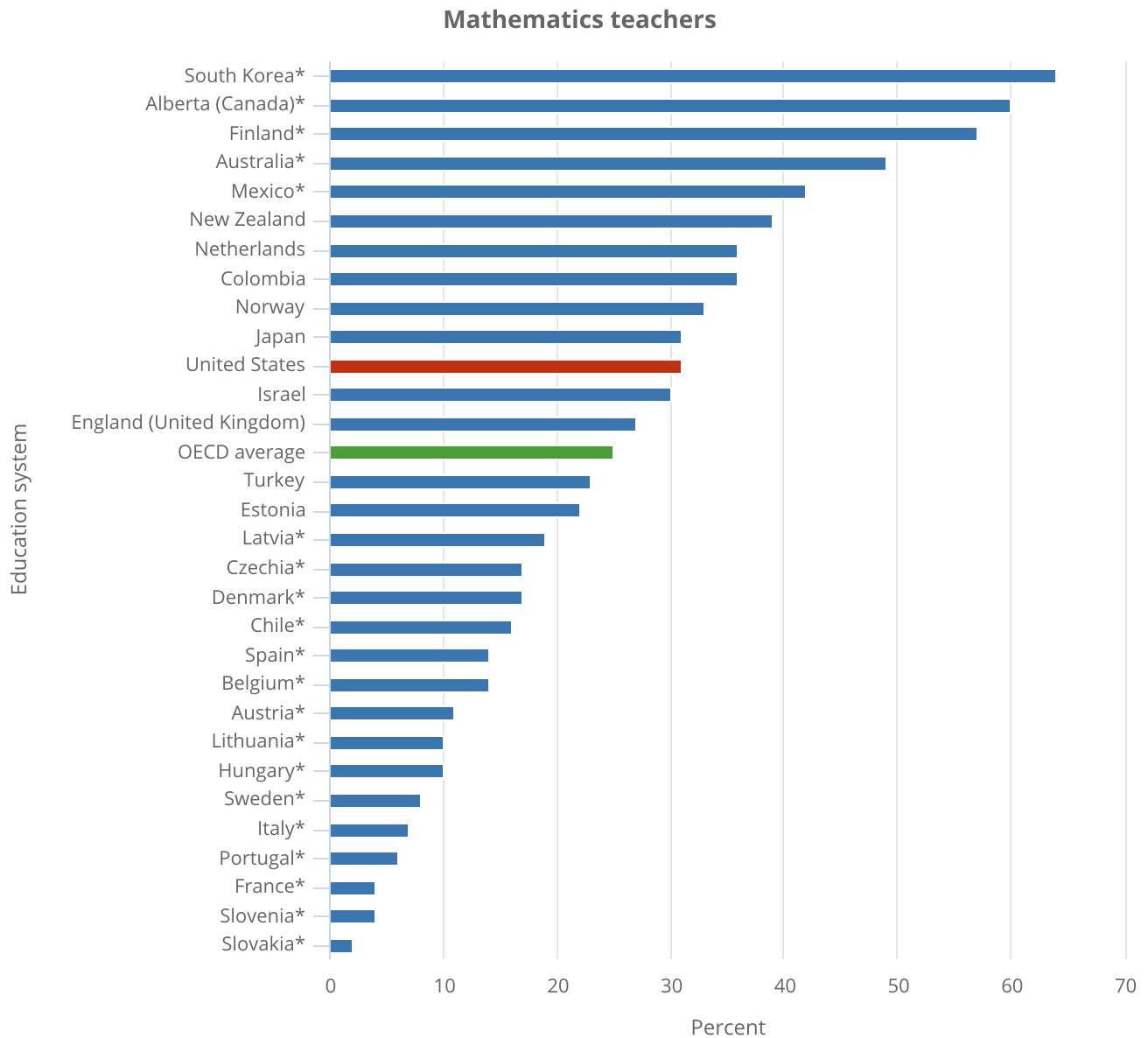
Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the OECD, Teaching and Learning International Survey (TALIS), 2018.
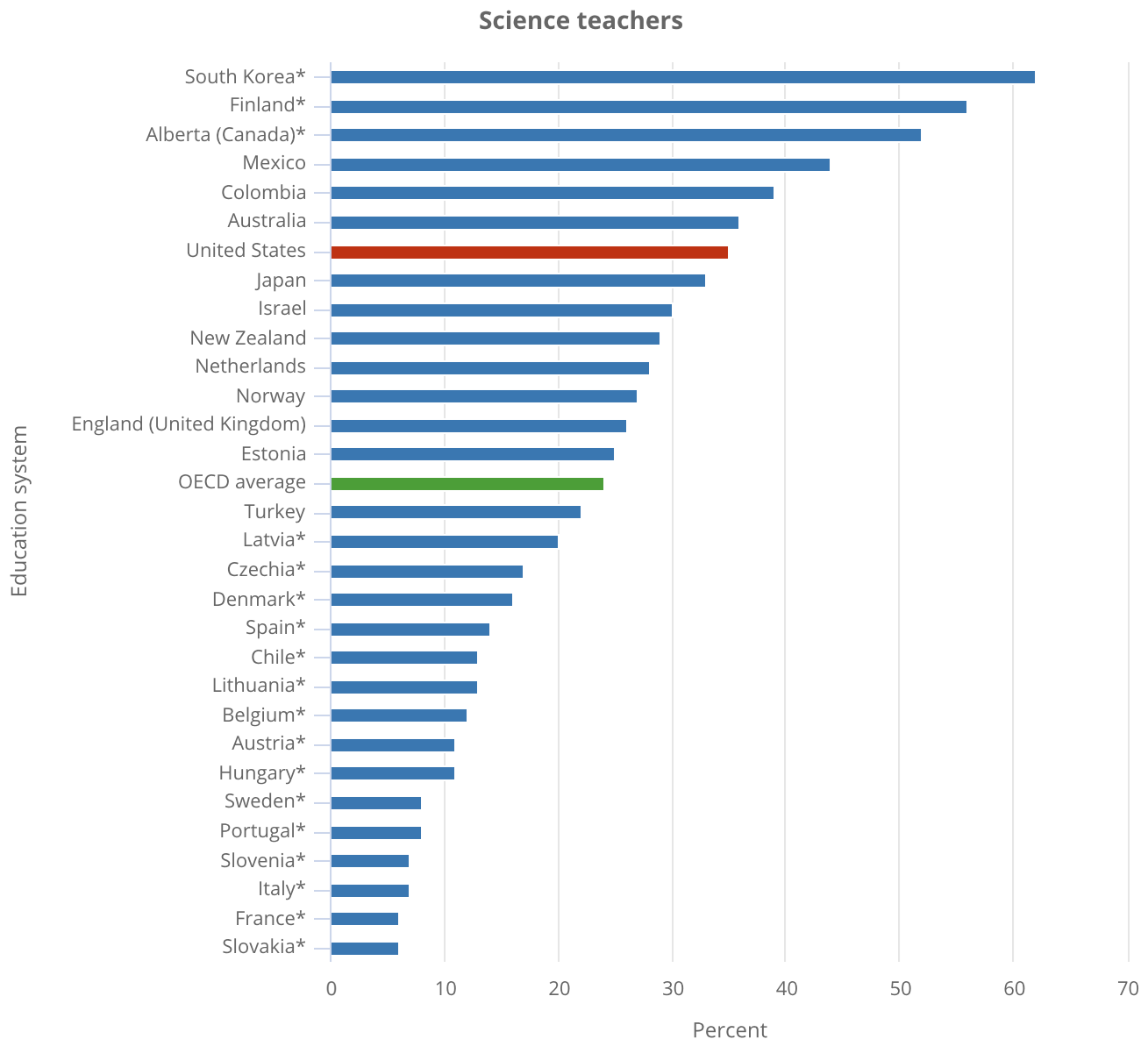
Science and Engineering Indicators

Post–High School Transitions

The U.S. education system strives to prepare every high school graduate for a career or for college, although studies suggest that more progress is needed in preparing students for these paths after high school. Research suggests that fewer than half of students may have the skills needed to succeed in college coursework or the workforce (ACT 2019; Cushing et al. 2019). This section begins with a discussion of the transition to postsecondary education and then provides information on those individuals who transition directly from high school into the workforce—specifically, the skilled technical workforce (STW).

Transition to Postsecondary Education

U.S. high school graduation rates have been rising steadily, reaching 85% in 2018 (Hussar et al. 2020).[16] Although high school completion represents a major milestone for adolescents, most of today's fastest-growing, well-paying jobs—especially those in STEM fields—require at least some postsecondary education, including the attainment of nondegree credentials (Carnevale et al. 2020; NASEM 2017; NSB 2019). In addition, a greater proportion of students who enter postsecondary education immediately after high school persist and attain a degree compared to students who delay their enrollment (Bozick and DeLuca 2005). This section focuses on indicators related to U.S. students' transition from high school to postsecondary education. It presents information about AP and dual enrollment coursetaking, in which students can earn college credits for courses taken in high school and increase their postsecondary preparedness and propensity to pursue postsecondary education after high school. It then presents national data on trends in immediate college enrollment after high school and examines the relationship between perceptions of high school mathematics and science identity and ability and the decision to major in STEM fields at the postsecondary level. For more information on trends in postsecondary STEM education, see the forthcoming *Indicators 2022* report, "[2022] Higher Education in Science and Engineering" section "[2022] Trends in Undergraduate and Graduate S&E Degree Awards."

Participation in Advanced Placement

The AP program, administered by the College Board, provides college-level courses and exams for high school students in 38 subjects, including 12 mathematics and science subjects. Nearly 3 million students took at least one AP exam in 2019, and approximately 23,000 schools offered at least one AP course for students (College Board 2019). Students who earn a score of at least 3 out of 5 on an AP exam may earn college credit for the course. For state-level data on the AP program, see *State Indicators*.

In the past decade, the number of students taking AP mathematics and science exams has increased in every STEM subject area (**Figure K12-20**). The number of high school students taking AP exams in STEM increased from 879,492 in 2009 to 1,684,501 in 2019. The number of students taking computer science exams experienced the largest growth, from about 17,000 students in 2009 to about 166,000 students in 2019, a nearly 10-fold increase. Female students took over half (56%) of the total number of AP exams in 2019 (**Figure K12-21**), including half or more in several STEM subjects, such as biology (63%), environmental science (56%), statistics (52%), and chemistry (51%). For the majority of STEM AP subjects, however, female students accounted for less than half of the test takers. Male students made up 60% or more of exam takers in computer science and physics. The AP exams with the highest proportion of male test takers were Physics C: Electricity and Magnetism (76%) and Computer Science A (75%).

Figure K12-20

Number of students taking AP STEM exams, by selected subjects: 2009 and 2019
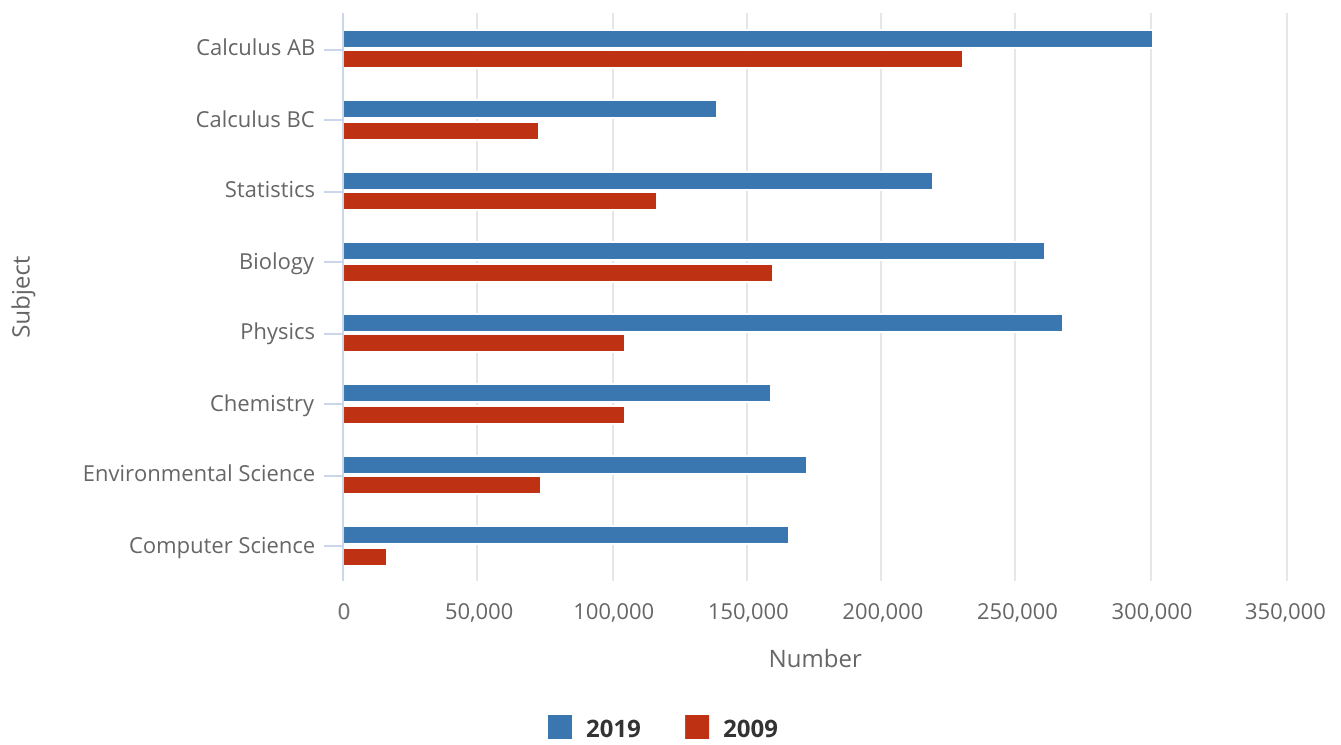
AP = Advanced Placement. STEM = science, technology, engineering, and mathematics.

Note(s):
Physics 1: Algebra-Based, Physics 2: Algebra-Based, Physics B, Physics C: Electricity and Magnetism, and Physics C: Mechanics. AP Computer Science exams include Computer Science A and Computer Science Principles.

Source(s):
College Board, AP Program Participation and Performance Data 2019. https://research.collegeboard.org/programs/ap/data/participation/ap-2019.

Science and Engineering Indicators

Figure K12-21

AP exam takers in selected subjects, by sex: 2019
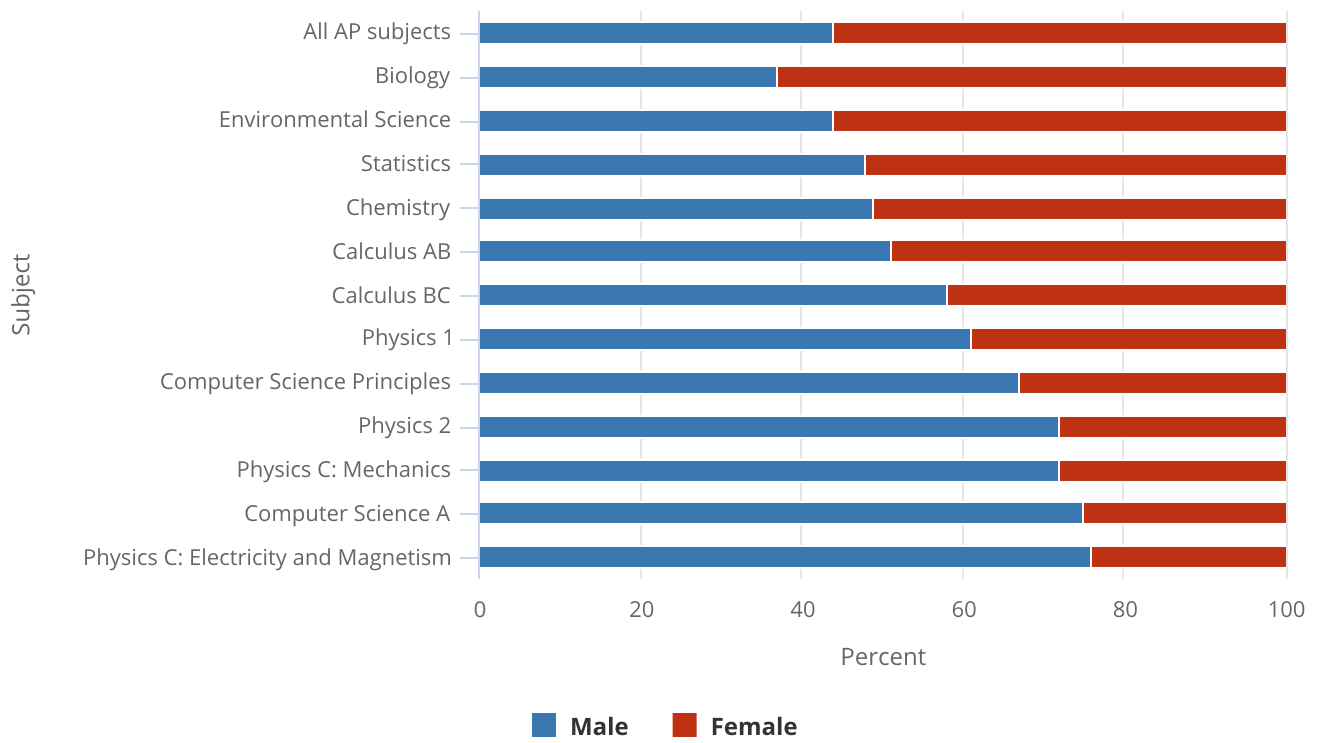
AP = Advanced Placement.

Note(s):
Percentages may not add to 100% because of rounding.

Source(s):
College Board, AP Program Participation and Performance Data 2019. https://research.collegeboard.org/programs/ap/data/participation/ap-2019.

Science and Engineering Indicators

Analysis of 2019 STEM AP exam taking by minority students shows that Black and Hispanic students are underrepresented in STEM AP exam taking. Although these students collectively made up 42% of the U.S. elementary and secondary school population in 2019,[17] together they accounted for 11%−29% of STEM subject-specific AP exam takers (**Figure K12-22**).

AP exam takers in selected subjects, by race or ethnicity: 2019
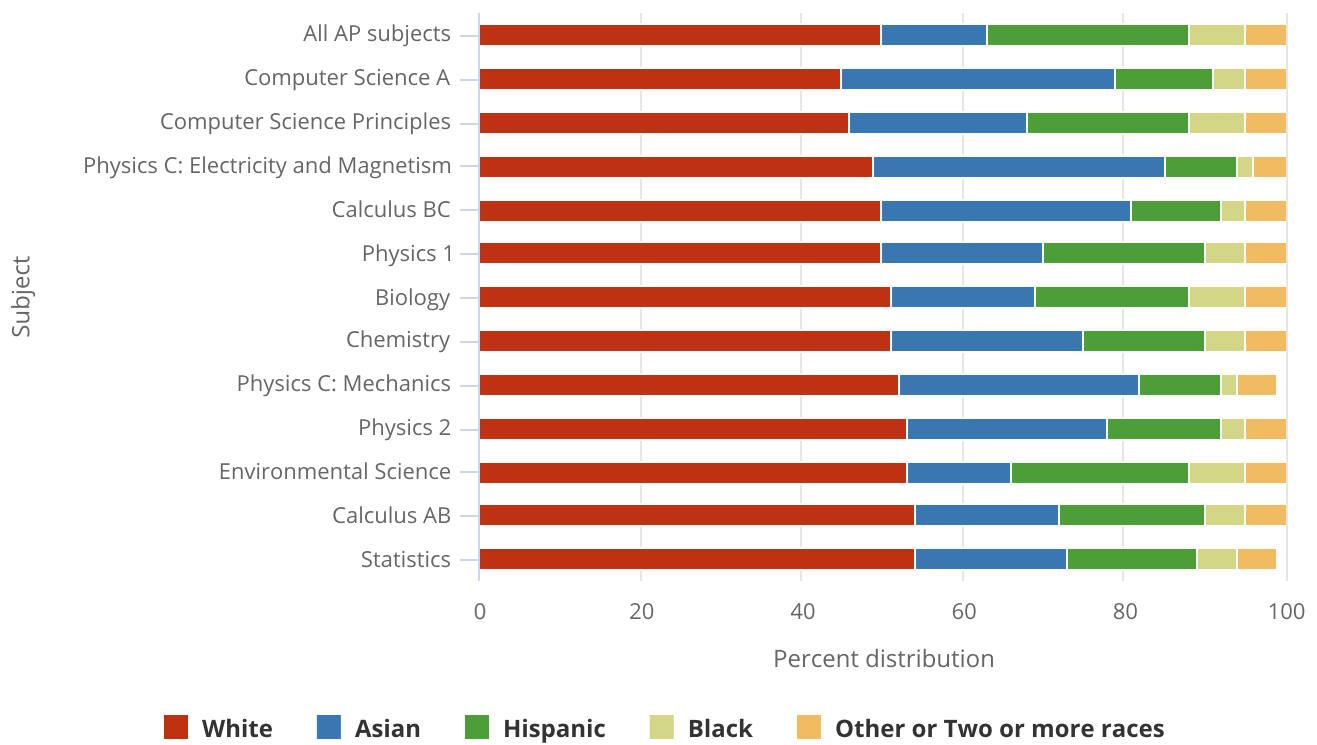
AP = Advanced Placement.

Note(s):
Hispanic may be any race; race categories exclude Hispanic origin. Percentages may not add to 100% because of rounding.

Source(s):
College Board, AP Program Participation and Performance Data 2019. https://research.collegeboard.org/programs/ap/data/participation/ap-2019.

Science and Engineering Indicators

The percentage of AP exam takers who passed AP exams in 2019 (earning at least a score of 3 out of 5) varied by subject. In mathematics, 58% of Calculus AB and 81% of Calculus BC exam takers scored a 3 or higher. In science, the percentage of students who scored 3 or higher ranged from a low of 45% for Physics 1 to a high of 82% for Physics C: Mechanics. A full report of 2019 AP exam scores is available at **AP Exam Score Distributions**.

Participation in Dual Enrollment Courses

In addition to AP courses, dual enrollment courses (courses for which students earn both high school and college credit) offer another option for high school students who wish to earn college credit while still in high school (Burns and Leu 2019). Students typically take these courses at their high school or a local college, either in person or online. Since a published source of STEM-specific dual enrollment statistics is not available, this section presents data on the overall availability and utilization of these courses.

In 2017–18, 82% of public high schools offered dual enrollment courses (Table SK12-24). Availability of dual enrollment courses was highest among rural high schools, 90% of which offered dual enrollment, and lowest among city high schools, 73% of which offered dual enrollment. Whereas 71% of high-poverty-enrollment schools (those in which 75% or more of students were eligible for free or reduced-price lunch) offered dual enrollment courses, 84%–93% of schools at all other poverty levels did so (**Figure K12-23**). Despite widespread dual enrollment availability, only a small proportion of students earn dual enrollment course credit. Among 2013 high school graduates, for example, only 11% earned dual enrollment credits, with an average of 2.5 credits (Burns and Leu 2019).

Figure K12-23

Among public schools with students enrolled in any of grades 9−12, percentage that offered dual or concurrent enrollment, by school poverty level: 2017−18
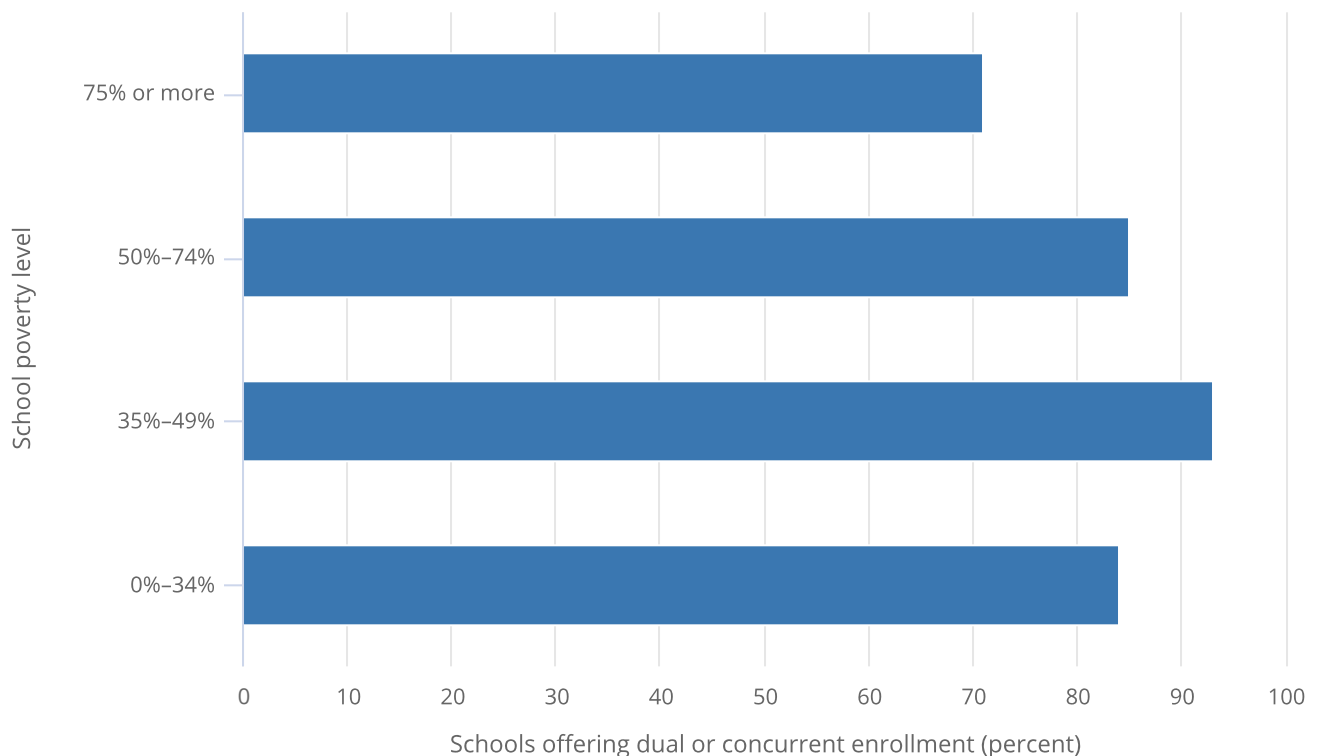
Note(s):
Dual or concurrent enrollment offers both high school and college credit. School poverty level is the percentage of students eligible for free or reduced-price lunch.

Source(s):
Taie S, Goldring R, *Characteristics of Public and Private Elementary and Secondary Schools in the United States: Results From the 2017–18 National Teacher and Principal Survey First Look,* NCES 2019-140, U.S. Department of Education, National Center for Education Statistics (2019). https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2019140.

Science and Engineering Indicators

Enrollment in Postsecondary Education

The 2018 estimates from the U.S. Census Bureau's Current Population Survey indicate that about 70% of students who graduate from high school in a given year enroll in college by October of the same year, a figure that has not meaningfully changed in the past decade (**Figure K12-24**). Among 2018 high school completers who immediately enrolled in college, 26% enrolled in a 2-year institution, and 44% enrolled in a 4-year institution.

Figure K12-24

Immediate college enrollment rates among high school completers, by institution type: 2008−18
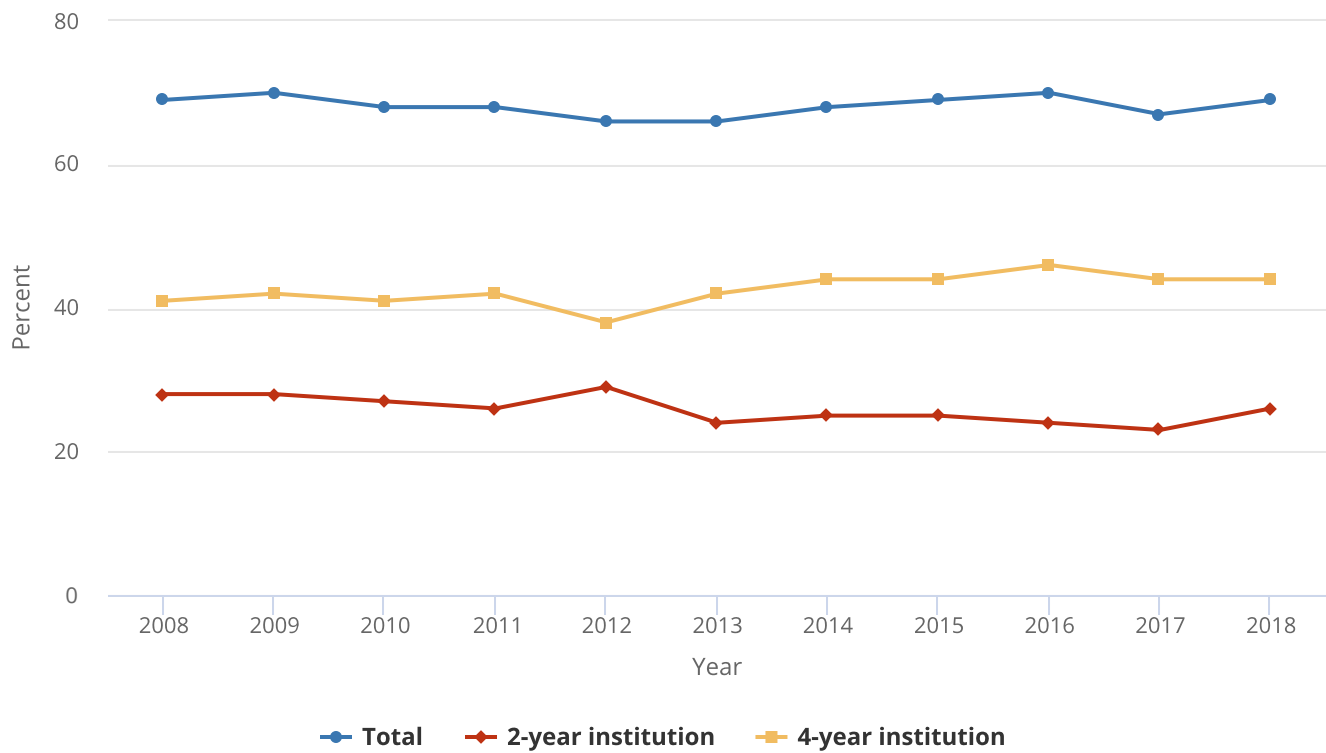
Note(s):
The figure includes students ages 16–24 who graduated from high school or completed a GED or other high school equivalency credential in each survey year. Immediate college enrollment rates are defined as rates of high school completers enrolled in college in October after completing high school earlier in the same calendar year. Percentages may not add to 100% because of rounding.

Source(s):
De Brey C, Snyder TD, Zhang A, Dillow SA, *Digest of Education Statistics 2019,* NCES 2021-009, Tables 302.10 and 302.20, U.S. Department of Education, National Center for Education Statistics (2021). https://nces.ed.gov/programs/digest/current_tables.asp.

Science and Engineering Indicators

Immediate college enrollment rates in 2018 were higher for Asian students compared with students from other racial or ethnic groups (**Figure K12-25**). Black and Hispanic high school completers enrolled at lower rates (62% and 63%, respectively) than their Asian (78%) and White (70%) counterparts did.

Figure K12-25

Immediate college enrollment rates among high school completers, by sex and race or ethnicity: 2018
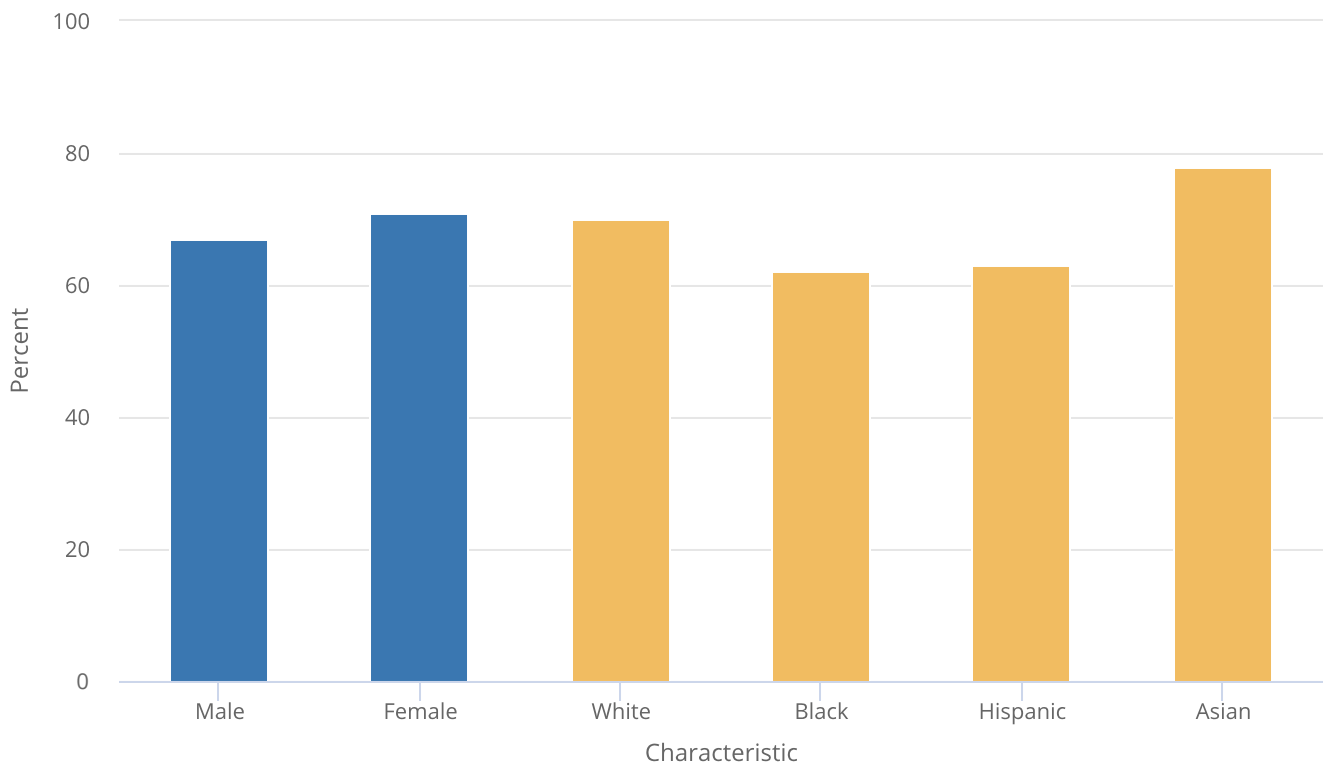
Note(s):
The figure includes students ages 16–24 who graduated from high school or completed a GED or other high school equivalency credential in 2018. Immediate college enrollment rates are defined as rates of high school completers enrolled in college in October after completing high school earlier in the same calendar year. Hispanic may be any race; race categories exclude Hispanic origin.

Source(s):
De Brey C, Snyder TD, Zhang A, Dillow SA, *Digest of Education Statistics 2019,* NCES 2021-009, Tables 302.10 and 302.20, U.S. Department of Education, National Center for Education Statistics (2021). https://nces.ed.gov/programs/digest/current_tables.asp.

Science and Engineering Indicators

High School Students' STEM Experience

With the goals of maintaining global competitiveness, enhancing capacity for innovation, and providing equal opportunity for all students to pursue STEM careers, U.S. policymakers have called for increasing the number and diversity of students pursuing postsecondary degrees in STEM fields (Allen-Ramdial and Campbell 2014). Demographic groups, including women, Blacks, and Hispanics, among others, continue to be underrepresented in STEM occupations compared to their proportion in the general population (NSB 2020).

Students' STEM experience in elementary and secondary school is associated with their postsecondary field of study and career choices: student reports of high self-efficacy in mathematics and science in high school are associated with the choice of STEM majors in college (Wang 2013). Research also indicates that teachers and counselors can play a role in encouraging historically underrepresented minorities to pursue STEM majors and careers (Mau and Li 2018; Reinhold, Holzberger, and Seidel 2018; Shillingford, Oh, and Finnell 2018).

This section uses national data from the High School Longitudinal Study of 2009 (HSLS:09) to explore students' reasons for taking mathematics and science courses in 2012 (while they are in high school) and their perceptions of their mathematics and science identity and ability.[18] It then looks at the relationship between their perceptions of their mathematics and science identity and ability in high school and their decisions to pursue STEM majors in college in 2016.

Reasons for Taking Mathematics and Science Courses in High School

Students' reasons for taking mathematics and science classes reveal how attitudes toward these subjects and outside influences may impact enrollment patterns in these STEM classes by sex and race or ethnicity. While most students, regardless of sex or race or ethnicity, report taking mathematics or science courses because they are required or because they will need them to get into college, there are some notable differences among groups in other factors and attitudes that influence taking these courses. For example, a slightly greater percentage of female students compared to male students reported that they were taking a mathematics or science course because someone else (e.g., a teacher, counselor, or parent) had encouraged them to do so (**Table K12-5**). However, the same proportion of male and female students reported that they took their mathematics class because they enjoy mathematics. Regarding science courses, a greater percentage of male students than female students reported that they took their science course because they enjoy science. The influence of friends was similar for male and female students in mathematics coursetaking, but a greater percentage of male students than female students reported that they were taking their science class because their friends were taking it.

Table K12-5

Among fall 2009 students in grade 9 who took a mathematics or science course in 2012, percentage reporting various reasons for taking it, by sex and race or ethnicity: 2012

(Percent)

Reasons	All students	Sex		Race or ethnicity				
		Male	Female	White	Black	Hispanic[a]	Asian	Other or Two or more races
Reasons for taking mathematics[b]								
I really enjoy math.	33	34	32	32	40	30	48	31
I had no choice; it is a high school requirement.	70	69	71	67	76	77	54	72
A high school counselor suggested I take it.	36	35	38	36	38	38	36	36
A teacher encouraged me to take it.	34	32	36	37	32	29	41	31
My parents encouraged me to take it.	32	31	33	37	26	23	39	29
My friends were taking it.	27	27	26	29	24	22	38	24
Reasons for taking science[c]								
I really enjoy science.	51	55	48	52	51	48	61	52
I had no choice; it is a high school requirement.	64	63	65	58	73	73	57	63
A high school counselor suggested I take it.	36	34	38	36	37	37	35	35
A teacher encouraged me to take it.	31	29	33	33	30	28	33	28
My parents encouraged me to take it.	27	26	29	32	22	19	32	25
My friends were taking it.	30	33	28	32	25	26	41	28

[a] Hispanic may be any race; race categories exclude Hispanic origin.

[b] Apply to students who took a mathematics course in the spring term of 2012. If a student took more than one mathematics course, the student was directed to the most challenging mathematics course taken. Students can choose more than one reason listed in the table.

[c] Apply to students who took a science course in the spring term of 2012. If a student took more than one science course, the student was directed to the most challenging science course taken. Students can choose more than one reason listed in the table.

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the High School Longitudinal Study of 2009 (HSLS:09), First Follow-Up.

Science and Engineering Indicators

About half or less (between 30% and 48%) of the students in each race and ethnic group indicate that they took mathematics courses because they enjoyed the subject, whereas about half or more (between 48% and 61%) in each group report the same reason for taking science courses. The influence of school counselors, teachers, parents, or friends was relatively similar across all races and ethnicities, with a few exceptions. About 40% of Asian students reported that they took a mathematics or science class because their friends were taking the course, relative to a third or less of the other groups. Asian students were also relatively more inclined, along with White students, to report that parents encouraged them to take these courses.

Students' Perceptions of Math and Science Identity and Ability

The available data suggest that male and female students vary in their perceptions of their mathematics and science identity and ability. For example, male high school students tended to agree more with the positive statements about their mathematics and science identity and their abilities in mathematics and science compared with their female counterparts (**Figure K12-26**). About half of male high school students agreed that they see themselves as a math person, compared with 39% of their female classmates, and 71% of male high school students agreed that they are confident in their ability to do an excellent job on science tests, compared with 62% of their female counterparts. There was some variation in responses by race or ethnicity (**Table K12-6**). For example, 59% of Asian students agreed that they see themselves as a math person, compared with 40%−44% of White, Black, and Hispanic students. Lower proportions of Hispanic students (62%) agreed that they were certain that they could master science skills compared with White, Black, and Asian students (70%−75%).

Figure K12-26

Fall 2009 students in grade 9 who agreed with various statements about their mathematics and science identity and ability, by sex: 2012

Table K12-6

Fall 2009 students in grade 9 who agreed with various statements about their mathematics and science ability, by race or ethnicity: 2012

(Percent)

Race or ethnicity	Mathematics			Science		
	I see myself as a math person.	I am confident in my ability to do an excellent job on math tests.	I am certain that I can master math skills.	I see myself as a science person.	I am confident in my ability to do an excellent job on science tests.	I am certain that I can master science skills.
White	44	65	71	52	67	70
Black	44	70	77	45	72	75
Hispanic[a]	40	65	68	42	60	62
Asian	59	68	74	54	64	70

[a] Hispanic may be any race; race categories exclude Hispanic origin.

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the High School Longitudinal Study of 2009 (HSLS:09), First Follow-Up.
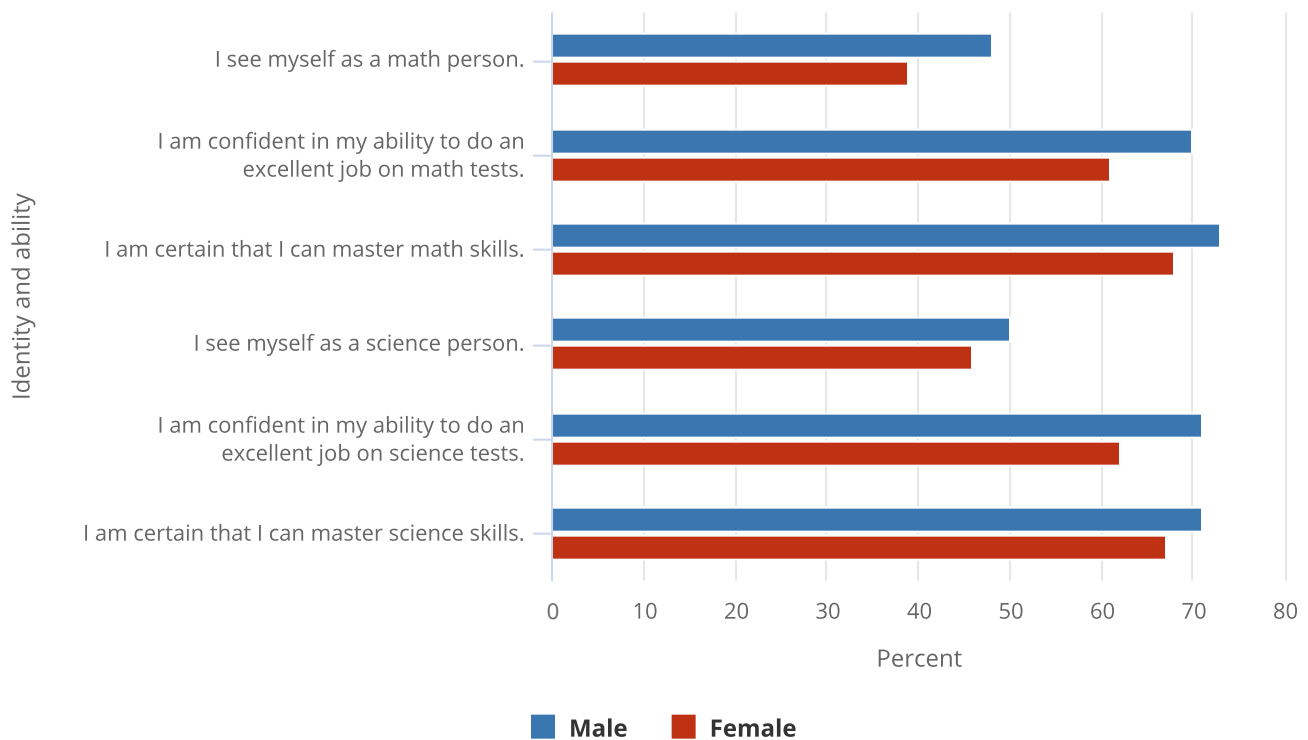
Science and Engineering Indicators

Perceptions of Mathematics and Science Identity and Ability and Declaration of Postsecondary STEM Major

Data from HSLS:09 indicate that students' perceptions of mathematics and science ability in high school are associated with postsecondary STEM choices. Students who agreed with positive statements about their mathematics and science identity and ability in high school declared STEM majors in college in greater proportions than students who disagreed (**Figure K12-27**). For example, students who saw themselves as a math or science person were more apt to declare a postsecondary STEM major than students who disagreed with these statements. Similarly, students who were certain that they could master math and science skills were more likely to declare a STEM major than peers who were not certain that they could master math and science skills.

Figure K12-27

Among fall 2009 students in grade 9 who enrolled in postsecondary education after high school, percentage who reported that their current or most recent major was in a STEM field, by perception of mathematics and science identity and ability: 2016
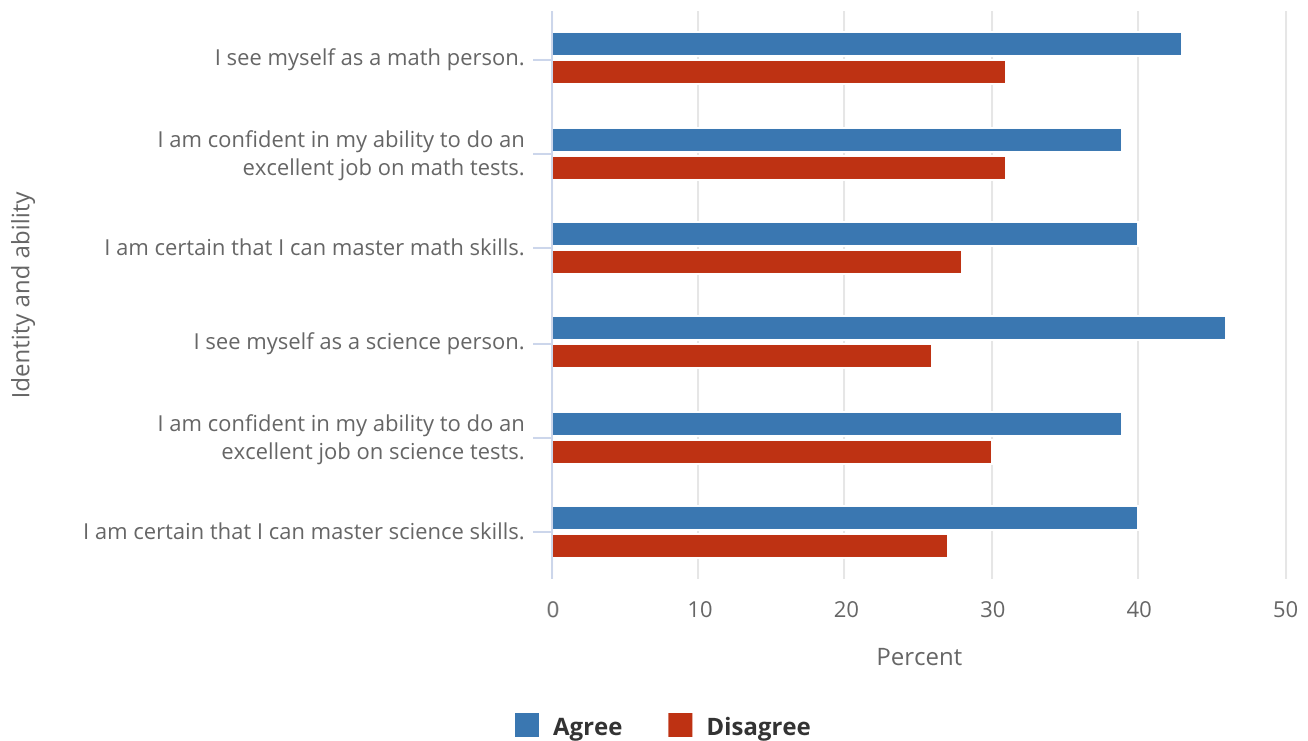
STEM = science, technology, engineering, and mathematics.

Note(s):
STEM majors include mathematics, biological and life sciences, physical sciences, computer and information sciences, engineering and related technologies, science technologies, social sciences, and psychology and are based on the first major declared by students for their current or most recent undergraduate degree or certificate program as of February 2016.

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the High School Longitudinal Study of 2009 (HSLS:09), First Follow-Up and Second Follow-Up.

Science and Engineering Indicators

Transition to the Skilled Technical Workforce

For students who do not transition into postsecondary education immediately after high school, STW jobs offer higher pay and more opportunities than other types of positions (Carnevale et al. 2018; Rothwell 2015). STW jobs are those that require skills in STEM fields but do not require a bachelor's-level degree for entry (Chen and Rotermund 2020). The *Indicators 2020* report "**Elementary and Secondary Mathematics and Science Education**" used data from HSLS:09 to examine which students entered the STW directly after high school and which high school courses were associated with entry into the STW. The STW workforce in this cohort was made up primarily of men; 79% of students who entered the STW were men, and 21% were women. By comparison, 59% of students who entered the job market directly after high school were men, and 41% were women. The racial and ethnic distribution of the STW also differed from the overall distribution of those entering the workforce, with White students overrepresented in STW jobs (58% in the STW compared to 47% overall), and Black and Hispanic students underrepresented in the STW relative to their percentages in the workforce overall (10% compared to 16% and 15% compared to 25%, respectively). In terms of high school preparation, a

greater percentage of students who had earned career and technical education (CTE) credits in the STEM-related fields of manufacturing; engineering and technology; architecture and construction; agriculture, food, and natural resources; and transportation, distribution, and logistics entered the STW directly after high school compared with those who had not earned any credits in these areas. For more information on the STW, see the forthcoming *Indicators 2022* report, "[2022] The STEM Labor Force of Today: Scientists, Engineers, and Skilled Technical Workers."

Online Education in STEM and Impact of COVID-19

The COVID-19 pandemic led to school building closures in March 2020 and an unprecedented, near-total transition to online or alternative learning, affecting approximately 55 million students in 124,000 U.S. public and private schools (Education Week 2020a). In fall 2020, the majority of school districts continued to rely on a distance-learning model for instruction, including some of the nation's largest school districts, such as Los Angeles Unified School District and Chicago Public Schools (Education Week 2020b). In response to these shifts in instruction, many researchers are endeavoring to understand the impact on students and are finding that there may be long-term effects on student learning (see sidebar Learning Losses and COVID-19).

SIDEBAR

Learning Losses and COVID-19: The Pandemic's Potential Long-Term Impact on Students

Studies from the Annenberg Institute at Brown University and the Center for Research on Education Outcomes (CREDO) at Stanford University project that there may be substantial learning losses for students because of the COVID-19 pandemic. These studies estimate, for example, that some students may lose up to a full year of math learning. These studies find that learning losses are not distributed evenly among all students and that some groups of students may be more negatively affected than others, such as students from low-income households or those with disabilities. These researchers caution that the results of these projections are estimates and should be interpreted carefully. However, based on their research, they conclude that the educational disruptions caused by the COVID-19 pandemic have the potential to negatively affect student learning and education. As a result, they suggest, schools should allocate additional resources to help students, especially the most vulnerable, accelerate their learning and regain these losses (CREDO 2020, Kuhfeld et al. 2020).

A report from the Annenberg Institute at Brown University estimates that students began the 2020–21 school year with a third to a half of the learning gains in math relative to a normal school year (Kuhfeld et al. 2020). The study used data from 5 million student test scores and utilized models based on student learning loss due to absenteeism, school closures, and summer break to project the effects of COVID-19 educational disruptions on student learning from spring 2020 (when most schools temporarily closed and then shifted to online instruction) through fall 2020 (the start of the 2020–21 school year). The authors note that their estimated reduction in the expected year-to-year math gains is not evenly distributed; some students may experience little loss, while others, particularly those from low-income households and students who were already low performing, may experience greater losses. The authors estimate that these more vulnerable students may have returned to school in fall 2020 already nearly a full year behind in math.

CREDO also estimates that some students may have lost up to a year of learning in math (CREDO 2020). The researchers used information based on prior years' achievement scores, days of instruction lost due to the pandemic, and projected learning losses associated with out-of-school time to estimate the amount of learning students lost by the end of the 2019–20 school year. CREDO provided estimates for 19 states and suggested that these learning losses could result from students not learning new concepts and not experiencing reinforcement of concepts already learned.

In a paper from the World Bank, researchers used data from 157 countries to estimate global learning losses due to education disruptions caused by COVID-19 and determined that students on average could lose from a third of a year to almost a full year of schooling as a result of the pandemic (Azevedo et al. 2020). They also estimated larger losses for more vulnerable groups, including ethnic minorities and students with disabilities, who could be more adversely affected by school closures.

In addition to estimating learning losses, researchers have estimated the economic impact of education losses resulting from COVID-19. These projections reflect current thinking about the economic impact of these losses, but they are based on economic conditions that are subject to change over time. As with learning loss, however, most researchers do agree that there will likely be some economic impact due to education losses resulting from the pandemic. A report from the Organisation for Economic Co-operation and Development estimates that the global closure of schools could lead to a 3% lower income for K−12 students over their lifetime and a corresponding average of 1.5% lower annual gross domestic product for countries for the remainder of the century (Hanushek and Woessmann 2020). A report from McKinsey Insights estimates that the average K−12 student in the United States could lose the equivalent of a year of full-time work income over the course of his or her lifetime, and these losses may be higher for Black and Hispanic students (Dorn et al. 2020).

This sections draws on education data from the Household Pulse Survey, a nationally representative survey conducted by the U.S. Census Bureau in collaboration with five federal agencies to gather data on the effects of COVID-19 on American households.[19] Although they are not specific to STEM classes, these data offer insight into student access to computers and the Internet as well as the amount of time families spent on education during the pandemic, both in spring 2020, immediately after the transition to distance learning for most students, and in fall 2020, when students returned to school either in person or virtually. To provide context for the pandemic-related shift to digital instruction, this section also presents data about teachers' and students' use of technology before the pandemic. These data show that the use of technology and online instruction were not widely prevalent before COVID-19 and underscore the challenges of a shift to fully remote and hybrid learning approaches during the pandemic.

Education during COVID-19

Household Pulse Survey data help illustrate how the COVID-19 pandemic affected schools, students, and families, including how schools and districts were able to make some adjustments by fall 2020 to improve access to teachers and digital devices needed for online learning. In the first week of May 2020, adults in households with children enrolled in K−12 schools reported an average of 13 hours per week spent on teaching activities with children, with Asian households reporting the lowest amount of time at about 10 hours per week. On average, students spent about 4 hours per week in live virtual contact with their teachers, but this fell to about 3 hours for households in which the respondent had less than a high school education (**Table K12-7**).

Table K12-7

Average number of hours in the past week spent on home-based education in households with children enrolled in K−12 school, by selected adult characteristics: 7−12 May 2020

(Average hours)

Adult characteristic	Average number of hours in the past week household members spent on teaching activities with children	Average number of hours in the past week students spent on all live virtual contact with their teachers
Total	13.0	4.2
Race or ethnicity		
White	13.1	5.0
Black	13.5	3.6
Hispanic[a]	12.9	5.0
Asian	9.9	5.6
Other or Two or more races	13.9	3.5
Education attainment		
Less than high school	11.3	2.6

Table K12-7

Average number of hours in the past week spent on home-based education in households with children enrolled in K–12 school, by selected adult characteristics: 7–12 May 2020

(Average hours)

Adult characteristic	Average number of hours in the past week household members spent on teaching activities with children	Average number of hours in the past week students spent on all live virtual contact with their teachers
High school	12.6	4.1
Some college or associate's degree	12.9	4.4
Bachelor's or higher degree	13.9	4.7

[a] Hispanic may be any race; race categories exclude Hispanic origin.

Note(s):
The table includes adults 18 years and older in households with children enrolled in K–12 school.

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the 2020 U.S. Census Bureau Household Pulse Survey.

Science and Engineering Indicators

In September 2020, respondents reported how much time their child spent on learning activities in the last week compared with a regular school day prior to the pandemic (**Table K12-8**). About half reported "as much," "a little bit more," or "much more" time spent, while one-fourth reported "a little bit less" time spent. More than one-fourth of respondents reported that their child spent "much less" time on learning activities compared with pre-COVID-19 instruction.

Table K12-8

Adults who reported time that their children spent on all learning activities in the past week relative to a school day before the COVID-19 pandemic, by selected adult characteristics: 16–28 September 2020

(Percent distribution)

Adult characteristic	Time that children spent on all learning activities in the past week relative to a school day before the COVID-19 pandemic				
	Much less than a school day before	A little bit less than a school day before	As much as a school day before	A little bit more than a school day before	Much more than a school day before
Total	28	24	31	10	7
Race or ethnicity					
White	27	24	33	10	6
Black	23	21	35	12	9
Hispanic[a]	34	25	25	11	6
Asian	24	30	30	8	9
Other or Two or more races	24	18	33	14	11
Education attainment					
Less than high school	28	26	32	9	5
High school	30	22	32	9	7
Some college or associate's degree	29	22	29	12	8
Bachelor's or higher degree	25	25	32	10	7
Household income					
Below $25,000	29	21	32	10	8
$25,000–$34,999	29	23	29	11	8

Table K12-8

Adults who reported time that their children spent on all learning activities in the past week relative to a school day before the COVID-19 pandemic, by selected adult characteristics: 16–28 September 2020

(Percent distribution)

Adult characteristic	Time that children spent on all learning activities in the past week relative to a school day before the COVID-19 pandemic				
	Much less than a school day before	A little bit less than a school day before	As much as a school day before	A little bit more than a school day before	Much more than a school day before
$35,000–$49,999	35	19	30	9	7
$50,000–$74,999	26	23	32	10	8
$75,000–$99,999	26	23	33	12	6
$100,000–$149,999	25	27	30	12	6
$150,000–$199,999	25	26	33	9	6
$200,000 and above	24	27	33	10	7

[a] Hispanic may be any race; race categories exclude Hispanic origin.

Note(s):
The table includes adults 18 years and older in households with children enrolled in K–12 school. Adults in households with only homeschooled children are not included. Percentages may not add to 100% because of rounding.

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the 2020 U.S. Census Bureau Household Pulse Survey.

Science and Engineering Indicators

A majority of respondents (85%) reported that their children had at least 2 days a week of live contact with their teachers, either in person or by phone or video (**Table K12-9**). More than two-thirds of respondents reported that their children had 4 days or more of contact with their teacher in the last week. However, 11% of respondents reported that their child had no contact with their teacher in the last week. In addition, live contact with teachers varied by students' household income and parental education. About 16% of households with the lowest income levels (below $25,000), as well as 20% of households in which the respondent had less than a high school education, reported no teacher contact. This compared with 6% of households at the highest income level ($200,000 and above) and 7% of households in which the respondent reported a bachelor's degree or higher.

Table K12-9

Adults who reported frequency of live contact of children with their teachers in person, by phone, or by video in the past week, by selected adult characteristics: 16–28 September 2020

(Percent distribution)

Adult characteristic	Frequency of live contact of children with their teachers in person, by phone, or by video in the past week			
	None	1 day	2–3 days	4 or more days
Total	11	4	18	67
Race or ethnicity				
White	8	4	19	68
Black	15	5	17	63
Hispanic[a]	16	3	16	65
Asian	11	4	12	74
Other or Two or more races	12	6	17	65
Education attainment				
Less than high school	20	5	21	55
High school	15	3	19	63
Some college or associate's degree	10	6	18	67

Table K12-9

Adults who reported frequency of live contact of children with their teachers in person, by phone, or by video in the past week, by selected adult characteristics: 16–28 September 2020

(Percent distribution)

Adult characteristic	Frequency of live contact of children with their teachers in person, by phone, or by video in the past week			
	None	1 day	2–3 days	4 or more days
Bachelor's or higher degree	7	3	16	74
Household income				
Below $25,000	16	6	18	61
$25,000–$34,999	12	5	23	60
$35,000–$49,999	18	3	20	60
$50,000–$74,999	11	5	19	66
$75,000–$99,999	9	6	17	68
$100,000–$149,999	9	3	16	72
$150,000–$199,999	8	2	16	74
$200,000 and above	6	2	13	79

[a] Hispanic may be any race; race categories exclude Hispanic origin.

Note(s):
The table includes adults 18 years and older in households with children enrolled in K–12 school. Adults in households with only homeschooled children are not included. Percentages may not add to 100% because of rounding.

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the 2020 U.S. Census Bureau Household Pulse Survey.

Science and Engineering Indicators

Although the proportion of respondents indicating that their child's classes were delivered fully online declined from 73% in May 2020 to 66% in September 2020 (Table SK12-30), in the majority of households with K–12 students, the students continued to receive fully online instruction in fall 2020, which underscores the importance of understanding students' access to computers and the Internet. The percentage of respondents reporting that a computer or other digital device and the Internet were always available for children to use at home for educational purposes increased from about 70% in May 2020 to about 77% in September 2020, although these proportions varied by household characteristics (**Table K12-10**). For example, 44% of households at the lowest education level of less than high school reported in May 2020 that a computer was always available for educational purposes compared with 62% in September 2020. However, this was still lower than the 85% of households with a bachelor's degree or higher who reported the same in September 2020.

Table K12-10

Adults who reported that a computer or other digital device and the Internet were always available for children to use at home for educational purposes, by selected adult characteristics: 7–12 May 2020 and 16–28 September 2020

(Percent)

Adult characteristic	7–12 May 2020		16–28 September 2020	
	Computer or other digital device	Internet	Computer or other digital device	Internet
Total	70	72	77	76
Education attainment				
Total	70	72	77	76
Less than high school	44	52	62	67
High school	67	67	71	70
Some college or associate's degree	69	73	80	76
Bachelor's or higher degree	81	83	85	85
Selected household income levels				

Table K12-10

Adults who reported that a computer or other digital device and the Internet were always available for children to use at home for educational purposes, by selected adult characteristics: 7–12 May 2020 and 16–28 September 2020

(Percent)

Adult characteristic	7–12 May 2020		16–28 September 2020	
	Computer or other digital device	Internet	Computer or other digital device	Internet
Total	70	72	77	76
Below $25,000	57	60	65	62
$50,000–$74,999	67	70	77	76
$100,000–$149,999	84	82	87	86
$200,000 and above	90	91	92	92

Note(s):
Adults in households with only homeschooled children are not included. Percentages may not add to 100% because of rounding.

Source(s):
National Center for Science and Engineering Statistics, special tabulations (2020) of the 2020 U.S. Census Bureau Household Pulse Survey.
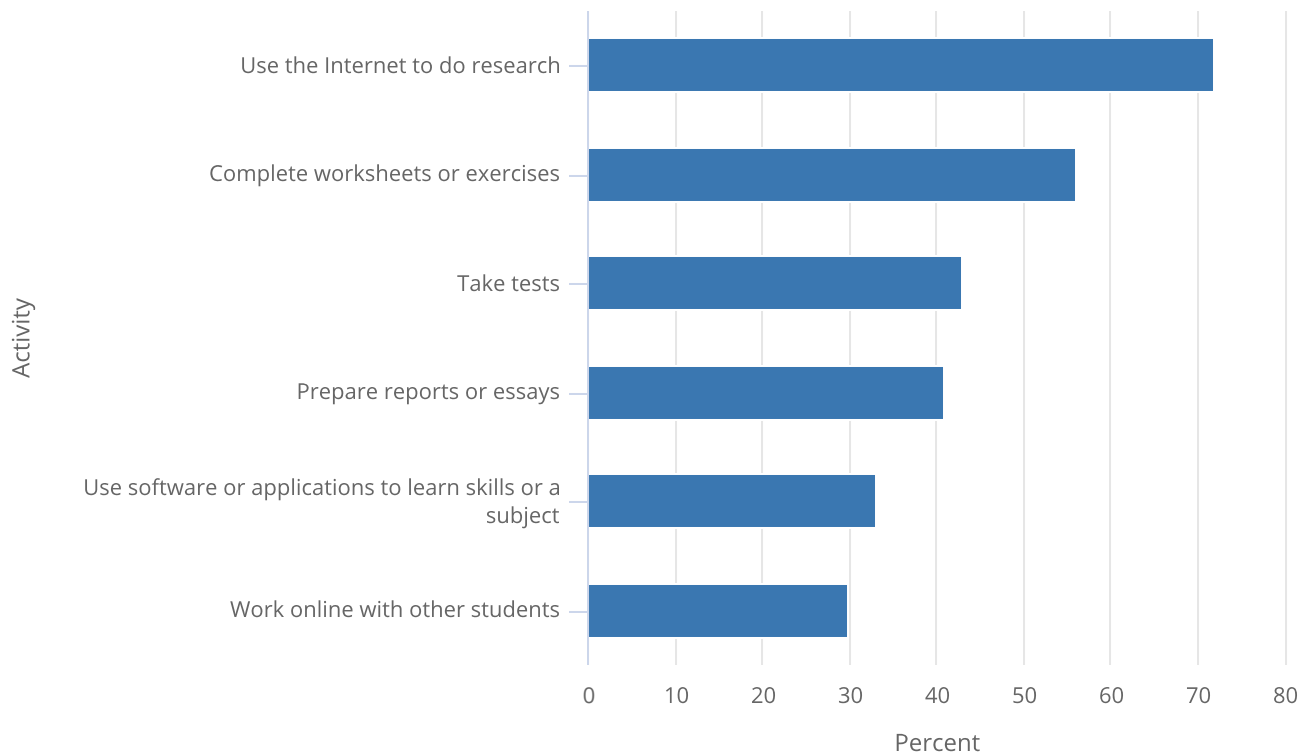
Science and Engineering Indicators

Schools and districts made progress in providing computers to students to use for educational purposes between May 2020 and the beginning of the new school year in fall 2020. About 40% of respondents reported that the child's school or district provided a computer for educational use in May 2020. That figure rose to 61% in September 2020 (Table SK12-32). The percentage of respondents reporting that the school or school district paid for Internet services changed slightly from 2% to 4% between May 2020 and September 2020, and nearly all respondents (97%) reported paying for these services themselves in both months.

Student and Teacher Use of Technology Prior to COVID-19

Pre-COVID-19 data on eighth-grade students' use of the Internet and computers to complete various learning activities indicate that there may have been a significant learning curve involved in the shift to remote instruction, when most schoolwork needed to be completed online. The 2018 ICILS offers insight into how students used information and computer technology for a variety of learning activities before COVID-19 (**Figure K12-28**). Almost three-fourths of students reported using the Internet to do research at least once a week. It was less common for students to use computers for other activities, such as completing worksheets or exercises (56%), taking tests (43%), using software to learn skills or subjects (33%), and working online with other students (30%).

Figure K12-28

U.S. students in grade 8 who reported using information and communications technologies for learning activities every school day or at least once a week, by activity: 2018
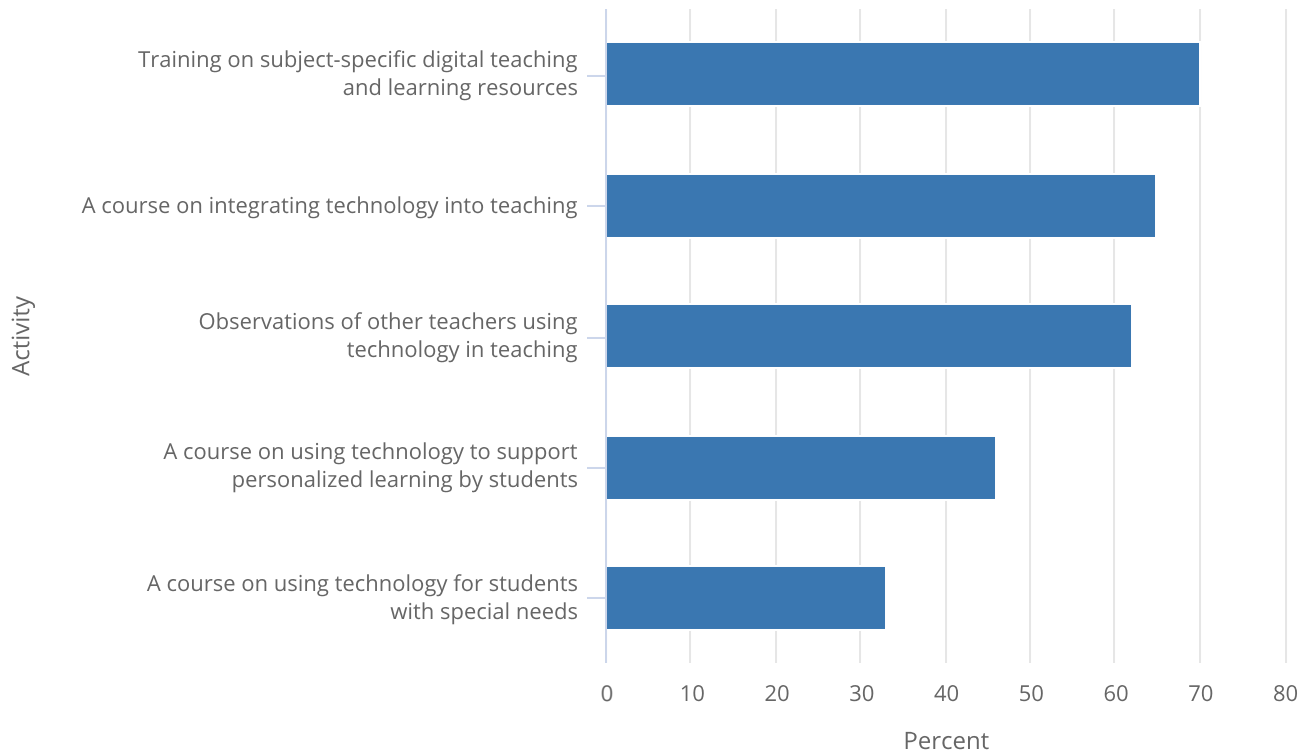
Science and Engineering Indicators

ICILS also offers insight into the extent to which U.S. eighth-grade teachers participated in professional development in using information and communications technologies (ICT) for various teaching tasks before the pandemic (**Figure K12-29**). These numbers suggest that eighth-grade teachers had some familiarity with using technology for instruction before the pandemic, although likely not at the levels needed to be fully online or responsive to the individual needs of students. About two-thirds of teachers reported participating in training on subject-specific digital resources or taking a course on integrating ICT into teaching and learning between 2016 and 2018. Less than half of teachers reported taking a course on how to use ICT to support personalized learning by students, and only a third reported taking a course on using ICT for students with special needs. About 60% of teachers reported that they had sufficient time to develop lessons incorporating technology and to develop expertise in the use of technology for teaching during the 2017–18 school year (Table SK12-35).

Figure K12-29

U.S. eighth-grade teachers who reported participating in technology-related professional learning activities at least once in the past 2 years, by type of activity: 2018

Science and Engineering Indicators

Conclusion

This report presented indicators of K−12 STEM education from a variety of sources across the spectrum of K−12 education. It explored mathematics achievement for fourth and eighth graders; computer science performance for eighth graders; U.S. mathematics, science, and computer science performance compared with that of other nations; U.S. mathematics and science teachers' qualifications; how U.S. teachers compare internationally on a variety of dimensions; and high school students' preparation for postsecondary education and the workforce. These data suggest that the United States has the potential for improvement in several areas, including ensuring that (1) all students have equal access to STEM opportunities; (2) STEM achievement continues to improve; and (3) the United States is globally competitive in K− 12 STEM education outcomes. The analyses presented here also suggest that K−12 STEM education plays a critical role in introducing students to STEM topics and preparing them to enter STEM majors and jobs.

Internationally, PISA data show that the United States ranks below other OECD countries in mathematics and science performance of 15-year-olds, although U.S. rankings in both subjects have improved since PISA was last administered in 2015. National data from NAEP indicate that mathematics performance for fourth and eighth graders has shown no overall measurable improvement since 2007. The data also indicate that underrepresented minorities and low-SES students post persistently lower test scores. Data from ICILS show a similar pattern of assessment score disparities for minority and low-income eighth graders in computer information literacy and computational thinking. Research has shown that a variety of factors contribute to the persistently lower achievement scores observed from these students. Some of these factors include exposure to trauma, inadequate medical care, disproportionate school disciplinary practices, lack of a social safety net, and attending under-resourced schools and schools with less qualified teachers (Bowman, Comer, and Johns 2018; Carnevale et al. 2019; Hanushek et al. 2020; Pearman 2020; Reardon, Kalogrides, and Shores 2019).

Data from NTPS indicate that the majority of U.S. middle school mathematics and science teachers are credentialed and trained in the subjects that they teach. Teachers at schools with high-poverty and high-minority enrollments are less likely to have degrees in the subjects they teach and are also more likely to be new teachers. The number of students taking AP examinations has increased for all STEM subjects over the past decade, although underrepresented minorities in STEM took AP exams at rates disproportionately lower than their representation in the school population.

The data reveal that student experiences in high school matter for future STEM outcomes in postsecondary education and the workforce. Analysis of HSLS:09 data shows that students who have higher confidence in their mathematics and science ability are more likely to declare a STEM major in college. Additionally, data presented in *Indicators 2020* report **Elementary and Secondary Mathematics and Science Education** showed that students who take certain STEM-related CTE courses earn higher wages in skilled technical jobs directly after high school.

Finally, the report discusses the impact of the COVID-19 pandemic on student access and learning, presenting data indicating students living in low-income households have less access to technology needed for online learning and are projected to suffer greater learning losses than students who live in higher income households. These data suggest vulnerable student populations, already at a disadvantage to other students, may be especially impacted by changes in the delivery of education as a result of the pandemic.

Glossary

Definitions

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

COVID-19: A contagious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

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

English language learner: An individual who, due to any of the reasons listed below, has sufficient difficulty speaking, reading, writing, or understanding the English language so as 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 environments where a language other than English has had a significant impact on the individual's level of English language proficiency.

GED (General Educational Development) certificate: This award is received after successfully completing the GED test. The GED program enables individuals to demonstrate that they have acquired a level of learning comparable with that of high school graduates. GED Testing Service is a joint venture of the American Council on Education, which started the GED program in 1942, and leading education company Pearson.

High school: A school that has at least one grade higher than grade 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 grade 5, and no grade higher than grade 8.

National School Lunch Program (NSLP): Established by President Truman in 1946, the NSLP is a federally assisted meal program operated in public and private nonprofit schools and residential childcare centers. To be eligible for free lunch, a student must be from a household with an income at or below 130% of the federal poverty guideline; to be eligible for reduced-price lunch, a student must be from a household with an income between 130% and 185% of the federal poverty guideline. Student eligibility for this program is a commonly used indicator of family poverty.

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.

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.

Socioeconomic status (SES): Most data sources for this report use participation in the National School Lunch Program as an indicator of socioeconomic status. For the High School Longitudinal Study of 2009 (HSLS:09), SES is a social status construct represented by an index that takes account of the student's home background as represented by parents' education, parents' occupation, and family income.

Underrepresented minorities: This category comprises racial or ethnic minority groups (Blacks or African Americans, Hispanics or Latinos, American Indians or Alaska Natives, and Native Hawaiian or Pacific Islanders) whose representation in science, technology, engineering, and mathematics (STEM) education or employment is smaller than their representation in the U.S. population.

Key to Acronyms and Abbreviations

AP: Advanced Placement

GED: General Educational Development

HSLS:09: High School Longitudinal Study of 2009

ICILS: International Computer and Information Literacy Study

K−12: kindergarten through 12th grade

NAEP: National Assessment of Educational Progress

NASEM: National Academies of Sciences, Engineering, and Medicine

NCES: National Center for Education Statistics

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

SES: socioeconomic status

STEM: science, technology, engineering, and mathematics

STW: skilled technical workforce

TALIS: Teaching and Learning International Survey

TIMSS: Trends in International Mathematics and Science Study

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Notes

1 For a comprehensive list of STEM occupations, see Table SLBR-1 in the forthcoming *Indicators 2022* report, "[2022] The STEM Labor Force of Today: Scientists, Engineers, and Skilled Technical Workers."

2 The rank assigned to all countries in a tie is the smallest of the corresponding ranks.

3 NAEP is the largest nationally representative and continuing assessment of what America's students know and can do in various subject areas. The NAEP mathematics assessment is administered to students in fourth and eighth grade every 2 years and students in 12th grade every 4 years. NAEP mathematics assessment results are reported as average scores on a 0–500 scale for fourth and eighth grades and 0–300 for 12th grade. NAEP reports student performance in two ways: scale scores, and student achievement levels. Regarding scale scores, NAEP states that "a statistically significant scale score that is higher or lower in comparison to an earlier assessment year is reliable evidence that student performance has changed" (NAEP 2018). Regarding student achievement levels, the National Assessment Governing Board (NAGB), an independent board that sets policy for NAEP, has developed three achievement levels, which are determined by score ranges that indicate students' achievement relative to expected achievement for each grade level. These score levels are: basic (partial mastery of knowledge and skills), proficient (solid academic performance at grade level), and advanced (superior academic performance). NAGB suggests that these levels are subject to refinement, and the results should be interpreted with caution. Because these achievement levels are considered provisional, they are not reported here. More information about NAEP scoring is available here: **https://nces.ed.gov/nationsreportcard/guides/scores_achv.aspx**.

4 SES is indicated by a student's eligibility for the National School Lunch Program (NSLP), with eligible students classified as low-SES students. Student eligibility for a free lunch program is a less-than-perfect measure of SES (Harwell and LeBeau 2010).

5 The U.S. Census Bureau divides the United States into four regions: Northeast, Midwest, South, and West. For more information, see **https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf**.

6 In PISA, the assessment of science literacy focuses on students' ability to engage with science-related issues, and with the ideas of science, as a reflective citizen. It requires students to engage in reasoned discourse about science and technology using their knowledge of facts and theories to explain phenomena scientifically. It also requires students to know the standard methodological procedures and patterns of reasoning used in science to evaluate or design scientific inquiries and interpret evidence. In PISA, mathematics literacy is defined as students' capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena.

7 PISA measures the performance of 15-year-old students in reading, mathematics, and science. PISA technical standards require that students in the sample be from 15 years and 3 months to 16 years and 2 months at the beginning of the testing period; thus, students in the United States were sampled on the basis of age rather than grade level. The assessment aims to measure students' ability to apply their knowledge to solving problems. PISA is coordinated by OECD and conducted every 3 years. The assessment was first implemented in 2000 and, as of 2018, includes 79 education systems. Education systems include both countries and selected cities within countries. PISA also provides information about students' proficiency levels. More information about these levels is available here: **https://nces.ed.gov/surveys/pisa/2018technotes-6.asp**.

8 Although it appears that PISA mathematics scores declined by 5 points, from 483 points in 2003 to 478 points in 2018, this score difference is not statistically significant, meaning that the scores are similar.

9 ICILS is a computer-based international assessment of eighth-grade students' capacities "to use information communications technologies (ICT) productively for a range of different purposes, in ways that go beyond a basic use of ICT." First conducted in 2013, ICILS assessed students' computer and information literacy (CIL) with an emphasis on the use of computers as information seeking, management, and communication tools. Twenty-one education systems around the world participated in ICILS in 2013. The second cycle of ICILS was administered in 2018 and continued to investigate CIL, with the added international optional component to assess students' computational thinking (CT) abilities, as well as how these relate to school and out-of-school contexts that support learning. The United States participated in ICILS for the first time in 2018, along with 13 other education systems. Among them, 9 education systems, including the United States, participated in the optional component of CT. ICILS is sponsored by the International Association for the Evaluation of Educational Achievement and is conducted in the United States by the National Center for Education Statistics (NCES) in the Institute of Education Sciences of the U.S. Department of Education.

10 The ICILS average score for both computer information literacy and computational thinking assessments did not include the U.S. score because the U.S. sample did not meet the guidelines of a sample participation rate of 85% needed to be included in the average score. The U.S. participation rate of 77% did meet the requirements for score validity and reporting. For more information, see https://nces.ed.gov/surveys/icils/international-requirements.asp.

11 The difference in computational thinking scores rounds to 112 points (112.35) when the more precise scores of 556.79 and 444.44 are compared.

12 The 2017–18 NTPS is a state and nationally representative sample survey of public and private K–12 schools, principals, and teachers in the 50 states and the District of Columbia. NTPS collects data on core topics, including teacher and principal preparation, classes taught, school characteristics, and demographics of the teacher and principal labor forces. It is developed by NCES, part of the Institute of Education Sciences within the U.S. Department of Education, and is conducted by the U.S. Census Bureau.

13 TALIS, sponsored by OECD, is an international, large-scale survey of teachers, teaching, and learning environments in schools. Conducted internationally in 2008, 2013, and 2018, TALIS data are based on questionnaire responses from nationally representative samples of teachers and their principals in participating countries and education systems. The United States first participated in 2013, along with 37 other education systems. The most recent round of data collection was in 2018, with 49 education systems participating.

14 Alternative teacher certification is a process by which a person is awarded a teaching license even though that person has not completed a traditional teacher certification program. In the United States, traditional teacher certification is earned through completing a bachelor's or master's degree in education, taking standardized tests, and fulfilling additional state requirements. Teachers with an alternative certification typically possess a bachelor's degree from an accredited college or university and complete an alternative certification program while teaching full time. Other state certification requirements, such as the type of education coursework or the length of practice teaching, may be modified or waived. NTPS asked respondents whether they entered teaching through an alternative route to certification program, a program that was designed to expedite the transition of nonteachers to a teaching career (e.g., a state, district, or university alternative route to certification).

15 Teachers' education is based on the International Standard Classification of Education 2011 (ISCED 2011), which defines nine education levels: level 0 = early childhood education, level 1 = primary education, level 2 = lower secondary education, level 3 = upper secondary education, level 4 = postsecondary non-tertiary education, level 5 = short-cycle tertiary education, level 6 = bachelor's degree or equivalent education, level 7 = master's degree or equivalent education, and level 8 = doctoral degree or equivalent education. More information about ISCED 2011 is available at http://uis.unesco.org/sites/default/files/documents/international-standard-classification-of-education-isced-2011-en.pdf.

16 This indicator examines the percentage of U.S. public high school students who graduate on time, as measured by the adjusted cohort graduation rate (ACGR). In this indicator, the United States includes public schools in the 50 states and the District of Columbia, except for Bureau of Indian Education schools. State education agencies calculate the ACGR by identifying the cohort of first-time ninth graders in a particular school year. The cohort is then adjusted by adding any students who immigrate from another country or 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 students in this adjusted cohort who graduate within 4 years with a regular high school diploma.

17 In 2019, 15.1% of elementary and secondary students were Black, 27.3% were Hispanic, 0.4% were Native Hawaiian or Pacific Islander, and 1.0% were American Indian or Alaska Native (Hussar et al. 2020).

18 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, 2013, and 2016, approximately 3 years after most had completed high school. These students' high school transcripts were collected in 2013, and for those who enrolled in postsecondary education after high school, their postsecondary transcripts were collected in 2017 and 2018. Combined, these data allow researchers to examine an array of young-adulthood outcomes, including whether students chose a STEM major at the postsecondary level. This analysis uses the National Science Foundation's definition of STEM majors, which includes not only mathematics, natural sciences, engineering, and computer and information sciences but also such social or behavioral sciences as psychology, economics, sociology, and political science.

19 The questionnaire is a result of collaboration between the U.S. Census Bureau and the U.S. Department of Agriculture Economic Research Service, the Bureau of Labor Statistics, the National Center for Health Statistics, NCES, and the Department of Housing and Urban Development. The Household Pulse Survey has been conducted in three phases. Data presented here are from Phase 1 and Phase 2. Each phase utilizes an overlapping weekly panel of respondents, each of whom are surveyed once per week for 3 consecutive weeks before being replaced by a new panel. Each phase is designed to be nationally representative of the U.S. population, though different panels responded in the Phase 1 and Phase 2 data collections. For more information, see https://www.census.gov/programs-surveys/household-pulse-survey/technical-documentation.html.

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