PATHS THROUGH MATHEMATICS AND SCIENCE

Patterns and Relationships in High School Coursetaking

NAEP
NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS

ies NATIONAL CENTER FOR EDUCATION STATISTICS
Institute of Education Sciences

NCES 2018-118
U.S. Department of Education

Contents

What is the High School Transcript Study?

The High School Transcript Study (HSTS) collects and analyzes transcripts from a representative sample of America's public and private high school graduates. The study is designed to inform the public about the types of courses that graduates take during high school, how many credits they earn, and their grade point averages (GPAs). The HSTS also explores the relationship between coursetaking patterns and student achievement, as measured by the National Assessment of Educational Progress (NAEP). High school transcript studies have been conducted periodically for nearly two decades, permitting the reporting of trends in coursetaking and GPA, as well as providing information about recent high school graduates. In addition to collecting transcripts, the HSTS collects student information such as gender, graduation status, race/ethnicity, and information about the schools studied.

What is the Nation's Report Card™?

The Nation's Report Card™ informs the public about the academic achievement of elementary and secondary students in the United States. Report cards communicate the findings of the National Assessment of Educational Progress (NAEP), a continuing and nationally representative measure of achievement in various subjects over time.

Since 1969, NAEP assessments have been conducted periodically in reading, mathematics, science, writing, U.S. history, civics, geography, and other subjects. NAEP collects and reports information on student performance at the national, state, and local levels, making the assessment an integral part of our nation's evaluation of the condition and progress of education. Only academic achievement data and related background information are collected. The confidentiality of individual students and their families is protected.

NAEP is a congressionally authorized project of the National Center for Education Statistics (NCES) within the Institute of Education Sciences of the U.S. Department of Education. The Commissioner of Education Statistics is responsible for carrying out the NAEP project. The National Assessment Governing Board oversees and sets policy for NAEP.

Executive Summary

Mathematics and science are critical areas of educational focus, seen by many as particularly important in preparing students for a rapidly changing, increasingly competitive global economy and society (BEST 2004; Thomasian 2011; Scott 2013). As the policy focus on science, technology, engineering, and mathematics (STEM) has grown, there is increasing need for research that describes the interrelationships between different quantitative and technical subject areas (Niess 2005; Hansen & Gonzalez 2014; Xin 2009). These relationships are important to understand because opportunities to learn in one subject may help explain student opportunities and outcomes in another (Trusty 2002). In addition, understanding course trajectories within mathematics, science, and technology provides a portrait of how students might engage with different components of STEM throughout school (Xin 2009).

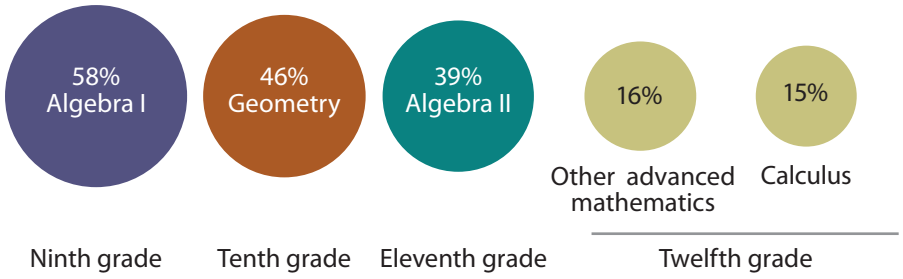
This report examines mathematics and science coursetaking in high school by providing a description of coursetaking within each of the mathematics and science subject areas across the high school years, as well as by showing the association between early mathematics coursetaking and subsequent science coursetaking. The report also describes coursetaking in engineering and technology, and the associations between coursetaking in these subject areas and in mathematics and science. Data on high school graduates from the National Assessment of Educational Progress's (NAEP's) High School Transcript Study (HSTS) serve as the basis for the report.

For the purposes of this report, individual courses taken by students were classified into levels of similar content. For example, algebra I as described in this report includes both algebra I and similar courses at that same level, including unified math 1, and algebra and geometry. For more information, see appendix A.

Pathways through Mathematics and Science

In ninth grade, most students took algebra I or a similar-level course; students were increasingly less concentrated in a single course as they progressed through high school.

Figure A. Most frequent mathematics courses completed at each grade: 2009



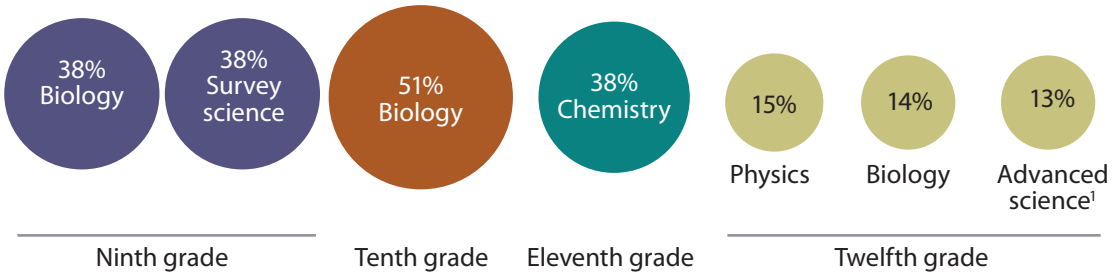
- In ninth grade, more than half of students (58 percent) took algebra I or a course at a similar level (such as unified math 1). In twelfth grade, the two most common course types were other advanced mathematics courses, which include trigonometry, statistics, and probability (16 percent), and calculus (15 percent) (figure A).
- More than one quarter (28 percent) of students did not take a mathematics course in twelfth grade.

Students completed more than 1,000 distinct 4-year high school mathematics course sequences.

- Ten percent of students each took the two most frequent mathematics sequences. From ninth to twelfth grade, they are: algebra I, geometry, algebra II, and no mathematics; and algebra I, geometry, algebra II, and precalculus.
- When examining just the first three courses in a 4-year sequence, 33 percent of students took algebra I, geometry, and algebra II in that order.
- The most frequent overall mathematics pathway (completed by 24 percent of students) was to take algebra I in the ninth grade and algebra II or a similar-level course (such as unified math 3 or linear algebra) as their highest course.

About half (51 percent) of tenth-graders earned credit in biology; twelfth-grade coursetaking was divided among physics, biology, and advanced science.

Figure B. Most frequent science courses completed at each grade: 2009



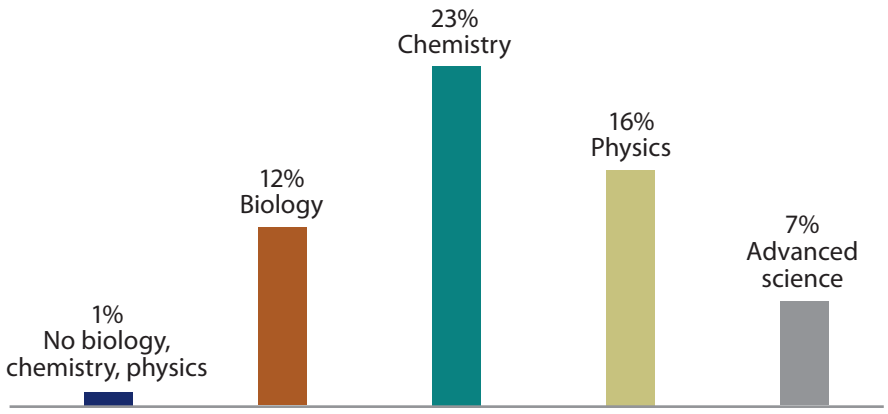
[1] Advanced science courses include Advanced Placement courses, International Baccalaureate courses, and specialized science courses such as genetics and microbiology.

- About 76 percent of ninth-grade students took one of two science courses: either survey science (38 percent) or biology (38 percent) (figure B).
- Forty-five percent of students did not earn credit in science in the twelfth grade.
- Two science pathways were the most frequently completed by students. Fifteen percent of students began with survey science in the ninth grade and reached chemistry as their highest level science course. Another 15 percent began with biology and reached physics.

Relationships Between Mathematics and Science

Students who completed algebra I in the ninth grade completed a range of science courses by the end of high school.

Figure C. Percentage of high school graduates who completed algebra I in grade 9 and given level of science by the end of high school: 2009



- The largest percentage of students (23 percent) took algebra I in the ninth grade and reached chemistry as their highest level course. The second largest percentage of students (16 percent) began with algebra I and reached physics.

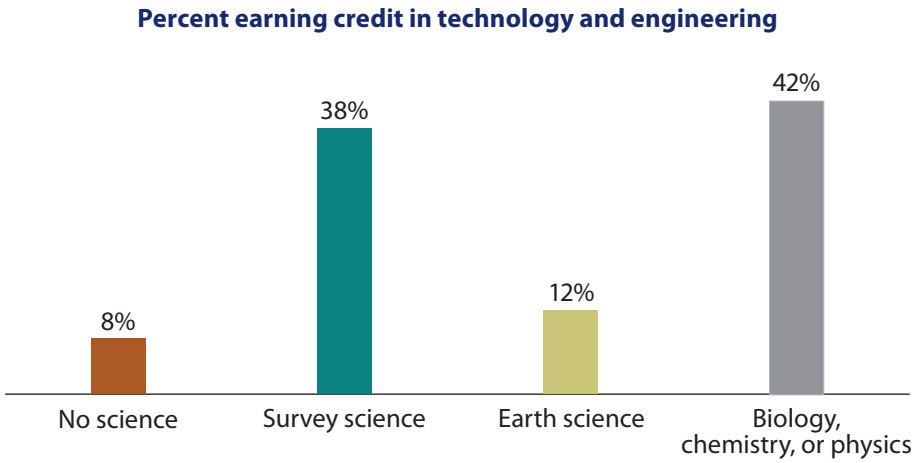
High-level mathematics and science courses were reached together more frequently than a mix of high-level and low-level mathematics and science.

- Nine percent of students reached both calculus and advanced science such as Advanced Placement or International Baccalaureate science courses; in contrast, 2 percent reached calculus and chemistry only (no physics or advanced science courses).
- Chemistry and physics were often reached with different levels of mathematics courses. The most common combination of highest mathematics and science courses reached was algebra II and chemistry, completed by 14 percent of students. An additional 6 percent of students completed chemistry and other advanced mathematics, and 7 percent completed chemistry and precalculus.

Technology and Engineering

Students who earned no science credit in ninth grade were less likely than their peers to earn credit in technology and engineering courses.

Figure D. Percentage of high school graduates who earned credits in technology and engineering, by ninth-grade science course taken: 2009



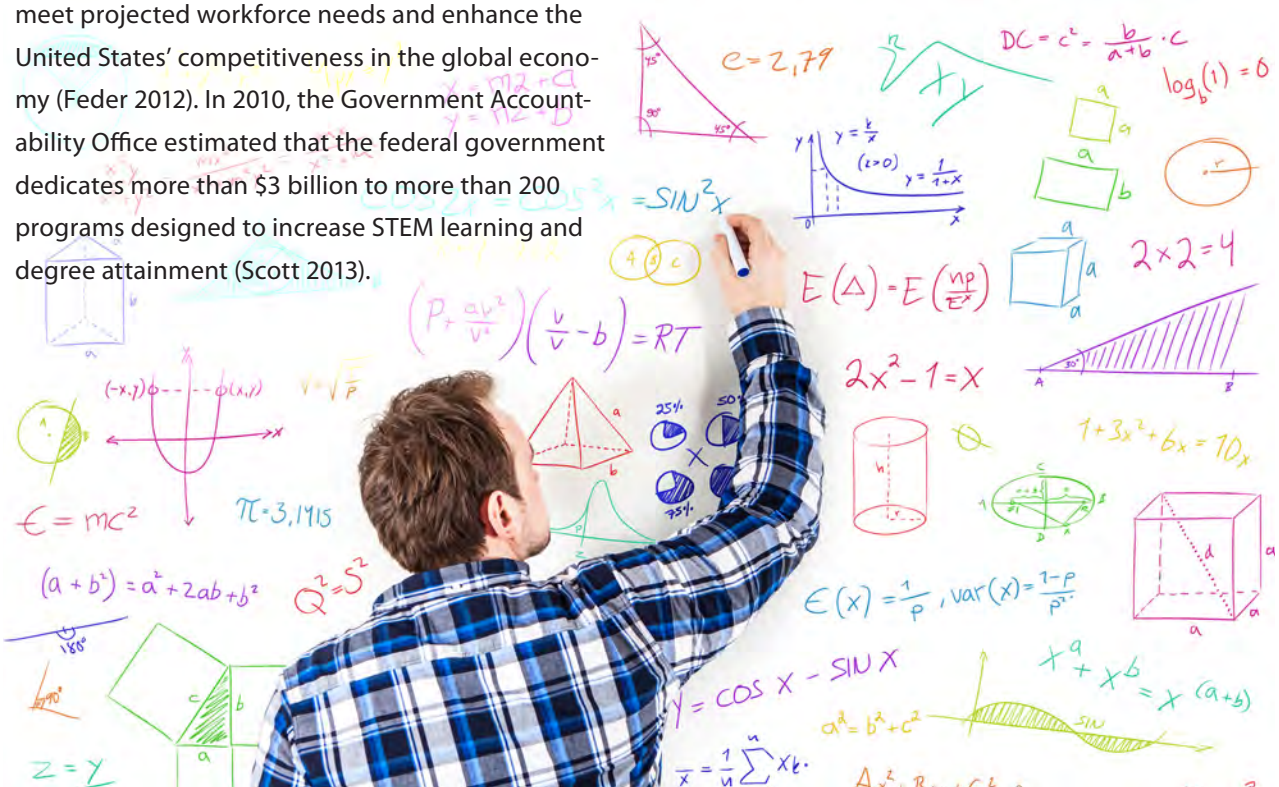
- Similarly, compared with students who completed a course below algebra I or no mathematics in the ninth grade, students who completed geometry or higher in the ninth grade took computer science more often (17 vs. 21 percent, respectively).
- Overall, 93 percent of students attended a school that offered a course in a technology or engineering field. The majority of students attended schools that offered courses in computer science (85 percent).

Introduction

Mathematics and science coursetaking during high school is associated with subsequent educational success. Students who take advanced mathematics and science courses in high school have higher 12th-grade assessment scores in these subjects, are more likely to enroll in college, and are more likely to complete a bachelor's degree (Bozick and Lauff 2007; Chen 2009; Nord et al. 2011). Advanced coursetaking in mathematics and science during high school is also associated with greater labor market returns and higher job satisfaction (Altonji, Blom, and Maghir 2012; National Research Council 2012).

Mathematics and science education have become focal areas in education policy in recent years, especially in the context of preparing students to be successful in STEM (science, technology, engineering, and mathematics) careers (U.S. Government Accountability Office 2014; Kuenzi 2008; Thomasian 2011). For example, in 2012, the Obama administration had set a goal of increasing by 1 million the number of students who earn undergraduate degrees in STEM fields from 2012–2022 in order to meet projected workforce needs and enhance the United States' competitiveness in the global economy (Feder 2012). In 2010, the Government Accountability Office estimated that the federal government dedicates more than $3 billion to more than 200 programs designed to increase STEM learning and degree attainment (Scott 2013).

Although the predominant literature on high school mathematics and science coursetaking focuses on individual fields and not on the relationships among them (Xin 2009; Hansen and Gonzalez 2014), these relationships are important to understand because coursetaking patterns in one subject may help to explain student trajectories in another. In addition, it's important to better understand the coursetaking sequences within mathematics and science and how students' trajectories in these subjects develop during high school (Newton 2010; Schneider, Swanson, and Riegle-Crumb 1997). This report examines mathematics and science coursetaking in high school by providing a description of coursetaking within each of the mathematics and science subject areas across the high school years, as well as by showing the association between early mathematics coursetaking and subsequent science coursetaking. Given the recent focus on STEM education, this report also describes coursetaking in engineering and technology, and the associations between coursetaking in these subject areas and in mathematics and science.



Understanding the Results

This report presents results from the 2009 National Assessment of Educational Progress (NAEP) High School Transcript Study (HSTS), which includes a nationally representative sample of 37,700 high school graduates representing approximately 3 million 2009 public and private high school students. All of the analyses presented in this report only include data for graduates who earned regular or honors diplomas. Graduates who received a special education diploma or certificate of completion (or attendance) were not included. The analytic sample was weighted to represent the high school graduating class of 2009, who are referred to as "students" throughout this report.

The NAEP HSTS applies consistent methods for classifying courses. High school courses vary by content and level, even among those with similar titles. Therefore, to compare the thousands of transcripts included from schools in the NAEP HSTS sample and to ensure that each course is uniquely identified, a common course coding system, the Classification of Secondary School Courses (CSSC), was used. For the purposes of this report, individual CSSC courses were further classified into levels of similar content, as defined in appendix A. For example, algebra I as described in this report includes both algebra I courses as well as similar courses at that same level, including unified math 1, and algebra and geometry. It is important to note that course titles do not capture all of the variation in coursetaking experience. For example, algebra I in the ninth grade may be designated as remedial or honors level courses (designations not captured by NAEP HSTS) and reflect different curricular experiences (Tyson and Roksa 2016).

High schools also vary in the way they assign course credits, so the NAEP HSTS also applied consistent methods for reporting course credits. Course credits were converted to standardized Carnegie units or credits, in which a single unit equals 120 hours of classroom time over the course of a year. In this report, findings are reported only for courses in which credit was earned.

All differences in coursetaking discussed in this report are determined to be statistically significant ($p < .05$). No adjustments were made for multiple comparisons. Information on interpreting figure results is provided in the notes below each figure. The symbol (*) is used in tables and figures to indicate selected statistically significant differences. More information about the NAEP HSTS and the analytic methods used in this report can be found in the Technical Notes.

Pathways Through Mathematics and Science

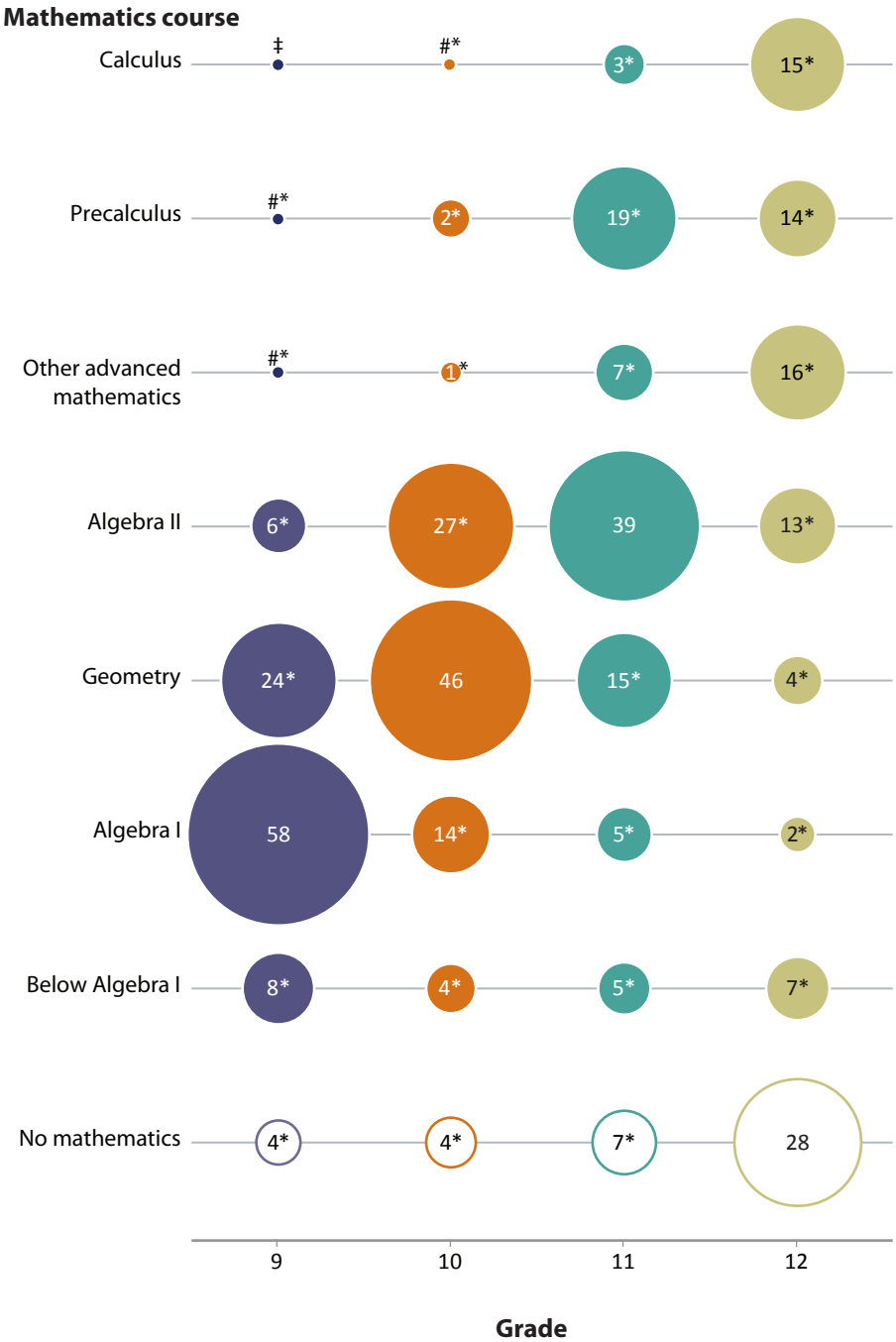
Prior studies have shown that reaching advanced mathematics and science courses depends on early coursetaking choices (Bozick and Ingels 2008; Stevenson, Schiller, and Schneider 1994; Leow et al. 2004). However, the pathways that students take in mathematics and science through high school can vary substantially. This section examines mathematics and science coursetaking separately. Coursetaking in each subject is examined by grade and as an overall pathway.

Mathematics Coursetaking by Grade

The mathematics coursetaking pattern most commonly expected for high school students is algebra I in the ninth grade, geometry in the tenth grade, algebra II in the eleventh grade, and higher level courses (i.e., trigonometry, precalculus, or calculus) in the twelfth grade (Domina and Saldana 2012). This pattern reflects the progression in focus on specific mathematics topics and the cognitive complexity of skills required to complete tasks within each course. However, the courses that students take are also influenced by students' mathematics coursetaking and achievement in middle school grades, high school course offerings, graduation requirements, and personal interest and motivation (Lee et al. 1998; Newton 2010). Therefore, this expected coursetaking pattern may not be common to all students. This section of the report describes student mathematics coursetaking patterns by showing the distribution of mathematics courses completed in each grade and the grade-to-grade course progressions of students. Note that courses referenced in this section represent a set of courses taken at that level—e.g., "algebra I" includes both algebra I courses as well as

In ninth grade, most students took algebra I or a similar-level course; students were increasingly less concentrated in a single course as they progressed through high school.

Figure 1. Percentage distribution of high school graduates who earned credits in various mathematics courses, by grade level: 2009



Rounds to zero.
‡ Reporting standards not met.
* Significantly different ($p < .05$) from the following courses in each grade: algebra I in ninth grade, geometry in tenth grade, algebra II in eleventh grade, and no mathematics in twelfth grade.
FIGURE READS: 58 percent of students completed algebra I or a similar-level course in ninth grade, more than any other course in that grade.
NOTE: The course categories shown in this figure are mutually exclusive. Graduates who earned credit in more than one category during one year are credited with the highest course they earned credit in that year. "Other advanced mathematics" includes algebra III, trigonometry, statistics, and probability.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

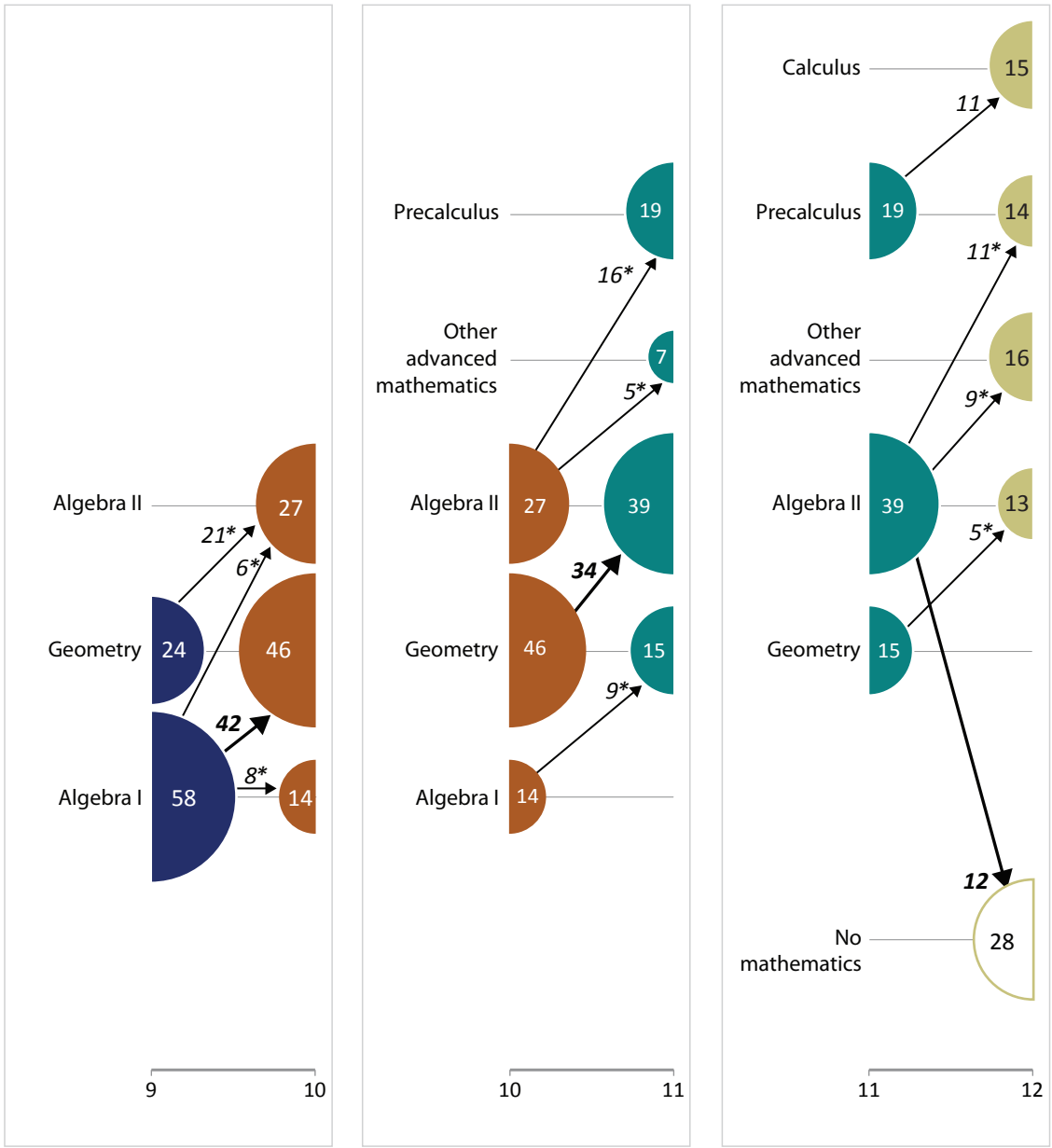
Grade-to-grade mathematics progressions were more varied between higher grades.

courses such as math 1, unified, and algebra and geometry. See appendix A for more information.

Figure 1 shows the percentage of high school students who completed various mathematics courses by grade. In the ninth grade, more than half of students completed algebra I or a similar-level course, but by the twelfth grade, most students did not complete a common mathematics course. The majority of students completed an algebra I course (58 percent) in the ninth grade, and the largest percentage of students completed a geometry course in the tenth grade (46 percent). Thirty-nine percent of students in the eleventh grade completed an algebra II course. The coursetaking patterns of twelfth-grade students were more diverse. For example, the two courses most frequently completed in the twelfth grade were calculus and other advanced mathematics, completed by 15 and 16 percent of students, respectively. However, more than one-quarter of students (28 percent) did not complete a mathematics course in the twelfth grade. This may be related to the fact that only 10 states (at the time of this study) required four credits of mathematics for graduation (NCES 2016).

Figure 2 shows the percentage of all students who progressed from one course to another as they moved from one grade to the next. Only those grade-to-grade course progressions that include 5 percent or more of students are shown (see appendix **table B-1** for all progressions). There are some clear progressions in mathematics coursetaking as students move from one grade to the next. The most frequent progression from ninth to tenth grade was algebra I to geometry (42 percent). The most frequent progression from tenth to eleventh grade was geometry to algebra II (34 percent), followed by algebra II to precalculus (16 percent). However, the grade-to-grade progressions of students between the eleventh and twelfth grade are less concentrated. The most common of these progressions are taken by 11 percent to 12 percent of students (12 percent from algebra II to no mathematics and 11 percent from precalculus to calculus). In addition, 11 percent of all students completed algebra II in the eleventh grade and then progressed to precalculus in the twelfth grade, and 9 percent completed algebra II and then other advanced mathematics.

Figure 2. Percentage of high school graduates who progressed to selected mathematics courses across grades: 2009



* Significantly different ($p < .05$) from the following course progressions across each grade pair: algebra I to geometry from ninth to tenth grade, geometry to algebra II from tenth to eleventh grade, and algebra II to no mathematics from eleventh to twelfth grade.
FIGURE READS: 42 percent of students completed algebra I or similar-level course in ninth grade followed by geometry or similar-level course in tenth grade. 58 percent of ninth-graders completed algebra I and 46 percent of tenth-graders completed geometry.
NOTE: The course categories shown in this figure are mutually exclusive. Graduates who earned credit in more than one category during one year are credited with the highest course they earned credit in that year. The arrows represent graduates progressing from one course to the next grade's course, and are shown when the percentage is 5 percent or greater. The full results for mathematics course progressions are shown in appendix table B-1. "Other advanced mathematics" includes algebra III, trigonometry, statistics, and probability.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

Overall Mathematics Pathways

This section examines the overall course pathways completed by students, in two ways. First, it examines the full 4-year mathematics course sequences completed during high school. Next, comparisons of the beginning and ending points of students' mathematics coursetaking are presented—that is, the course that students completed in the ninth grade compared with the highest level course that they completed by the end of high school.

Table 1 shows the percentage of students who completed the most frequent 4-year mathematics course sequences. About 10 percent each of students earned credit in the two most frequent sequences. The order of those sequences is algebra I, geometry, algebra II, and no mathematics and algebra I, geometry, algebra II, and precalculus. Note that the course names here and in other tables and figures refer to multiple courses. For example, algebra II, which is listed twice in the last pathway, may involve a two-year sequence of algebra II or courses in math 3 or linear algebra. When examining just the first 3 courses in the 4-year course sequence, one-third (33 percent) of all students earned credit in algebra I, geometry, and algebra II, in that order (data not shown in table). An additional 8 percent started their high school mathematics sequence with geometry in the ninth grade, followed by algebra II in the tenth grade, precalculus in the eleventh grade, and calculus in the twelfth grade. In addition to these five most frequent 4-year course sequences, students completed another 1,015 unique mathematics course sequences during high school. The data show that there was not one 4-year course sequence completed by most students.

Figure 3 shows the highest level course completed in high school by the ninth-grade mathematics courses in which credit was earned. Because the majority of students completed algebra I in the ninth grade (58 percent, see **figure 1**), some of the most frequent overall pathways involved this group of students. The most frequent overall mathematics pathway for students was to take algebra I in the ninth grade and algebra II as their highest level course (24 percent). Completing algebra I in the ninth grade was also a

Students completed more than 1,000 distinct 4-year high school mathematics course sequences.

Table 1. Percentage distribution of high school graduates who earned credit in various 4-year mathematics course sequences: 2009

Most frequently taken mathematics pathways	Percent
Algebra I - Geometry - Algebra II - No math	10.1
Algebra I - Geometry - Algebra II - Precalculus	9.7
Geometry - Algebra II - Precalculus - Calculus	7.8
Algebra I - Geometry - Algebra II - Other advanced mathematics	7.4
Algebra I - Geometry - Algebra II - Algebra II	3.2
All other math pathways (1,015 Total)	61.8

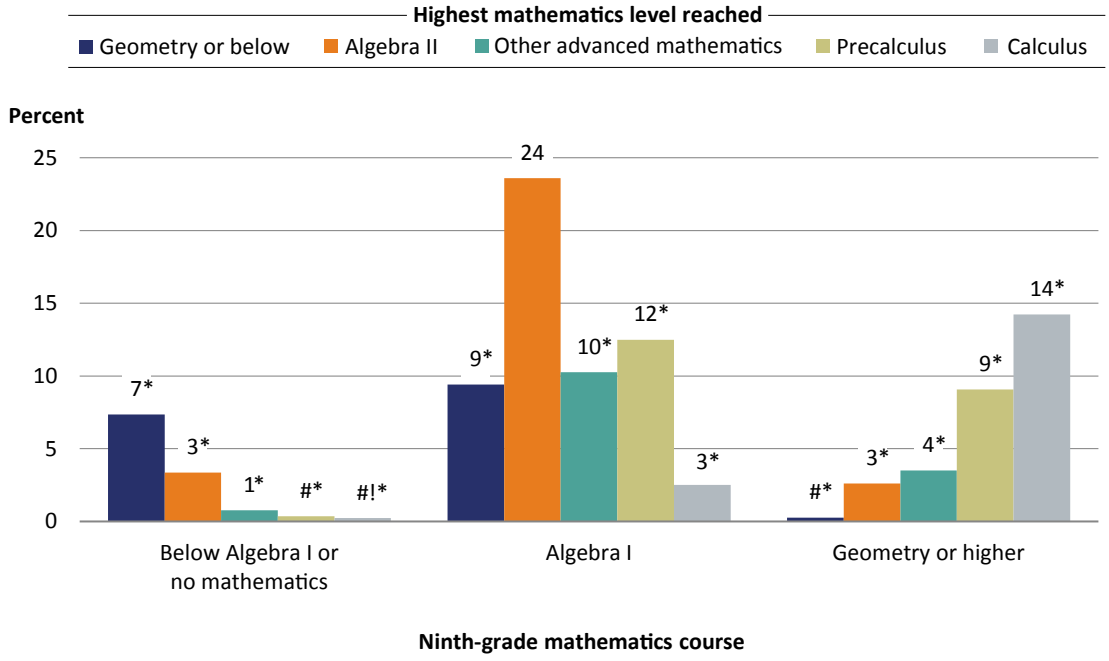
NOTE: Course labels reflect a set of courses at that level, including courses with that specific title. For example, the "Algebra II" label includes algebra II courses as well as courses in linear algebra and math 3, unified. See appendix A for more information. "Other advanced mathematics" includes algebra III, trigonometry, statistics, and probability. Other math pathways include any other combination of eight course levels, such as "Geometry – Algebra II – Precalculus – Other advanced mathematics" and "Algebra I – Geometry – Algebra II – Below algebra I."
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

Students who completed algebra I in the ninth grade subsequently took a variety of higher and lower level mathematics courses.

pathway to reaching an advanced mathematics course. Ten percent of students completed algebra I in the ninth grade and reached an advanced mathematics course below precalculus (e.g., algebra III, trigonometry, and probability or statistics) as their highest level course by the time they graduated. Another 12 percent reached precalculus, and 3 percent reached calculus. Nine percent of students completed algebra I in the ninth grade but did not take a course more rigorous than geometry. This percentage is not statistically different from the 10 percent of students who reached an advanced mathematics course below precalculus.

In contrast, fewer students earned credit in a course below algebra I in the ninth grade, or did not take a mathematics course, and reached a higher level course, such as calculus, precalculus, or an advanced mathematics course below precalculus (1 percent combined). Completing a course below algebra I or no mathematics in the ninth grade and reaching geometry or below was the most frequent lower pathway, one that was completed by 7 percent of all students. Similarly, fewer students completed geometry or above in the ninth grade and did not complete calculus, precalculus, or an advanced mathematics course below precalculus (3 percent combined) as their highest level course. Rather, 9 percent of students reached precalculus,

Figure 3. Percentage distribution of high school graduates, by ninth grade mathematics course completed and highest level of mathematics course completed: 2009



Rounds to zero.
! Interpret data with caution. The coefficient of variation (CV) for this estimate is 30 percent or greater.
* Significantly different ($p < .05$) from algebra I in the ninth-grade plus algebra II as the highest mathematics level reached.
FIGURE READS: 24 percent of all high school graduates completed algebra I in the ninth grade and algebra II as their highest course level by the end of high school, more than took algebra I in the ninth grade and geometry or below as their highest course level.
NOTE: The course categories shown in this figure are mutually exclusive. Graduates who earned credit in more than one category are credited with the highest course. "Other advanced mathematics" includes algebra III, trigonometry, statistics, and probability.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

and 14 percent reached calculus. Collectively, more students completed these two higher pathways (23 percent) than completed the lower pathways starting with courses below algebra I or no mathematics in ninth grade (12 percent).

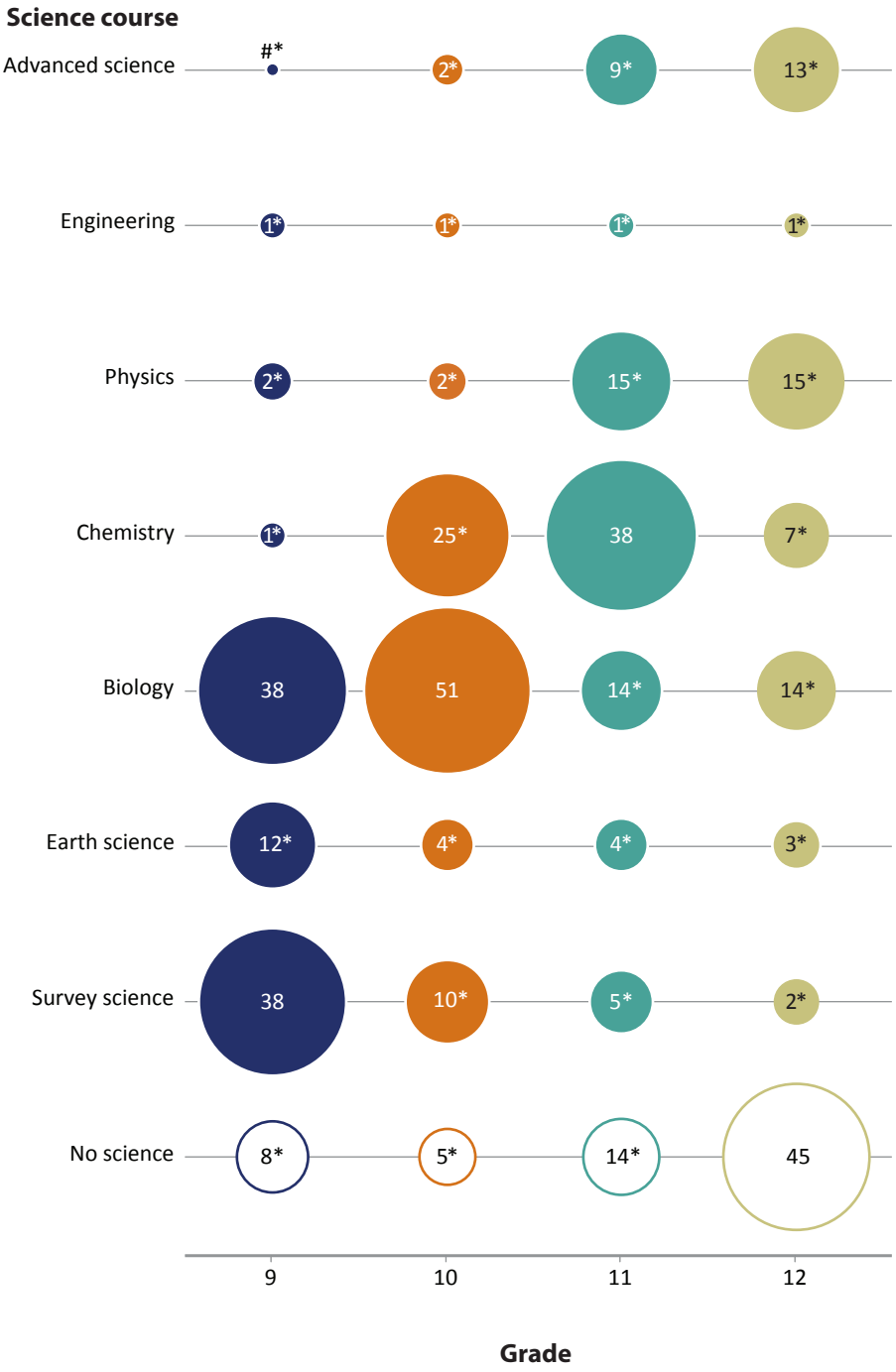
Science Coursetaking by Grade

In contrast to high school mathematics, there is no generally agreed-upon hierarchy for high school science coursetaking (Schneider, Swanson, and Riegle-Crumb 1997). The science coursetaking pattern considered most common for high school students involves a core of three courses, but not always taken in order: biology, chemistry, and physics (Kilpatrick, Quinn, and National Academy of Education 2009). In addition, whereas most students complete four courses in mathematics during high school, the average number of courses completed in science is three (Nord et al. 2011).

To provide information about how students move through this more limited, but less defined, set of science courses, this section presents the distribution of science courses completed in each grade and the most frequent grade-to-grade science progressions. Note that courses referenced in this section represent a set of courses taken at that level—e.g., "survey science" covers courses such as science, unified, and physical science. See appendix A for more information.

Figure 4 shows the percentage of high school students who completed various science courses by grade. In comparison to mathematics, science coursetaking patterns are varied. About 76 percent of ninth-grade students completed one of two science courses: either survey science (38 percent) or biology (38 percent). About half of tenth-graders (51 percent) completed biology, and 38 percent of eleventh-graders completed chemistry. However, in their senior year, 45 percent of students did not earn credit in any science course; this may be related to the

Figure 4. Percentage distribution of high school graduates who earned credits in various science courses, by grade level: 2009



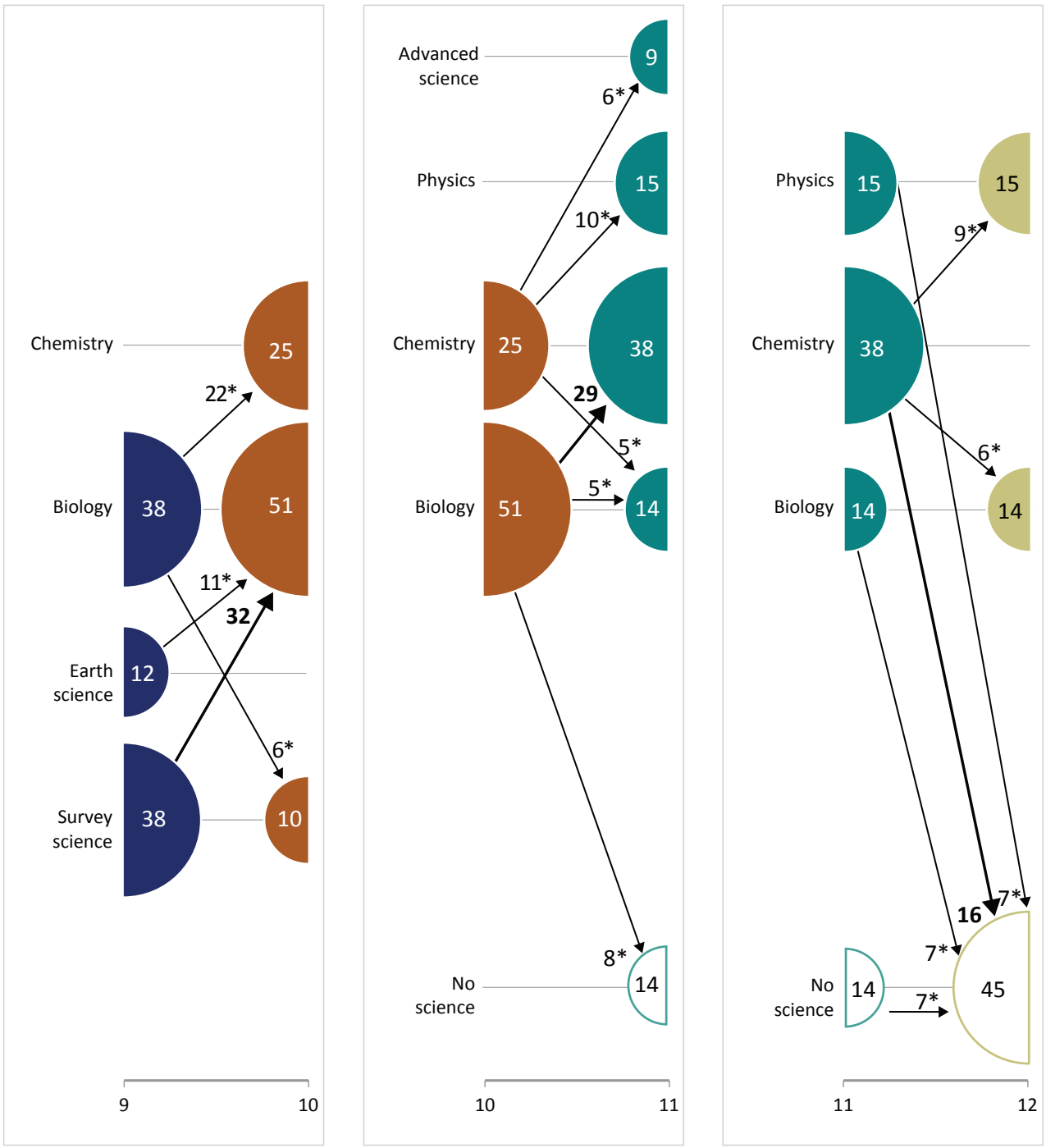
Rounds to zero.
* Significantly different ($p < .05$) from the following courses in each grade: survey science in ninth grade, biology in tenth grade, chemistry in eleventh grade, and no science in twelfth grade.
FIGURE READS: 51 percent of students completed biology or a similar-level course in tenth grade, more than any other course in that grade.
NOTE: The course categories shown in this figure are mutually exclusive. Graduates who earned credit in more than one category during one year are credited with the highest course they earned credit in that year. "Advanced science" refers to chemistry II, physics II, various advanced science topics, and Advanced Placement (AP) and International Baccalaureate (IB) courses.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

Almost half of students did not take a science course in the twelfth grade.

fact that only three states (at the time of this study) required four credits of science for graduation (NCES 2016). The most frequent twelfth-grade courses were completed by similar percentages of students: 14 percent of students completed biology; 15 percent completed physics; and 13 percent completed an advanced science course (i.e., any Advance Placement (AP) or International Baccalaureate (IB) course, advanced biology, chemistry II, or physics II).

Figure 5 shows the percentage of all students who progressed from one course to another across grades; only progressions that include 5 percent or more of students are shown (see appendix **table B-2** for all progressions). The two largest grade-to-grade progressions were from survey science in the ninth grade to biology in the tenth grade (completed by 32 percent of all students) and from biology in the tenth grade to chemistry in the eleventh grade (29 percent). In progressing from chemistry in the tenth grade, students completed several different courses: biology (5 percent), physics (10 percent), and advanced science (6 percent). As in mathematics, the progressions from the eleventh to twelfth grade were less concentrated. The most frequent science progression between the eleventh and twelfth grade was from chemistry to no science, completed by 16 percent of students. It was one of three progressions from chemistry in the eleventh grade that involved 5 percent or more of students.

Figure 5. Percentage of high school graduates who progressed to selected science courses across grades: 2009



Grade and percent moving from course to course

* Significantly different ($p < .05$) from the following course progressions across each grade pair: survey science to biology from ninth to tenth grade, biology to chemistry from tenth to eleventh grade, and chemistry to no science from eleventh to twelfth grade.

FIGURE READS: 32 percent of students completed survey science in ninth grade followed by biology or similar-level course in tenth grade. 38 percent of ninth-graders completed survey science and 51 percent of tenth-graders completed biology.

NOTE: The course categories shown in this figure are mutually exclusive. Graduates who earned credit in more than one category during one year are credited with the highest course they earned credit in that year. The arrows represent graduates progressing from one course to the next grade's course and are shown when the percentage is 5 percent or greater. The full results for science course progressions are shown in appendix table B-2. "Advanced science" refers to chemistry II, physics II, various advanced science topics, and Advanced Placement (AP) and International Baccalaureate (IB) courses.

SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

The biology-to-chemistry course progression was common throughout high school.

Though the biology-to-chemistry progression was not one of the largest progressions between the eleventh and twelfth grade, taking biology and then chemistry, regardless of the grade level in which a student takes biology, was a core science progression throughout the grade levels. Collectively, 57 percent of all students made a transition from biology-to-chemistry at some point during high school (HSTS, 2009; data not shown in figure).

Overall Science Pathways

This section discusses overall science pathways by examining 4-year science coursetaking sequences and the beginning and ending points of these sequences during high school—i.e., the relationship between the science course completed in the ninth grade and the highest level science course completed by the end of high school.

Table 2 shows the percentages of students who completed the five most frequent 4-year course sequences in science. Each 4-year science course sequence was completed by fewer than 10 percent of students. The most frequently completed 4-year course sequence, taken by 8 percent of students, was survey science in the ninth grade, biology in the tenth grade, chemistry in the eleventh grade, and no science course in the twelfth grade. Combined with the remaining science sequences, there were 1,501 unique coursetaking sequences completed by students: involving the eight course levels referenced in **figure 4**.

Figure 6 shows the percentages of students who reached various combinations of ninth-grade and highest level science courses. In this figure and subsequent results, we define course levels based on combinations of biology, chemistry, and physics, following

Students completed more than 1,500 distinct 4-year science course sequences.

Table 2. Percentage distribution of high school graduates who earned credit in the five most frequent science course pathways: 2009

Most frequently taken science pathways	Percent
Survey science - Biology - Chemistry - No science	8.0
Biology - Chemistry - Physics - No science	4.7
Survey science - Biology - Chemistry - Physics	4.5
Survey science - Biology - Chemistry - Biology	3.3
Biology - Chemistry - Physics - Advanced science	2.6
All other science pathways (1,501 total)	76.9

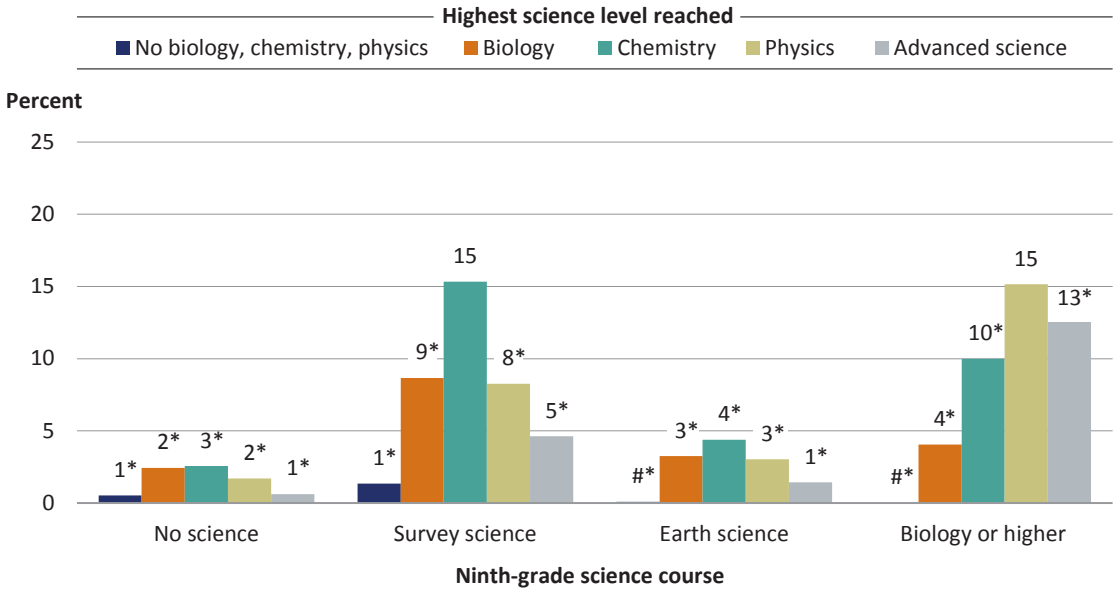
NOTE: Course labels reflect a set of courses at that level, including courses with that specific title. For example, the "Biology" label includes biology courses as well as courses in ecology and botany. See appendix A for more information. The course categories shown in this table are mutually exclusive. Graduates who earned credit in more than one category during the ninth grade are credited with the highest course. "Advanced science" refers to chemistry II, physics II, various advanced science topics, and Advanced Placement (AP) and International Baccalaureate (IB) courses. "Other science pathways" include any other combination of eight course levels, such as "Biology – Survey Science – Chemistry – Advanced science."
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

Completing biology or higher in the ninth grade was most often followed by advanced science coursetaking.

Burkam and Lee (2003). In addition, chemistry, physics, and advanced science are defined as higher than biology. However, it is important to note that individual schools or school systems may organize their science pathways differently.

Because the largest groups of students completed either survey science or biology in the ninth grade (38 percent each, see **figure 4**), the overall pathways with the largest groups of students included these ninth-grade courses. For example, 15 percent of all students began with survey science in the ninth grade and reached chemistry as their highest level science course. An additional 15 percent of all students began with biology or higher in the ninth grade and reached physics. A larger percentage of students who completed biology or higher in the ninth grade had physics or advanced science as their highest level science course than did students who completed survey, earth, or no science course in the ninth grade.

Figure 6. Percentage distribution of high school graduates who reached various levels of science, by ninth-grade science course taken: 2009



Rounds to zero.
* Significantly different ($p < .05$) from the bar representing survey science in ninth-grade and chemistry as the highest science level reached.
FIGURE READS: 15 percent of all high school graduates completed survey science in the ninth grade and chemistry as their highest course level by the end of high school, more than completed survey science in the ninth grade and biology as their highest course level.
NOTE: The course categories shown in this figure are mutually exclusive. Graduates who earned credit in more than one category are credited with the highest course. "Advanced science" refers to chemistry II, physics II, various advanced science topics, and Advanced Placement (AP) and International Baccalaureate (IB) courses.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

Specifically, the percentages of students who began with survey science and reached either physics (8 percent) or advanced science (5 percent) were smaller than the percentages whose pathway began with biology or higher and reached physics (15 percent) or advanced science (13 percent). In addition, 1 percent of students began with survey science but did not reach biology, chemistry, or physics. Of course, starting the ninth grade with biology, chemistry, or physics ensured that students completed at least one of those courses.

Relationships Between Mathematics and Science

Because mathematics and science are considered complementary subjects (Xin 2009), it is helpful to consider how coursetaking in each subject relates to the other. Here, this relationship is examined in several ways. First, the most frequent mathematics and science course pairs completed in each grade are presented. Second, the relationship between ninth-grade mathematics courses and the highest level of science reached is shown. Third, the relationship between the highest levels reached in each subject by the end of high school is examined.

Mathematics and Science Coursetaking by Grade

Mathematics and science often complement each other, with each building on skills taught by the other subject; for that reason, it is useful to examine which courses are completed simultaneously. **Table 3** presents the three most frequent mathematics and science courses taken together in each grade.

The most common mathematics and science course combination in twelfth grade involved not taking any science or mathematics courses.

Table 3. Percentage of high school graduates who earned credit in the three most frequently taken mathematics and science course combinations, by grade: 2009

Course combination	Percent
Grade 9	
Algebra I - Survey science	24.7
Algebra I - Biology	19.5*
Geometry - Biology	12.4*
Grade 10	
Geometry - Biology	26.9
Algebra II - Chemistry	12.6*
Algebra II - Biology	10.9*
Grade 11	
Algebra II - Chemistry	20.0
Precalculus - Chemistry	6.5*
Algebra II - Physics	5.5*
Grade 12	
No mathematics - No science	16.3
Other advanced mathematics - No science	6.6*
Calculus - Advanced science	6.3*

* Significantly different ($p < .05$) from the most frequently completed course combination in each grade (e.g., algebra I and survey science in ninth grade).
NOTE: "Other advanced mathematics" includes algebra III, trigonometry, statistics, and probability. "Advanced science" refers to chemistry II, physics II, various advanced science topics, and Advanced Placement (AP) and International Baccalaureate (IB) courses.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

As might be expected, the most frequently completed mathematics and science courses in each grade (as shown in **figures 1 and 4** above) constituted the most frequent mathematics and science course pairs. For example, in the ninth grade, algebra I was the most frequently completed course (58 percent, **figure 1**), and survey science was one of the two most frequently completed science courses (38 percent, **figure 4**). Considered together, algebra I and survey science were completed in the ninth grade by 25 percent of all students. Similarly, geometry and biology was the most frequent course pair in the tenth grade (taken by 27 percent of students), and algebra II and chemistry was the most frequent course pair in the eleventh grade (20 percent).

In the twelfth grade, however, the most frequently completed course pair was taking no mathematics nor science course: 16 percent of all students did not earn credit in any mathematics or science course in the twelfth grade. In addition, the second most frequent mathematics-science course pair in the twelfth grade also included taking no science: 7 percent of students completed an advanced mathematics course below precalculus along with no science. Not taking mathematics or science in the twelfth grade could be the result of students having completed their credit requirements and/or choosing to focus on other subjects.

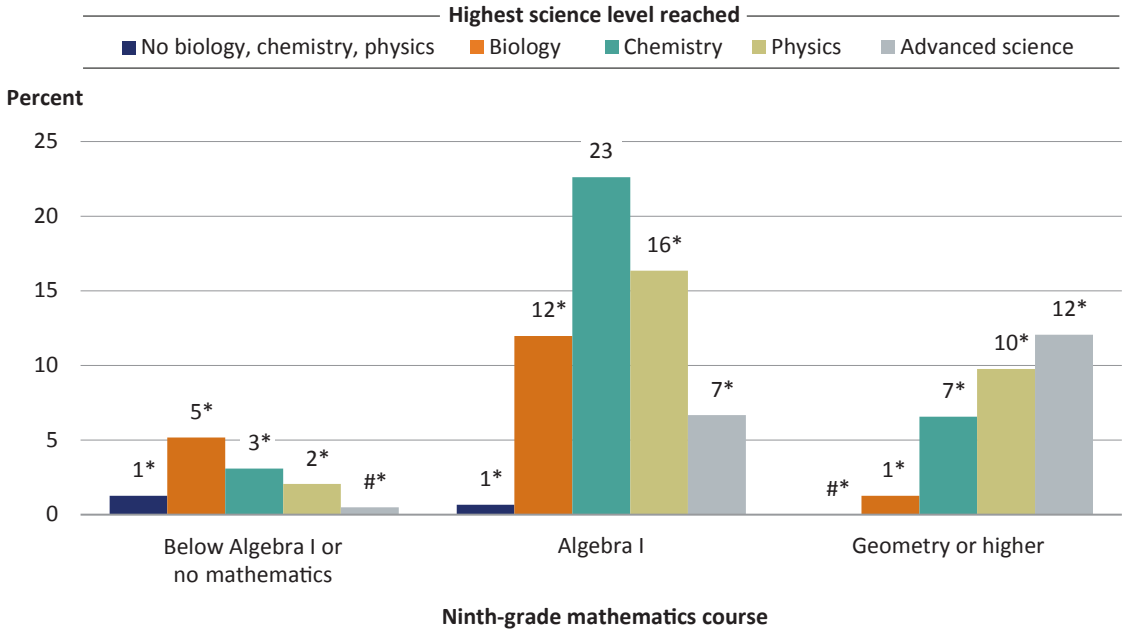
Ninth-Grade Coursetaking in Mathematics and Highest Level Science Course

Another way to examine the relationship between mathematics and science coursetaking is to compare how early high school mathematics coursetaking relates to the highest level science course reached by the end of high school. **Figure 7** shows the relationship between the mathematics course completed in the ninth grade and the highest science course completed while in high school.

As shown earlier in this report, more than half of ninth-grade students completed an algebra I course (58 percent, **figure 1**). Therefore, the relationship between ninth-grade mathematics and the highest level of science often begins with ninth-grade algebra I. The largest percentage of students (23 percent) earned credit in algebra I in the ninth grade and reached chemistry as their highest level course. The second largest percentage of students (16 percent) began with algebra I and reached physics. While 7 percent of all students reached advanced science after starting with algebra I in the ninth grade, 12 percent reached biology. Therefore, completing algebra I in the ninth grade led to a range of both lower- and higher-level science courses by the end of high school.

Students who completed algebra I in the ninth grade completed a range of science courses by the end of high school.

Figure 7. Percentage distribution of high school graduates who reached various levels of science, by ninth-grade mathematics course taken: 2009



Rounds to zero.
* Significantly different ($p < .05$) from the bar representing algebra I in the ninth grade and chemistry as the highest science level reached.
FIGURE READS: 23 percent of all high school graduates completed algebra I in the ninth grade and chemistry as their highest science course level by the end of high school, more than completed algebra I in the ninth grade and biology as their highest science course level.
NOTE: The course categories shown in this figure are mutually exclusive. Graduates who earned credit in more than one category are credited with the highest course. "Advanced science" refers to chemistry II, physics II, various advanced science topics, and Advanced Placement (AP) and International Baccalaureate (IB) courses.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

Seven percent of students completed geometry or higher in ninth grade and reached chemistry, and 10 percent reached physics, as their highest level science course. A larger percentage of students completed geometry or higher in the ninth grade and reached advanced science (12 percent) than completed algebra I in the ninth grade and reached advanced science (7 percent).

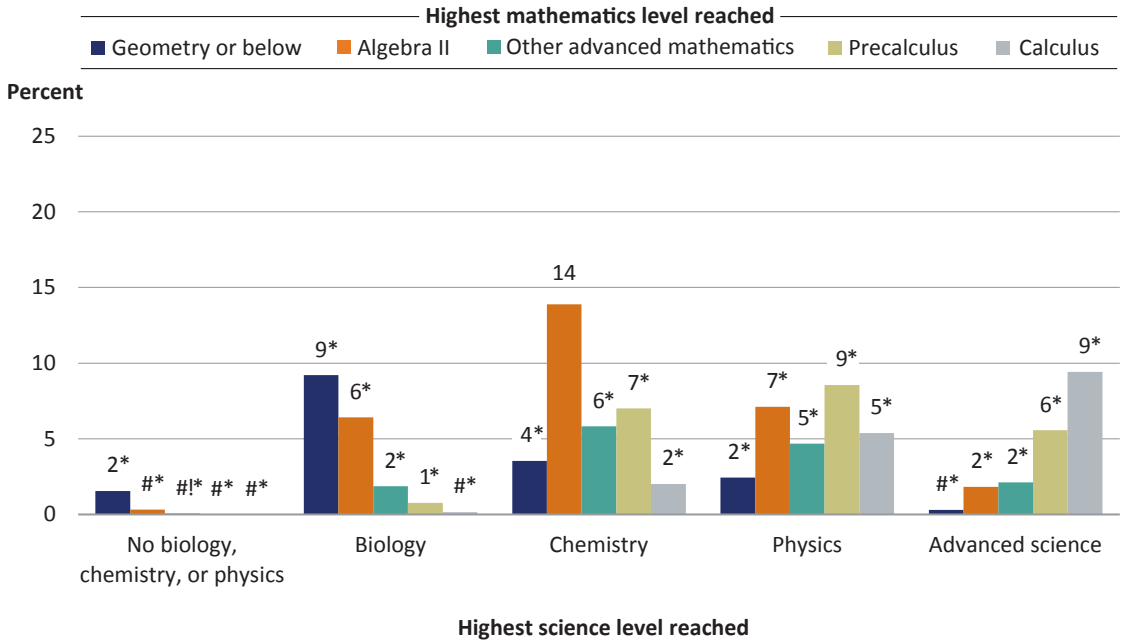
Highest Levels of Mathematics and Science Reached

The final way the relationship between mathematics and science coursetaking is explored is by examining the highest levels of mathematics and science courses reached. **Figure 8** shows the percentage of students who completed various combinations of mathematics and science by the end of high school.

Overall, the largest percentage of students (14 percent) completed algebra II and chemistry by the end of high school. Significantly smaller percentages of students completed algebra II as their highest level mathematics course and physics or advanced science as their highest level science course (7 and 2 percent, respectively). While 5 percent of students completed other advanced mathematics courses as their highest level mathematics course along with physics, a smaller percentage completed an advanced science course (2 percent). In addition, a larger percentage of students reached calculus and an advanced science course (9

High-level mathematics and high-level science were reached together more frequently than a mix of high-level and low-level mathematics or science.

Figure 8. Percentage distribution of high school graduates who reached various levels of mathematics and science, by highest science level reached: 2009



Rounds to zero.
! Interpret data with caution. The coefficient of variation (CV) for this estimate is 30 percent or greater.
* Significantly different ($p < .05$) from the bar representing chemistry as the highest science level reached and algebra II as the highest mathematics level reached.
FIGURE READS: 14 percent of all high school graduates completed chemistry as their highest science course level and algebra II as their highest mathematics course level, more than completed chemistry and geometry or below as their highest course levels.
NOTE: The course categories shown in this figure are mutually exclusive. "Advanced science" refers to chemistry II, physics II, various advanced science topics, and Advanced Placement (AP) and International Baccalaureate (IB) courses. "Other advanced mathematics" includes algebra III, trigonometry, statistics, and probability.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

Chemistry and physics were completed in combination with a range of mathematics courses.

percent) or physics (5 percent) than reached calculus along with chemistry (2 percent). For students who took precalculus as their highest level mathematics course, the percentages who completed chemistry (7 percent), physics (9 percent), or advanced science (6 percent) are all measurably different from each other. Larger percentages of students who completed advanced science reached advanced mathematics such as precalculus and calculus (6 and 9 percent, respectively) than reached lower levels of mathematics (2 percent reached algebra II). In an inverse pattern, larger percentages of students whose highest course was biology also completed geometry or below or algebra II (9 and 6 percent, respectively) than higher levels of mathematics (3 percent reached other advanced mathematics or precalculus) by the end of high school.

The patterns of highest course reached in mathematics and science are more varied for students completing chemistry or physics. The largest percentage of students overall (14 percent) completed both algebra II and chemistry, but an additional 6 percent of students completed chemistry and other advanced mathematics, and 7 percent completed chemistry and precalculus. Similarly, the distribution of students who reached physics was spread across different levels of mathematics: for example, while the largest group (9 percent) reached precalculus, another 7 percent reached algebra II.

Technology and Engineering

Technology and engineering courses include courses in career and technical education (CTE) such as computer and information sciences, engineering and science technology, and health sciences. They also include engineering courses that are often counted as part of the science curriculum. This section shows relationships between technology and engineering, mathematics, and science courses.

About one-third of students earned credit in technology and engineering.

Mathematics and science provide the basis for technology and engineering fields, and educational policy discussions often group them under the acronym STEM. However, researchers have rarely looked at the link between technology or engineering and the mathematics and science courses that serve as their foundation. To address this association, this section examines relationships between early mathematics and science courses and credits earned in STEM-related CTE areas. The technology and engineering areas examined include computer science, technical engineering and scientific technology courses, and health science courses, which have a technical focus and relate to the science of medicine. This section also includes analysis of engineering courses that are counted as part of the science curriculum (referred to as "regular engineering" in this report) in order to provide more information about its relationship to mathematics and other science subjects.

For context, **table 4** presents the percentage of students who earned any amount of course credit, the average credit earned, and the percent earning given

Table 4. Percentage of high school graduates who earned credits in technology or engineering courses, and average credits earned and percent earning given credits: 2009

Area	Percent earning credit	Among graduates with credit				
		Average credits earned	Percent earning given credits			
			0.5 or less	More than 0.5 up to 1	More than 1 up to 2	More than 2
Total in any of the four areas	**33.0***	**1.5***	**26.8***	**38.1***	**18.1***	**17.0***
Computer science	18.8	1.1	36.5	42.7	13.3	7.5
Advanced computer science	1.5*	1.1	16.9*	66.4*	12.6	4.1!*
Engineering/science technologies	10.4*	1.3*	30.2	52.1*	12.7	5.0
Health science/technology	8.1*	2.0*	20.9*	34.0*	15.4	29.7*
Engineering	3.4*	1.3*	24.8*	50.1*	16.1*	9.0

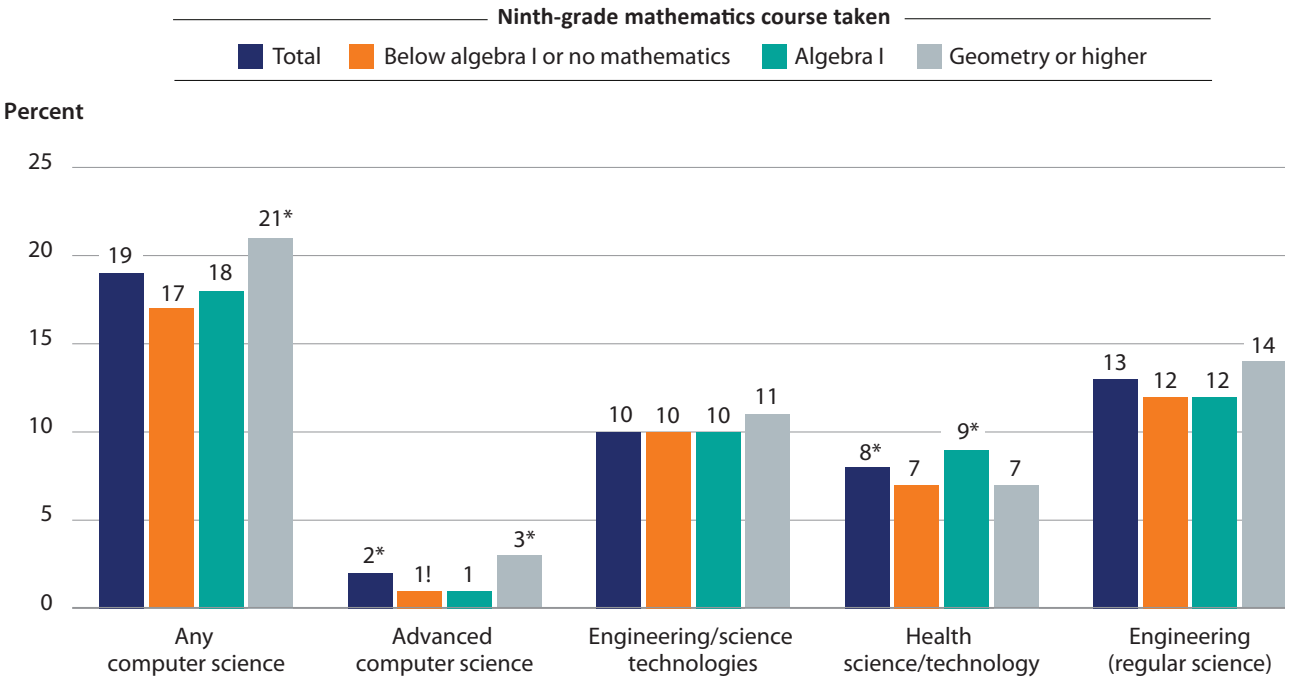
! Interpret data with caution. The coefficient of variation (CV) for this estimate is 30 percent or greater.
* Significantly different ($p < .05$) from computer science.
NOTE: The course categories shown in this table are mutually exclusive. "Advanced computer sciences" refers to Advanced Placement (AP), International Baccalaureate (IB), and courses with "advanced" in their title, and are a subset of all computer science courses.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

levels of credit in different technology and engineering courses. Overall, 33 percent of students earned credit in technology or engineering courses. Of these, students with credit earned 1.5 credits on average. These students earned relatively more credits on average in health science/technology (2.0), engineering/science technologies (1.3), and engineering (1.3) than in computer science (1.1). In health science/technology, 30 percent of students with credit earned more than 2 credits, compared to only 7.5 percent of students who did so in computer science.

A larger percentage of students completed computer science than earned credit in other technology or engineering areas, while students who completed health science courses (such as EKG technician or toxicology) earned more credits than students who completed courses in other areas. Specifically, 19 percent of students completed a computer and information sciences course, compared to 10 percent completing an engineering/science technologies course (such as electrical technology or computer-assisted design/drafting), 8 percent completing a health science/technology course, and 13 percent completing a regular engineering course (see appendix A for a list of courses comprising each area). Two percent of students earned credit in an advanced course in computer science (an AP, IB, advanced, or second- or third-year course).

Students who completed higher levels of mathematics or science in the ninth grade were more likely to earn computer and information sciences credit than those who took the lowest level courses.

Figure 9. Percentage of high school graduates who earned credits in technology and engineering courses, by ninth-grade mathematics course taken: 2009



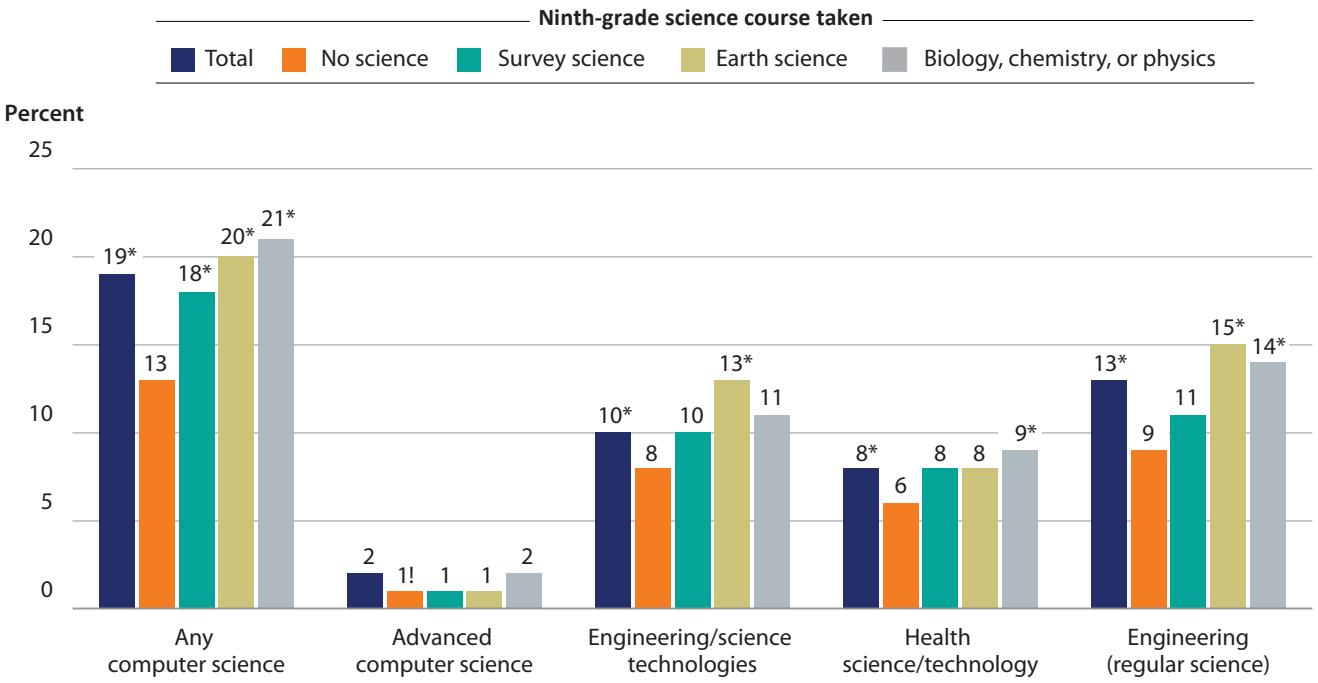
! Interpret data with caution. The coefficient of variation (CV) for this estimate is 30 percent or greater.
* Significantly different ($p < .05$) from below algebra I or no mathematics, within each technology or engineering area.
NOTE: The ninth-grade mathematics course categories shown in this figure are mutually exclusive. "Advanced computer sciences" refers to Advanced Placement (AP), International Baccalaureate (IB), and courses with "advanced" in their title. Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

Figure 9 shows the percentage of students who completed a technology and engineering course by the mathematics course taken in the ninth grade. Compared with students who completed a course below algebra I or no mathematics in the ninth grade, a larger percentage of students who completed geometry or higher in the ninth grade took computer science overall (21 vs. 17 percent) and earned credit for advanced courses in this area (3 vs. 1 percent). Otherwise, there were few measurable differences in technology and engineering course-taking by ninth-grade mathematics course.

Figure 10 shows the percentage of students who completed a technology and engineering course by the science course taken in the ninth grade. A smaller percentage of students who did not complete a science course in the ninth grade earned computer science credit (13 percent) than did their peers who completed a science course in the ninth grade (18 percent or more). A smaller percentage of the students with no science credits in the

Fewer than half of students attended schools that offered courses in advanced computer science, health science/technology, or engineering.

Figure 10. Percentage of high school graduates who earned credits in technology and engineering courses, by ninth-grade science course taken: 2009



! Interpret data with caution. The coefficient of variation (CV) for this estimate is 30 percent or greater.
* Significantly different ($p < .05$) from no science, within each technology or engineering area.
NOTE: The ninth-grade science course categories shown in this figure are mutually exclusive. "Advanced computer sciences" refers to Advanced Placement (AP), International Baccalaureate (IB), and courses with "advanced" in their title. Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

ninth grade earned credits in advanced computer science, engineering/science technologies, health science/technology, or engineering than did students who took biology, chemistry, or physics in the ninth grade. Also, a larger percentage of students who completed earth science in the ninth grade earned engineering/science technologies or engineering credit than did students who completed no science in the ninth grade.

It is important to consider students' access to technology and engineering courses in their schools. **Table 5** shows the percentage of high school students who attended schools that offered technology and engineering courses. Overall, 93 percent of students attended a school that offered a course in one of these technology or engineering fields. The majority of schools that students attended offered courses in computer science (85 percent); in contrast, 36 percent of schools offered advanced computer science courses. Smaller percentages of students attended schools that offered courses in engineering/science technologies (69 percent), health science/technology (42 percent), and engineering (39 percent).

Table 5. Percentage of high school graduates who attended schools that offered courses in technology and engineering and percent of those earning credit: 2009

Area	Percent	Among those at schools offering credit, percent earning credit
Total in any of the four areas	**92.7***	**34.1***
Computer science	85.3	21.2
Advanced computer science	36.0*	3.5*
Engineering/science technologies	69.3*	14.8*
Health science/technology	42.0*	13.9*
Engineering (regular science)	39.1*	8.6*

* Significantly different ($p < .05$) from computer science.
NOTE: "Advanced computer sciences" refers to Advanced Placement (AP), International Baccalaureate (IB), and courses with "advanced" in their title.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

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Technical Notes

The 2009 National Assessment of Educational Progress (NAEP) High School Transcript Study (HSTS) collects information about the coursetaking and course performance of nationally representative samples of public and private high school graduates. The HSTS collects and analyzes transcripts from a representative sample of America's public and private high school graduates. The HSTS also explores the relationship between coursetaking patterns and student achievement, as measured by NAEP. This report uses data collected as part of the 2009 HSTS. In 2009, HSTS collected 37,700 transcripts (from about 41,000 sampled students), representing approximately 3 million public and private high school graduates. The Technical Notes provide basic information about the samples used in this report. Further information about HSTS design, data collection procedures, and results can be found at http://www.nationsreportcard.gov/hsts_2009.

Sampling and weighting

NAEP regularly assesses the achievement of nationally representative samples of public and private students. In 2009, NAEP assessed students in mathematics, science, and reading when they were in the fourth, eighth, and twelfth grades. (For more information about NAEP, see nces.ed.gov/nationsreportcard.)

In 2009, the HSTS public school sample was a subset of the NAEP twelfth-grade public school sample members who participated in the mathematics and science assessments. Because NAEP public schools were oversampled to achieve state-level reporting of NAEP estimates, the HSTS subsample represents public school students in proportion to their prevalance in the entire twelfth-grade population. The HSTS private school sample consisted of the NAEP twelfth-grade private school sample members who participated in the mathematics and science assessments. (There was no NAEP oversampling of the private school students.)

Students were only included in the HSTS if they graduated in 2009 and if the school provided a complete transcript for the graduate. Some students who were absent or excluded from the NAEP assessments nevertheless participated in the HSTS; these students represented about 20 percent of the HSTS sample. The final weighted school response rate was 94.8 percent, and the final weighted graduate response rate was 99.3 percent.

To obtain estimates of coursetaking pathways and relationships for the national population of the graduating class of 2009, all estimates were weighted using sampling weights, which account for oversampling or undersampling of key populations and correct for bias introduced by nonresponse. Two types of weights are provided with the HSTS data file: NAEP-linked weights and HSTS sample weights. The NAEP-linked weights are appropriate for HSTS analyses that involve NAEP assessment scores. HSTS sample weights are appropriate for all other HSTS analyses (e.g., of coursetaking). Given that the analyses in this report did not include NAEP assessment or questionnaire data, a HSTS sample weight (FINSTUWT) was used for all analyses.

Analytical sample

To be consistent with previously published analyses of the NAEP HSTS data, all of the analyses presented in this report only included graduates with regular or honors diplomas. Graduates who received a special education diploma or certificate of completion (or attendance) were not included in this report. Students who did not graduate or had less than 3 years of transcript data were excluded from all of the analyses. The criteria for inclusion in the analyses for this report were established to ensure that the transcripts were complete and valid. The analyses were also restricted to those high school graduates with 16 or more earned Carnegie credits and a nonzero number of English Carnegie credits. Nine percent (weighted) of the twelfth-grade HSTS sample was excluded from the analysis based on these criteria. All of the inclusion and exclusion criteria for analyses are consistent with those used in previous reports.

Variance estimation

Estimates presented in this report are not exact measures of the graduating class of 2009 because the estimates are derived from a sample, rather than from the entire population. The error introduced by using a sample is measured by the standard error, which indicates how much the estimate would likely change if it had been based on another sample drawn in the same manner as the actual sample. Standard errors were estimated using a jackknife replication method, which involves constructing multiple subsamples (replicates) from the full sample, computing the estimate of interest for each subsample, and measuring the variability across the different estimates. Replicate subsamples were defined by variables REPWT1 through REPWT62.

Interpreting statistical significance

To distinguish differences among estimates that are likely due to sampling error from estimates due to underlying differences in the actual population, statistical tests were conducted that consider both the size of the difference and the standard errors of each estimate. For example, a seemingly large difference between two estimates may not be statistically significant if the estimates' standard errors are large (i.e., the null hypothesis of no difference cannot be rejected with confidence). Further, differences of the same size may be statistically significant in some cases but not in others, depending on the sizes of the associated standard errors.

All differences between means or percentages discussed in this report are statistically significant at the $p < .05$ level using a two-tailed t test, unless otherwise noted. In conducting the statistical significance tests used in this report, no adjustments were made for multiple comparisons. The t statistic can be computed using the following formula, where x are the estimates and SE are the standard errors of each estimate:

$$t = \frac{x_1 - x_2}{\sqrt{\left(SE_1^2 + SE_2^2\right)}}$$

Course coding

The HSTS applies consistent methods for classifying courses. High school courses vary by content and level, even among those with similar titles. Therefore, to compare the thousands of transcripts collected from schools in the HSTS sample and to ensure that each course is uniquely identified, a common course coding system, the Classification of Secondary School Courses (CSSC), was used.

Course credits were converted to standardized Carnegie units or credits, in which a single unit equals 120 hours of classroom time over the course of a year. Schools provided information on how many course credits represent a Carnegie unit at their school. Course credits recorded on the transcript were then converted into Carnegie units for the data analysis in this report.

This report examines courses taken in science, technology, engineering, and mathematics (STEM) subjects—including STEM-related career and technical education (CTE) courses. The report categorizes course codes (defined by the CSSC) into separate levels for mathematics and science and into specific fields of computer and information sciences, health sciences, and engineering technologies for STEM-related CTE. The categorization scheme used is consistent with that used in prior HSTS reports (e.g., Nord et al. 2011), as shown in appendix A.

Appendix A—STEM Course Categories

Mathematics

Below algebra I

Code	Course
270100	Math, Other General
270101	Mathematics 7 - Middle School Level
270102	Mathematics 7, Accelerated
270103	Mathematics 8 - Middle School Level
270104	Mathematics 8, Accelerated
270105	Mathematics, Basic
270106	Mathematics 1, General
270107	Mathematics 2, General
270108	Science Mathematics
270109	Mathematics in the Arts
270110	Mathematics, Vocational
270111	Technical Mathematics
270112	Mathematics Review
270113	Mathematics Tutoring
270114	Consumer Mathematics
270200	Actuarial Sciences, Other
270300	Applied Mathematics, Other
270400	Pure Mathematics, Other
270401	Pre-Algebra
270601	Basic Math 1
270602	Basic Math 2
270603	Basic Math 3
270604	Basic Math 4
279900	Mathematics, Other
320108	Mathematics, Vocational
541001	General Math Skills
541009	Functional Math Skills Not For Credit
541101	Functional Consumer Math
541109	Functional Consumer Math, Not For Credit
541201	Functional Vocational Math
541209	Functional Vocational Math, Not For Credit
562700	Special Education Math
562701	Resource General Math
562709	Resource General Math, Not For Credit
562711	Resource Vocational Math
562719	Resource Vocational Math, Not For Credit
562721	Resource Consumer Math
562729	Resource Consumer Math , Not For Credit

Algebra I

Code	Course
270402	Algebra I, Part 1
270403	Algebra I, Part 2
270404	Algebra I
270421	Math 1, Unified
270427	Unified Math 1, Part 1
270428	Unified Math 1, Part 2
270438	Algebra and Geometry
270439	Algebra Review

Geometry

Code	Course
270406	Geometry, Plane
270407	Geometry, Solid
270408	Geometry
270409	Geometry, Informal
270422	Math 2, Unified
270425	Geometry, Part 1
270426	Geometry, Part 2
270429	Pre-IB Geometry

Algebra II

Code	Course
270405	Algebra II
270414	Algebra and Trigonometry
270415	Algebra and Analytic Geometry
270417	Linear Algebra
270423	Math 3, Unified

Advanced mathematics

Code	Course
270410	Algebra III
270411	Trigonometry
270413	Trigonometry and Solid Geometry
270500	Statistics, Other
270511	Statistics
270521	Probability
270531	Probability and Statistics
270532	AP Statistics
270412	Analytic Geometry

Code	Course
270424	Math, Independent Study
270436	Discrete Math
270437	Finite Math
270442	Functions, Statistics, and Trigonometry
270443	Advanced Functions and Modeling
270440	IB Further Mathematics Standard
270441	IB Mathematics Higher
270431	IB Math Methods 1
270432	IB Math Studies 1

Code	Course
Precalculus	
270416	Analysis, Introductory
270430	Pre-IB Algebra 2/Trigonometry
270433	IB Math Studies 2
Calculus	
270418	Calculus and Analytical Geometry
270419	Calculus
270420	AP Calculus AB
270434	IB Math Studies/Calculus
270435	AP Calculus BC

Science

Code	Course
Survey science	
300100	Biological and Physical Sciences, Other
300111	Science Unified
300112	College-Prep Science Skills
300113	Science Unified Advanced
300121	Science Study Independent
400100	Physical Sciences, Other General
400111	Science 8
400121	Physical Science
400141	Physical Science, Applied
544001	Functional Science
544009	Functional Science, Not For Credit
564000	Special Education General Science
564001	Resource General Science
564009	Resource General Science, Not For Credit
400700	Miscellaneous Physical Sciences, Other
409900	Physical Sciences, Other
Earth science	
400400	Atmospheric Sciences and Meteorology, Other
400411	Meteorology
400600	Geological Sciences, Other
400611	Earth Science
400621	Earth Science, College Preparatory
400631	Geology
400632	Geology - Field Studies
400641	Mineralogy
400711	Oceanography

Code	Course
Biology	
260611	Ecology
260100	Biology, Other General
260111	Science 7
260121	Biology, Basic 1
260122	Biology, Basic 2
260131	Biology, General 1
260132	Biology, General 2
260141	Biology, Honors 1
260143	Pre-IB Biology
260151	Field Biology
260171	Biopsychology
260200	Biochemistry and Biophysics, Other
260211	Biochemistry
260300	Botany, Other
260311	Botany
260400	Cell and Molecular Biology, Other
260411	Cell Biology
260600	Miscellaneous Specialized Areas, Other Life Sciences
260621	Marine Biology
260631	Anatomy
260700	Zoology, Other
260711	Zoology
260721	Zoology, Vertebrate
260731	Zoology, Invertebrate
260741	Animal Behavior
260751	Physiology, Human
260761	Pathology

Code	Course
260771	Comparative Embryology
260781	Entomology
260791	Ornithology
269900	Life Sciences, Other

Chemistry

400131	Chemistry and Physics Laboratory Techniques
400500	Chemistry, Other
400511	Chemistry, Introductory
400512	Chemistry in the Community
400521	Chemistry 1
400523	Pre-IB Chemistry
400531	Organic Chemistry
400541	Physical Chemistry
400551	Consumer Chemistry

Physics

141211	Instrumentation Physics 1
141212	Instrumentation Physics 2
141213	Instrumentation Physics 3
141214	Instrumentation Physics 4
400200	Astronomy, Other
400211	Astronomy
400300	Astrophysics, Other
400800	Physics, Other
400811	Physics, General
400812	Principles of Technology 1
400821	Physics 1
400841	Electricity and Electronics Science
400851	Acoustics
400900	Planetary Science, Other
400911	Rocketry and Space Science
401000	Aerospace Science, Other
401011	Aerospace Science
410211	Radioactivity

Engineering

140100	Engineering, Other General
140111	Orientation to Engineering
140121	Independent Project
140200	Aerospace, Aeronautical, and Astronautical Engineering, Other
140211	Aerospace Materials
140221	Aerospace Engineering Design
140300	Agricultural Engineering, Other
140400	Architectural Engineering, Other
140411	Strength of Materials - Architectural
140500	Bioengineering and Biomedical Engineering, Other
140600	Ceramic Engineering, Other
140700	Chemical Engineering, Other
140800	Civil Engineering, Other
140900	Computer Engineering, Other
140911	Robotics
141000	Electrical, Electronics and Communications Engineering, Other
141100	Engineering Mechanics, Other
141200	Engineering Related, Other
141300	Engineering Science, Other
141400	Environmental Health Engineering, Other
141500	Geological Engineering, Other
141600	Geophysical Engineering, Other
141700	Industrial Engineering, Other
141800	Materials Engineering, Other
141900	Mechanical Engineering, Other
141911	Strength of Materials, Mechanical Technology
142000	Metallurgical Engineering, Other
142011	Metallurgy/Powder Metal Basics
142100	Mining and Mineral Engineering, Other
142200	Naval Architecture and Marine Engineering, Other
142300	Nuclear Engineering, Other
142400	Ocean Engineering, Other
142500	Petroleum Engineering, Other
142600	Surveying and Mapping Sciences
142611	Cartography
142700	Systems Engineering
142800	Textile Engineering
149900	Engineering
300300	Engineering and Other Disciplines, Other
300311	Engineering Concepts

Advanced science

260142	Biology, Advanced
260144	IB Biology 1
260145	IB Biology 2
260146	AP Biology
260161	Genetics
260181	Biology Seminar
260500	Microbiology, Other
260511	Microbiology
260622	Marine Biology, Advanced
260752	Physiology, Advanced

Code	Course
300321	IB Design Technology, Standard (SL)
300322	IB Design Technology, Higher (HL)
300623	IB Environmental Studies
400622	AP Environmental Science
400522	Chemistry 2
400524	IB Chemistry 1
400525	IB Chemistry 2
400526	AP Chemistry

Code	Course
400561	Chemistry, Independent Study
400813	Principles of Technology 2
400822	Physics 2
400823	IB Physics
400824	AP Physics B
400825	AP Physics C: Mechanics
400826	AP Physics C: Electricity/Magnetism
400831	Physics 2 Without Calculus

STEM-Related Career and Technical Education

Code	Course
	Computer science
110100	Computer and Information Sciences, Other General
110121	Computer Mathematics 1
110122	Computer Mathematics 2
110131	Computer Applications
110132	Computer Applications, Independent Study
110141	Computer Sciences 3
110142	IB Computer Science I
110143	AP Computer Science A
110144	AP Computer Science AB
110145	IB Information Technology in a Global Society I
110146	IB Information Technology in a Global Society II
110147	IB Computer Science II
110151	Artificial Intelligence
110200	Computer Programming, Other
110211	Computer Programming 1
110212	Computer Programming 2
110213	Computer Programming 3
110221	Fortran, Introduction
110231	Pascal, Introduction
110232	Advanced Pascal
110241	Basic, Introduction
110242	Advanced Basic
110251	Cobol, Introduction
110252	Advanced Cobol
110261	Logo, Introduction
110271	Rpg Programming, Introduction
110272	C Programming
110273	C++ Programming
110274	Visual Basic
110275	Oracle Programming

Code	Course
110300	Data Processing, Other
110311	Data Processing, Introduction
110312	Data Processing, Intermediate
110313	Data Processing, Advanced
110321	Computer Programming - Cooperative Education
110400	Information Sciences and Systems, Other
110500	Systems Analysis, Other
110600	Computer Programming and Website Design, Other
110601	HTML
110602	Java
110603	Web Site Design, Development
110604	Network Administration/Management 1
110605	Network Administration/Management 2
110606	Network Administration/Management 3
110607	Network Administration/Management 4
119900	Computer and Information Sciences, Other
151001	PC Operating Systems
470191	Computer Repair and Maintenance
559211	Computer Repair and Maintenance
	Health science/technology
170100	Dental Services, Other
170111	Dental Assistant 1
170112	Dental Assistant 2
170121	Dental Assistant, Cooperative
170131	Dental Technology 1
170132	Dental Technology 2
170200	Diagnostic and Treatment Services, Other
170211	First Aid
170221	EKG Technician
170300	Medical Laboratory Technologies, Other
170311	Laboratory Program 1

Code	Course
170312	Laboratory Program 2
170321	Chemical Technology 1
170322	Chemical Technology 2
170400	Mental Health/Human Services, Other
170411	Home Health Aide
170421	Community Health
170431	Mental Health Worker
170500	Miscellaneous Allied Health Services, Other
170511	Health Occupations 1
170521	Health Occupations 2
170522	Central Service Technician
170531	Medical Terminology
170551	Medical Assisting
170571	Veterinary Science
170581	Chemistry for Health Science
170591	Health Occupations, Independent Study
170592	Health Occupations - Cooperative Education 1
170593	Health Occupations - Cooperative Education 2
170600	Nursing-Related Services, Other
170611	Student Assessment of Child Health
170621	Nursing, Practical
170631	Nurse's Aide and Orderly
170641	Nurse's Aide, Cooperative
170700	Ophthalmic Services, Other
170711	Optical Services Assistant
170800	Rehabilitation Services, Other
179900	Allied Health, Other
180100	Audiology and Speech Pathology, Other
180200	Basic Clinical Health Sciences, Other
180300	Chiropractic, Other
180400	Dentistry, Other
180500	Emergency/Disaster Science, Other
180600	Epidemiology, Other
180700	Health Sciences Administration, Other
180800	Hematology, Other
180900	Medical Laboratory, Other
181000	Medicine, Other
181100	Nursing, Other
181200	Optometry, Other
181300	Osteopathic Medicine, Other
181400	Pharmacy, Other
181411	Pharmacy Technician
181500	Podiatry, Other
181600	Population and Family Planning, Other
181700	Pre-Dentistry, Other
181800	Pre-Medicine, Other
181801	Medical Ethics
181900	Pre-Pharmacy, Other

Code	Course
182000	Pre-Veterinary, Other
182200	Public Health Laboratory Science, Other
182300	Toxicology (Clinical), Other
182400	Veterinary Medicine, Other
182501	Bio-Medical Technology, General
182502	Biotechnology
189900	Health Sciences, Other
200461	Diatetic Aide
553011	General Health Occupations 1
553019	General Health Occupations 1, Not For Credit
553021	General Health Occupations 2
553029	General Health Occupations 2, Not For Credit
553031	General Health Occupations 3
553039	General Health Occupations 3, Not For Credit
553111	Health Occupations Work Study 1
553119	Health Occupations Work Study 1, Not For Credit
553121	Health Occupations Work Study 2
553129	Health Occupations Work Study 2, Not For Credit
553211	Health Occupations Work Experience 1
553219	Health Occupations Work Experience 1, Not For Credit
553221	Health Occupations Work Experience 2
553229	Health Occupations Work Experience 2, Not For Credit

Engineering/science technologies

150100	Architectural Technologies, Other
150111	Structural Engineering Technician
150200	Civil Technologies, Other
150211	Surveying
150221	Civil Engineering Technician
150300	Electrical and Electronic Technologies, Other
150311	Audio Electronics
150321	Electrical Technology
150331	Electronic Technology 1
150332	Electronic Technology 2
150333	Electronics Fabrication
150341	Electrical/Electronics Engineering Technician
150400	Electromechanical Instrumentation and Maintenance Technologies, Other
150411	Electromechanical Technology 1; Robotics Technology
150412	Electromechanical Technology 2
150421	Instrumentation Technology
150431	Computer-Assisted Design/Drafting (CAD)

Code	Course
150432	Computer-Assisted Design/Drafting (CAD) 2
150433	Computer-Assisted Design/Drafting (CAD) 3
150434	Computer-Assisted Design/Drafting (CAD) 4
150500	Environmental Control Technologies, Other
150511	Environmental Control Technologies
150600	Industrial Production Technologies, Other
150601	Industrial Research & Development; Product Creation/Improvement
150611	Industrial Production Technology 1; Manufacturing Process Technology 1
150612	Industrial Production Technology 2; Manufacturing Process Technology 2
150621	Chemical Manufacturing Technology
150631	Optics Technology
150700	Quality Control and Safety Technologies, Other
150711	Quality Control Technology
150800	Mechanical and Related Technologies, Other
150811	Automotive Design & Technology
150821	Mechanical Engineering Technology
150900	Mining and Petroleum Technologies, Other
150911	Mining Technology
150921	Petroleum Technology
159900	Engineering and Engineering-Related Technologies, Other
410100	Biological Technologies, Other
410200	Nuclear Technologies, Other
410300	Physical Science Technologies, Other
419900	Science Technologies, Other
480100	Drafting, Other
480111	Drafting 1; Mechanical Drawing 1; Projection Theory; Drafting Fundamentals
480112	Drafting 2; Mechanical Drawing 2; Projection, Applied; Drafting, Technical
480113	Drafting 3; Mechanical Drawing 3; Machine Drawing; Illustration, Technical
480114	Drafting 4; Mechanical Drawing 4
480131	Engineering Drawing 1; Engineering Drafting; Engineering Graphics 1
480132	Engineering Drawing 2; Engineering Graphics 2
480141	Blueprint Reading; Sketching and Blueprint Reading
480151	Drafting 1, Cooperative
480152	Drafting 2, Cooperative

Appendix B—Supplemental Tables

Table B-1. Percentage of high school graduates with various mathematics course paths across grades: 2009

Grade comparison and course	Latter grade (tenth, eleventh, or twelfth)							
	No mathematics	Below Algebra I	Algebra I	Geometry	Algebra II	Other advanced mathematics	Precalculus	Calculus
Ninth versus tenth grade								
No mathematics	0.3	0.4	1.9	0.8	0.2	#	#	#
Below Algebra I	0.6	2.9	4.3	0.5	0.1	#	#	#
Algebra I	2.4	0.9	7.6	41.5	5.7	0.1	#	#
Geometry	0.5	0.1 !	0.4	0.5	21.0	0.4	0.5	#
Algebra II	0.2	#	#	2.5	0.4 !	0.5	1.8	0.1 !
Other advanced mathematics	#	#	0.1 !	‡	0.1 !	‡	0.1	#
Precalculus	#	#	#	#	#	#	#	0.1
Calculus	#	#	#	#	#	#	#	#
Tenth versus eleventh grade								
No mathematics	0.5	0.4	0.8	1.4	0.9	0.1	0.1	#
Below Algebra I	0.5	1.9	1.1	0.5	0.3	#	0.1 !	#
Algebra I	1.2	0.7	1.6	8.9	1.6	0.2 !	‡	#
Geometry	3.2	1.4	1.4	2.0	34.4	1.3	2.3	0.1 !
Algebra II	1.6	0.4	0.1 !	2.2	2.2	4.8	15.6	0.6
Other advanced mathematics	0.1	#	#	0.1	0.1	0.2 !	0.6	0.1 !
Precalculus	0.1	#	#	#	#	0.2	0.2!	1.9
Calculus	#	#	#	#	#	#	#	0.1
Eleventh versus twelfth grade								
No mathematics	2.6	1.0	0.3	0.7	1.6	0.6	0.3	0.1
Below Algebra I	2.1	1.3	0.3	0.3	0.5	0.1	‡	0.1 !
Algebra I	1.4	0.7	0.4	1.3	0.9	0.3	‡	#
Geometry	4.1	1.3	0.7	1.2	5.5	1.2	0.8	‡
Algebra II	12.0	2.1	0.3	0.7	3.7	8.9	10.7	1.0
Other advanced mathematics	1.9	0.2	#	#	0.3	1.1	1.7	1.6
Precalculus	3.5	0.4	#	#	0.1	3.4	0.5	11.1
Calculus	0.6	0.1 !	#	#	#	0.9	#	1.2

Rounds to zero.
! Interpret data with caution. The coefficient of variation (CV) for this estimate is 30 percent or greater.
‡ Reporting standards not met. The coefficient of variation (CV) for this estimate is 50 percent or greater.
NOTE: The course categories shown in this table are mutually exclusive. Graduates who earned credit in more than one category during a grade are credited with the highest course. "Other advanced mathematics" includes algebra III, trigonometry, statistics, and probability.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

Table B-2. Percentage of high school graduates with various science course paths across grades: 2009

Grade comparison and course	Latter grade (tenth, eleventh, or twelfth)							
	No science	Survey science	Earth science	Biology	Chemistry	Physics	Engineering	Advanced science
Ninth versus tenth grade								
No science	1.0	1.1	0.6 !	4.5	0.5 !	0.1 !	#	#
Survey science	1.4	2.5	0.4 !	31.6	1.5	0.2	0.2	0.5 !
Earth science	0.5	0.3	0.1 !	10.7	0.4	0.1 !	‡	‡
Biology	1.9	5.8	3.1	2.8	21.8	1.3	0.3	0.7
Chemistry	#	#	#	0.4 !	#	0.3 !	#	‡
Physics	0.1 !	0.1 !	#	1.0	0.8	0.1	‡	0.1 !
Engineering	#	0.1 !	#	0.4	0.2	#	0.1	#
Advanced science	#	#	#	#	0.1 !	#	#	0.1 !
Tenth versus eleventh grade								
No science	0.9	0.5	0.4	1.7	1.3	0.3	#	0.1
Survey science	2.1	1.0	0.4	2.0	3.5	0.5	0.1 !	0.2 !
Earth science	0.8	0.2	0.1 !	0.9	1.5	0.4	#	‡
Biology	7.8	2.6	2.0	4.6	29.4	3.1	0.4	1.3
Chemistry	2.3	0.3	1.0	4.5	0.5	10.5	0.2	6.0
Physics	0.4	#	‡	0.2	0.8	0.1 !	#	0.4
Engineering	0.1 !	#	0.1 !	#	0.2	0.1	0.1	0.1
Advanced science	0.1	#	#	0.1	0.4	0.2	#	0.7
Eleventh versus twelfth grade								
No science	7.1	0.7	0.8	2.0	2.1	1.2	0.1	0.5
Survey science	2.8	0.4	0.2	0.5	0.4	0.3 !	#	0.1 !
Earth science	2.4	0.1	0.2	0.5	0.4	0.3	#	0.1
Biology	6.5	0.5	0.6	1.7	2.0	1.6	0.1 !	1.1
Chemistry	16.2	0.4	1.0	5.9	0.7	8.7	0.4	4.1
Physics	7.2	0.1	0.6	2.1	0.9	0.7	0.2	3.5
Engineering	0.4	#	#	0.1	0.1 !	0.2	0.1	0.1
Advanced science	2.0	#	0.1	1.0	0.2	1.6	0.1	3.9

Rounds to zero.
! Interpret data with caution. The coefficient of variation (CV) for this estimate is 30 percent or greater.
‡ Reporting standards not met. The coefficient of variation (CV) for this estimate is 50 percent or greater.
NOTE: The course categories shown in this table are mutually exclusive. Graduates who earned credit in more than one category during a grade are credited with the highest course. "Advanced science" refers to chemistry II, physics II, various advanced science topics, and Advanced Placement (AP) and International Baccalaureate (IB) courses.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

Table B-3. Percentage of high school graduates with various mathematics and science course combinations, by grade: 2009

	Ninth-grade science							
Ninth-grade mathematics	No science	Survey science	Earth science	Biology	Chemistry	Physics	Engineering	Advanced science
No mathematics	0.9	1.2	0.5	0.9	#	0.1	#	#
Below Algebra I	1.2	4.2	1.1	1.7	#	0.2 !	0.1	#
Algebra I	4.7	24.7	7.3	19.5	0.3 !	1.3	0.5	0.1 !
Geometry	0.9	6.4	2.6	12.4	0.3 !	0.6	0.2	0.1 !
Algebra II	0.1	1.6	0.7 !	2.8	0.2 !	0.1 !	0.1 !	0.1 !
Other advanced mathematics	#	0.1 !	#	0.2 !	‡	#	#	#
Precalculus	#	#	#	0.1 !	#	#	#	#
Calculus	#	#	#	#	#	#	#	#

	Tenth-grade science							
Tenth-grade mathematics	No science	Survey science	Earth science	Biology	Chemistry	Physics	Engineering	Advanced science
No mathematics	0.7	0.6	0.2	2.1	0.4	0.1 !	#	#
Below Algebra I	0.6	1.3	0.2	2.0	0.2	0.1	#	‡
Algebra I	1.3	2.1	1.3	8.2	1.0	0.3	0.1	0.1 !
Geometry	1.9	4.4	2.0	26.9	9.2	0.8	0.3	0.4
Algebra II	0.5	1.3	0.5	10.9	12.6	0.7	0.3	0.7
Other advanced mathematics	#	‡	#	0.5	0.5	0.1 !	#	#
Precalculus	#	#	#	0.6	1.3	0.2	0.1	0.2
Calculus	#	#	#	#	0.1	#	#	#

	Eleventh-grade science							
Eleventh-grade mathematics	No science	Survey science	Earth science	Biology	Chemistry	Physics	Engineering	Advanced science
No mathematics	2.3	0.4	0.4	1.2	1.8	0.7	0.1	0.2
Below Algebra I	1.5	1.0	0.3	1.0	0.8	0.3	#	#
Algebra I	1.5	0.5	0.5	1.3	0.9	0.3	#	#
Geometry	3.4	1.1	1.2	2.9	4.5	1.5	0.2 !	0.3
Algebra II	4.2	1.3	1.5	5.0	20.0	5.5	0.4	1.6
Other advanced mathematics	0.6	0.2 !	0.1	0.9	2.4	1.4	0.1	1.1
Precalculus	0.9	0.1	0.2	1.6	6.5	5.1	0.2	4.5
Calculus	0.1	#	#	0.2	0.7	0.6	#	1.2

	Twelfth-grade science							
Twelfth-grade mathematics	No science	Survey science	Earth science	Biology	Chemistry	Physics	Engineering	Advanced science
No mathematics	16.3	0.7	1.0	3.8	1.7	2.7	0.2	1.7
Below Algebra I	4.2	0.5	0.3	0.8	0.4	0.6	0.1	0.2
Algebra I	1.1	0.1	0.2	0.4	0.2	0.1	#	#
Geometry	2.2	0.3	0.3	0.6	0.5 !	0.3	#	0.1
Algebra II	5.8	0.4	0.6	1.9	1.7	1.5	0.2	0.6
Other advanced mathematics	6.6	0.2	0.6	2.5	1.0	2.9	0.2	2.4
Precalculus	4.8	0.1	0.4	2.3	0.8	3.4	0.2	2.2
Calculus	3.5	0.1 !	0.2	1.4	0.4	3.3	0.2	6.3

Rounds to zero.
! Interpret data with caution. The coefficient of variation (CV) for this estimate is 30 percent or greater.
‡ Reporting standards not met. The coefficient of variation (CV) for this estimate is 50 percent or greater.
NOTE: The course categories shown in this table are mutually exclusive. Graduates who earned credit in more than one category during a grade are credited with the highest course. "Advanced science" refers to chemistry II, physics II, various advanced science topics, and Advanced Placement (AP) and International Baccalaureate (IB) courses. "Other advanced mathematics" includes algebra III, trigonometry, statistics, and probability.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, High School Transcript Study (HSTS), 2009.

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This report was prepared for the National Center for Education Statistics under Contract No. ED-IES-12-D-0002 with American Institutes for Research. Mention of trade names, commercial products, or organizations does not imply endorsement by the U.S. Government

SUGGESTED CITATION

Brown, J., Dalton, B., Laird, J., and Ifill, N. (2018). *Paths Through Mathematics and Science: Patterns and Relationships in High School Coursetaking* (NCES 2018-118). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education, Washington, DC.

CONTENT CONTACT

Linda Hamilton
202-245-6360
Linda.Hamilton@ed.gov

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