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Advanced Mathematics and Science Coursetaking in the Spring High School Senior Classes of 1982, 1992, and 2004

Statistical Analysis Report

NCES 2007-312

U. S. DEPARTMENT OF EDUCATION

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AUGUST 2007

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Executive Summary

In order to take advantage of rewarding opportunities in college or the world of work, high school graduates increasingly require strong quantitative and analytical skills. As mathematical and scientific knowledge and abilities grow in value, the amount and quality of instruction American high school students receive in mathematics and science become the focus of attention. While increased academic requirements for high school graduation have long been advocated (National Commission on Excellence in Education 1983; Achieve, Inc. 2005; National Governors Association 2005), current research shows a mixed record in mathematics and science achievement among American middle and high school students relative to some of their international peers (Gonzales et al. 2004; Lemke et al. 2004; Organization for Economic Cooperation and Development 2004).

In response to these concerns and other calls for reform, states have increased the number of courses required for a high school diploma (Council of Chief State School Officers 2005).[1] Research using high school transcripts collected by the National Center for Education Statistics (NCES) indicates that states have been successful in encouraging students to take more courses in science and mathematics before graduation (Legum et al. 1998; Perkins et al. 2004; Shettle et al. 2007). However, important questions remain about trends in mathematics and science coursetaking. Are more students taking higher level courses in mathematics and science, in addition to increasing the number of courses taken? Have upward trends in coursetaking been sustained in recent years? And have disparities among student subgroups in coursetaking experiences changed over time?

This report uses in-depth information on the coursetaking patterns of high school graduates[2] in 1982, 1992, and 2004 to answer these questions. The analysis employs traditional counts of credits earned alongside measures based on the most advanced level of courses a student completed in high school in order to examine both the quantity and types of mathematics and science courses taken. Coursetaking information was derived from high school transcripts collected by NCES during three studies: the High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B), the National Education Longitudinal Study of 1988 (NELS:88), and the Education Longitudinal Study of 2002 (ELS:2002).[3] Differences in coursetaking over time or across student subgroups are only reported if the comparison met both the criteria of statistical significance (using *t* statistics with an alpha level of .05) and substantive difference (using effect sizes that are greater than .20 standard deviations for continuous variables and 5 percentage points for categorical variables). All coursetaking information is based on courses where credit was earned—meaning that the student received a passing grade according to his or her school's grading system. The major findings are summarized below.

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[1] For example, between 1987 and 2004, the number of states requiring at least 2.5 credits in mathematics more than doubled and in science more than tripled (Council of Chief State School Officers 2005).
[2] High school graduates in this report are defined as spring-term high school seniors who graduated with an honors or standard diploma by the end of the summer (August 31) of their senior year.
[3] More information on these studies can be found on the National Center for Education Statistics (NCES) World Wide Web home page at http://nces.ed.gov.

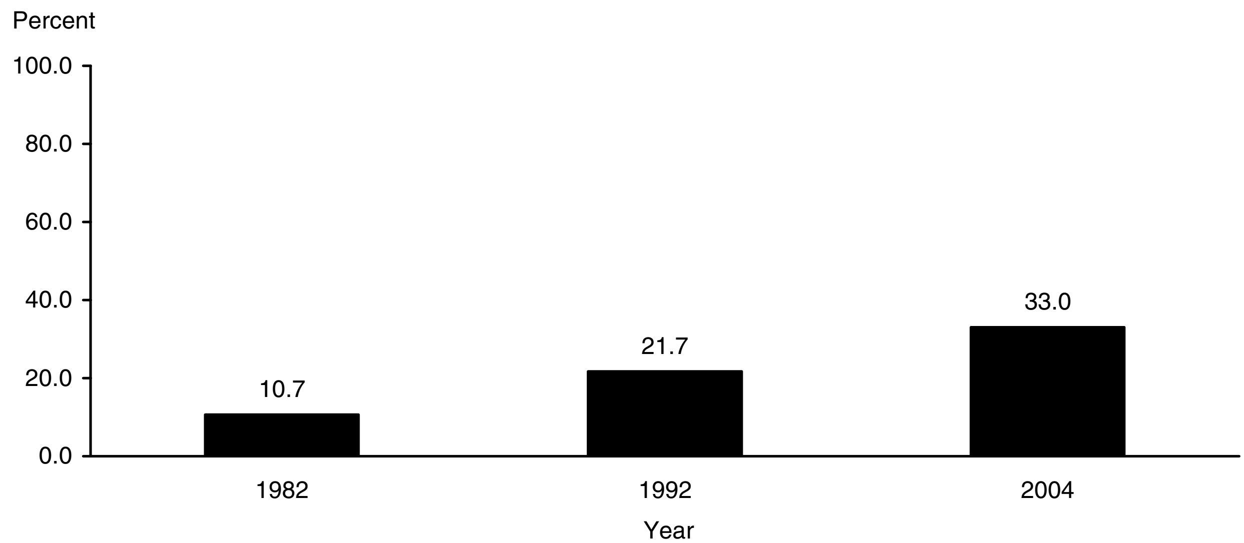
Mathematics Coursetaking Overall

High school graduates' completion of mathematics courses clearly increased across the three cohorts studied in this report. Graduates came much closer to taking 4 full years of academic coursework in mathematics, moving from, on average, 2.7 total credits in mathematics in 1982 to 3.6 total credits in 2004.

In addition, graduates shifted from taking lower level mathematics courses to taking more advanced courses.[4] For example, the percentage of graduates who persisted through the mathematics curriculum into the two most advanced levels—precalculus and calculus—tripled between 1982 and 2004 (figure A). Moreover, the upward trend in high-end mathematics coursetaking occurred in both time periods—the percentage of graduating seniors completing precalculus or calculus increased 11 percentage points between 1982 and 1992 and between 1992 and 2004.

Accompanying the increase in advanced-level mathematics coursetaking was a significant drop in the percentage finishing high school with one of the two lowest levels of mathematics courses completed (no or low academic mathematics, or algebra I/plane geometry). In 1982, over half of graduates (56 percent) finished high school with algebra I or less as their highest course, while by 2004 only 23 percent of graduates finished at these low levels.

Figure A. Percentage of high school graduates who completed precalculus or calculus: 1982, 1992, and 2004



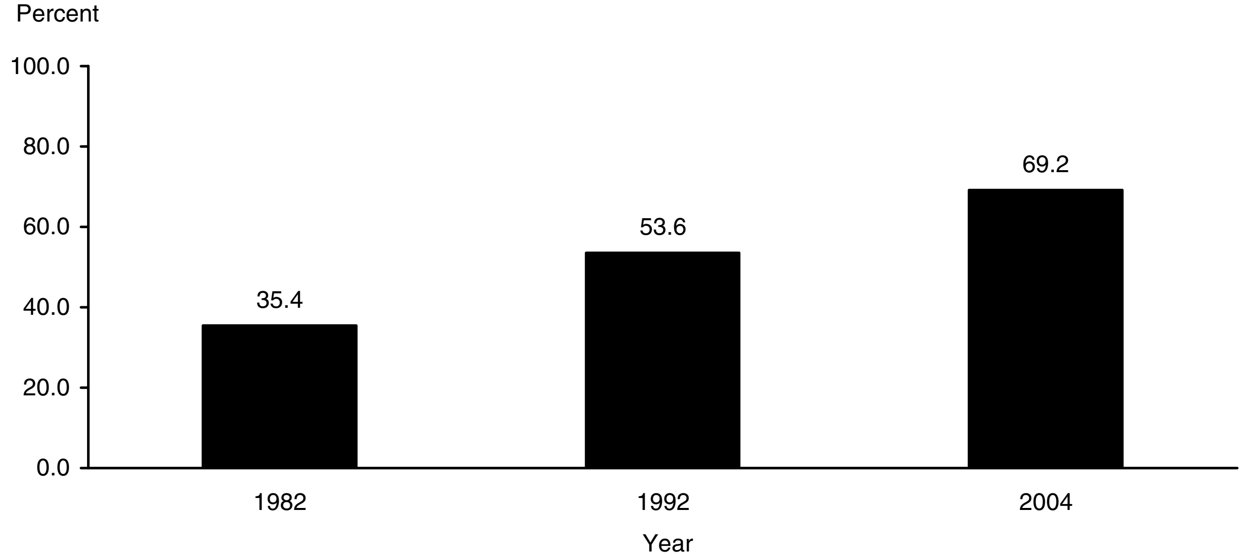
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

[4] The mathematics "pipeline" (course level) measure was divided into six categories, moving from least to most advanced: (1) no or low (e.g., general math or consumer math) academic mathematics; (2) algebra I/plane geometry; (3) algebra II; (4) algebra III/trigonometry/analytic geometry; (5) precalculus; and (6) calculus.

Science Coursetaking Overall

Clear trends were also evident for science coursetaking. The average number of science credits increased from 2.2 total credits in 1982 to 3.3 total credits in 2004. Further, graduates shifted in significant proportions from taking lower level science courses to taking upper level ones.[5] For example, smaller proportions of high school graduates finished high school with courses at the two lowest science levels (no or low-level science, or secondary physical science and basic biology): 29 percent of graduates finished at these levels in 1982, while only 6 percent of graduates finished at these levels in 2004. This was complemented by growth in the upper half of science courses (i.e., the top three levels). The percentage of high school graduates who completed chemistry (I or II), physics (I or II), or advanced biology about doubled (from 35 percent to 69 percent) between 1982 and 2004 (figure B).

Figure B. Percentage of high school graduates who completed chemistry, physics, or advanced biology: 1982, 1992, and 2004



SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), “High School Transcript Study”; National Education Longitudinal Study of 1988 (NELS:88/92), “Second Follow-up, Transcript Survey, 1992”; and Education Longitudinal Study of 2002 (ELS:2002), “First Follow-up, High School Transcript Study, 2004.”

Mathematics and Science Coursetaking Among Student Subgroups

In addition to these overall trends in coursetaking, the number and level of courses taken in mathematics and science increased for all student subgroups examined. Across categories of sex, race/ethnicity, socioeconomic status[6] (SES) background, educational expectations, and

[5] The science “pipeline” (course level) measure was divided into six categories, from least to most advanced: (1) no or low-level science; (2) secondary physical science and basic biology; (3) general biology; (4) chemistry I or physics I; (5) chemistry I and physics I; and (6) chemistry II, physics II, or advanced biology.

[6] Each of the three NCES high school cohort studies employed in this report (HS&B, NELS:88; ELS:2002) constructed a standardized socioeconomic status (SES) variable based on a composite of parental education, occupation, income, and, in HS&B, household items (such as number of books, electric dishwasher, number of cars, own room, etc.). The form of the variable used in this report divides the SES distribution into four equally weighted quartiles.

school sector, graduates in 2004 took more and higher levels of mathematics and science than their peers in 1992 and 1982.

- **Sex.** Both male and female graduates completed advanced-level coursework in mathematics at higher percentages in 2004 than in 1992 and 1982. However, while both sexes increased their advanced mathematics coursetaking, they did not differ from each other at any of the three points in time: in each of the cohorts, there were no substantive differences detected between females and males in the percentage completing advanced mathematics courses (precalculus and calculus).

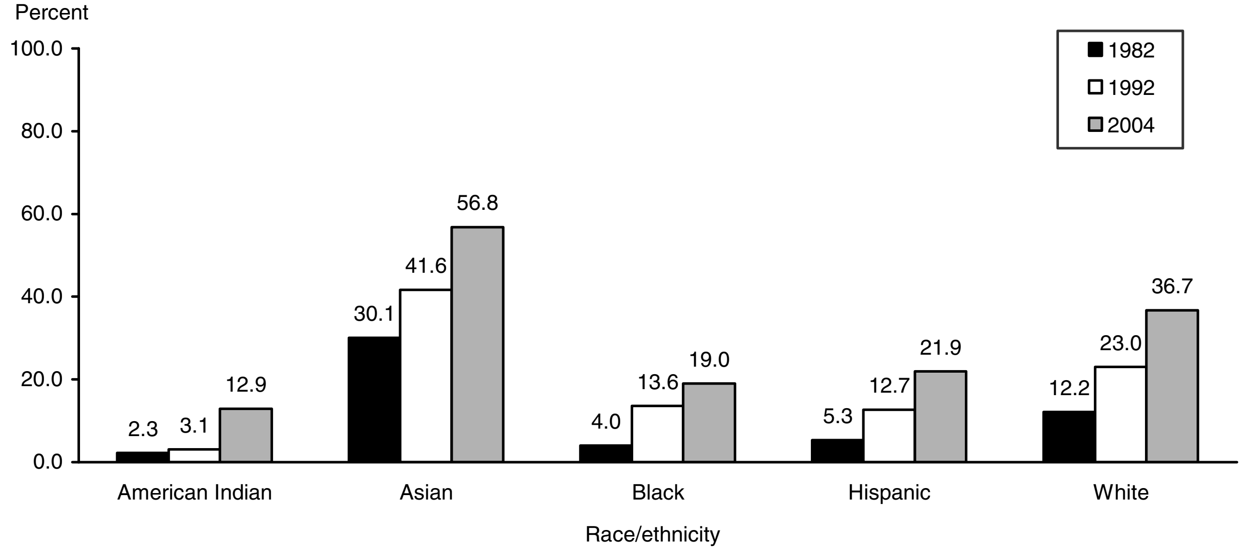
  In science, both males and females completed similar levels of coursework across the three cohorts, with the exception of a middle level of science courses, chemistry I or physics I. Although the percentages of males and females completing chemistry I or physics I showed no detectable differences in 1982, females surpassed males at this middle level of science attainment in 2004 (37 percent versus 30 percent completing up to chemistry I or physics I, respectively).

- **Race/ethnicity.**[7] All racial/ethnic groups increased their participation in higher levels of mathematics and science coursework. Between 1982 and 2004, the percentages of students completing either precalculus or calculus as their highest mathematics course increased from 2 to 13 percent for American Indians, 4 to 19 percent for Blacks, 5 to 22 percent for Hispanics, 12 to 37 percent for Whites, and 30 to 57 percent for Asians (figure C).

  Despite the progress made in advanced-level mathematics coursetaking, disparities among racial/ethnic groups persisted across the two decades. White and Asian graduates in all three cohorts were more likely than their Black, Hispanic, and American Indian peers to persist in the mathematics pipeline through precalculus and calculus (and Asian graduates more likely than Whites). For example, the gap between Blacks and Whites in advanced mathematics (precalculus and calculus) enrollment persisted at all points in time: in 1982, 4 percent of Blacks and 12 percent of Whites had completed advanced mathematics, while in 1992 the respective figures were 14 percent and 23 percent, and in 2004 19 percent and 37 percent. Nevertheless, in terms of average credits earned in mathematics, no statistical difference was detected between Blacks and Whites in 2004 (mean mathematics credits were 3.7 for Blacks and 3.6 for Whites).

[7] In this report, American Indian includes Alaska Native, Asian includes Native Hawaiian or Other Pacific Islander, Black includes African American, and Hispanic includes Latino. Respondents who identified themselves as being of Hispanic origin are classified as Hispanic, regardless of race. Choosing more than one race was not permitted in HS&B and NELS:88.

Figure C. Percentage of high school graduates who completed precalculus or calculus, by race/ethnicity: 1982, 1992, and 2004



NOTE: Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native.

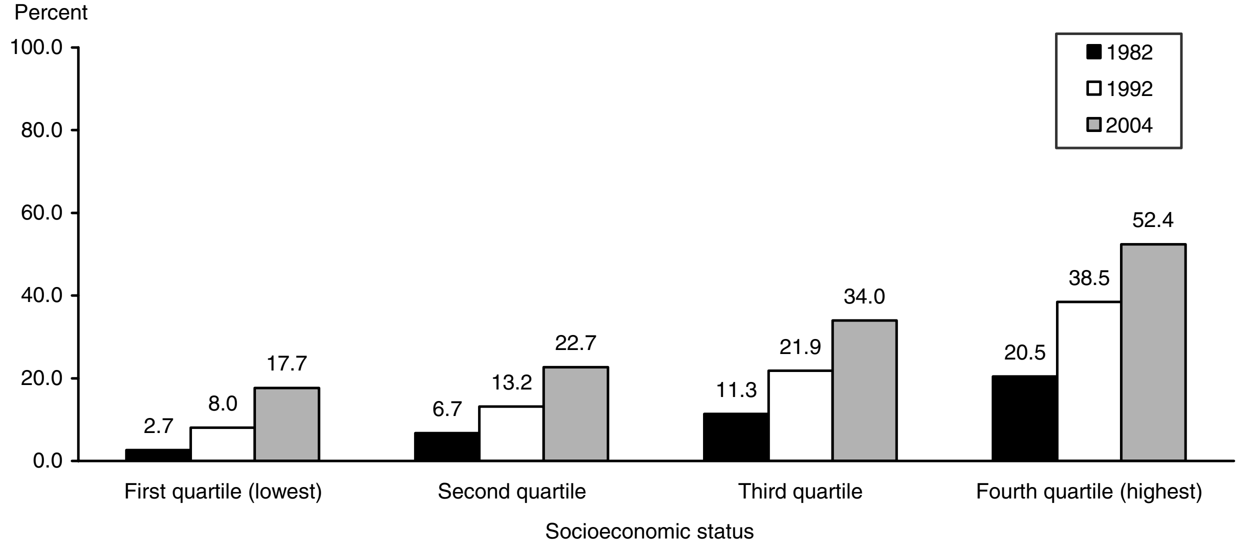
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

In science, Asian students in each cohort were more likely than students from all other racial/ethnic groups to complete the most advanced level of science courses, and this advantage increased over time. In 1982, 24 percent of Asian graduates completed chemistry II, physics II, or advanced biology, and 23 percent completed this level in 1992; in 2004, however, 39 percent of Asian graduates did so. The proportions of non-Asian minority students completing the most advanced level of science remained relatively stable from 1982 to 2004, except for Whites, whose completion rates for chemistry II, physics II, or advanced biology were relatively stable between 1982 and 1992 but rose from 16 percent in 1992 to 21 percent in 2004.

- **Socioeconomic status.** Students in each of the four SES quartiles increased their participation in advanced mathematics courses over time. The percentage of graduates completing precalculus or calculus grew over time; students in the lowest quartile, for example, increased their calculus and precalculus completion rates from 3 percent in 1982 to 18 percent in 2004 (figure D). The completion rates in precalculus more than doubled from 1982 to 2004 for graduates from each SES quartile.

In 1982, 1992, and 2004, high SES graduates were consistently more likely than low SES graduates to complete advanced-level coursework in mathematics. Disparities between the highest and lowest SES quartiles in the percentages of students who completed precalculus and calculus not only persisted but increased from 1982 to 2004: the gap between the highest and lowest quartiles was 18 percentage points in 1982 but 35 percentage points in 2004.

Figure D. Percentage of high school graduates who completed precalculus or calculus, by socioeconomic status: 1982, 1992, and 2004

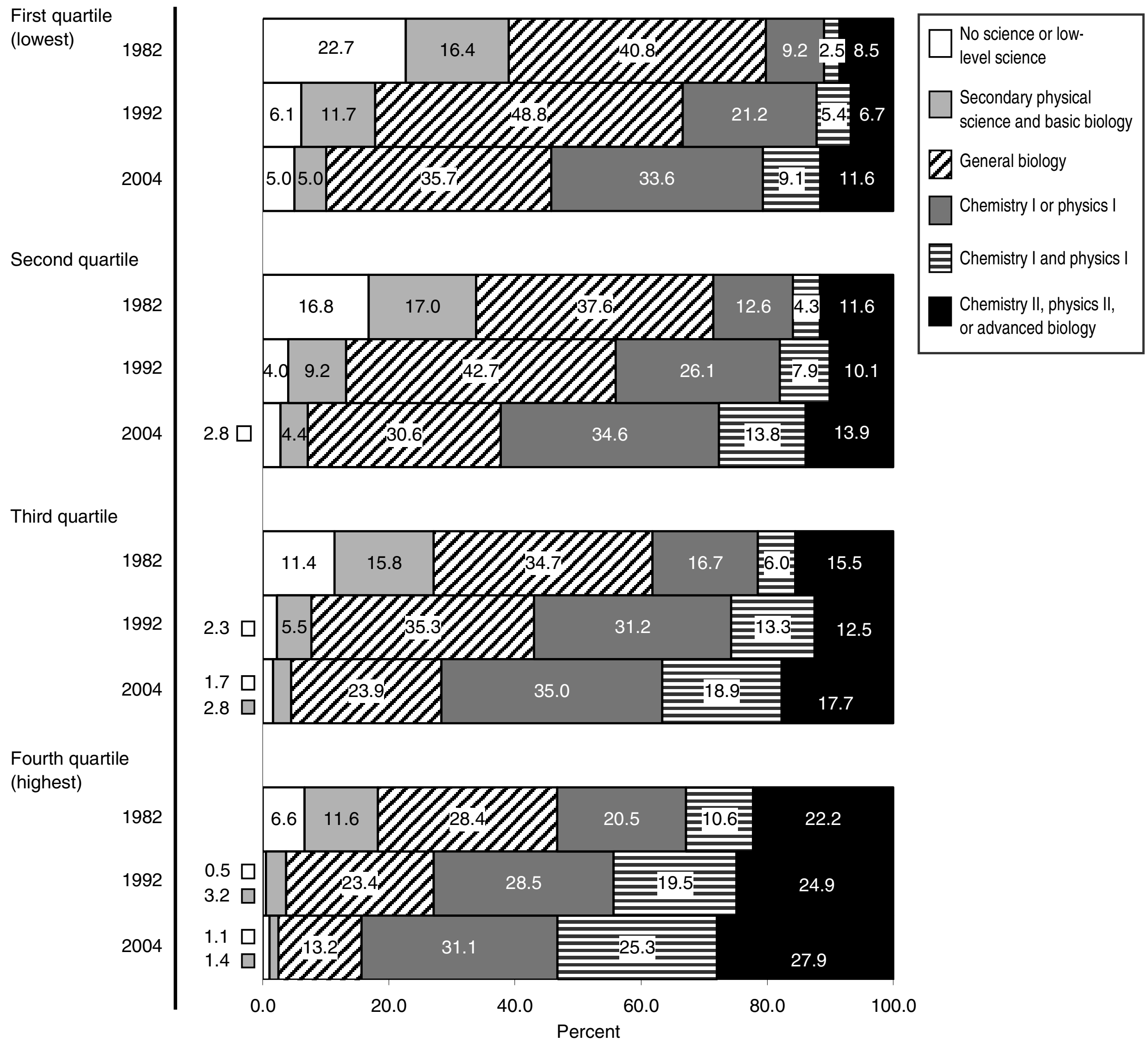


SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

The percentage of students who completed two of the three highest science course levels (chemistry I or physics I, or chemistry I and physics I) also increased for all SES groups, with the growth in students completing one standard course in chemistry or physics the strongest (figure E). Students in the highest SES quartile also consistently completed the most advanced level of science courses at higher rates than their peers in all three cohorts.

- **Educational expectations.** Between 1982 and 2004, high school graduates at all levels of educational expectations increased their participation in middle and advanced-level mathematics courses. Among lower expectation students (expecting less than a college degree), most of this growth was in a middle level of mathematics (algebra II), with little or no improvement in the percentage completing the most advanced mathematics. In contrast, higher expectation students, especially those who expected a graduate or professional degree, increased their coursetaking in precalculus and calculus. Specifically, over half (53 percent) of those who expected to earn a graduate degree had taken calculus or precalculus in 2004, compared with 8 percent of those who expected to achieve only some postsecondary education and 33 percent of those who expected to attain a baccalaureate degree. For the group with graduate or professional degree expectations, precalculus-calculus completion increased from 27 percent in 1982 to 41 percent in 1992 and 53 percent in 2004.

Figure E. Percentage of high school graduates who completed different levels of science courses, by socioeconomic status: 1982, 1992, and 2004



NOTE: Detail may not sum to totals because of rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

In science, students who expected only a high school degree or less grew most in a middle level of science courses, chemistry I or physics I (these students moved from 4 percent to 19 percent completion rates at this level between 1982 and 2004), with no improvement in the percentage completing the most advanced science courses. In 2004, high school seniors who expected to earn a graduate or professional degree continued to be most likely to complete chemistry II or physics II or advanced biology. Nearly 29 percent of students expecting to earn a graduate or professional degree completed the most advanced level of science courses, compared with 16 percent of students expecting to earn a baccalaureate degree, 7 percent of students expecting to earn some postsecondary education, and 8 percent of students expecting to earn no more than a high school diploma.

- **School sector.** In contrast to the foregoing student-level characteristics, school sector represents one aspect of the context in which high school coursetaking occurs. From 1982 to 2004, increased proportions of students from the public, Catholic, and other private school sectors graduated with credits earned in advanced mathematics courses. Precalculus completion rates more than doubled between 1982 and 2004 across school sectors; calculus rates also rose for students from all sectors. In 1982, 9 percent of public school graduates completed one of these advanced mathematics courses, but this proportion had reached 31 percent in 2004. Similarly, Catholic school graduates increased their completion of precalculus or calculus-level courses from 19 percent to 51 percent, and other private school graduates increased their rate from 30 percent to 57 percent.

  In science, the participation rates of public and Catholic high school students in courses like chemistry I, physics I, or both more than doubled from 1982 to 2004. However, completion rates of the most advanced level of science courses (chemistry II, physics II, or advanced biology) remained relatively stable between 1982 and 2004 across school sectors. Despite increased completion of advanced-level mathematics and science courses by graduates from all school sectors, Catholic and other private school students remained more likely than their public school counterparts to complete advanced-level courses in mathematics and science.

These results show that American high school students took an increasing number of academic courses between 1982 and 2004 and became more likely to complete advanced-level coursework before they graduated from high school. The upward trend in advanced-level coursetaking not only occurred among high school graduates nationwide but persisted in all subgroups examined in this report, including those identified by sex, race/ethnicity, SES, educational expectations, and school sector. Although some disparities remain or have grown, the overarching trend for all students is toward completing more demanding mathematics and science courses.

Foreword

This report presents new time series data on the coursetaking patterns of the high school classes of 1982, 1992, and 2004. Using coursetaking pipeline measures developed by University of Michigan researchers (Burkam 2003; Burkam and Lee 2003), this report examines both the quantity and level of academic coursetaking, with a focus on the highest level of coursework that high school graduates completed in mathematics and science. Additionally, the analysis focuses on differences in coursetaking patterns among various subgroups defined by sex, race/ethnicity, socioeconomic status, educational expectations, and school sector. Coursetaking information was derived from high school transcripts collected by the National Center for Education Statistics (NCES) from three longitudinal studies: the High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B), the National Education Longitudinal Study of 1988 (NELS:88), and the Education Longitudinal Study of 2002 (ELS:2002).

We hope that the information provided in this report will be useful to a wide range of readers, including policymakers and educators interested in improving preparation in mathematics and science. Additionally, we hope that the results reported here will encourage other researchers to use NCES's longitudinal datasets to investigate issues that will help enhance the functioning of our schools and, consequently, the educational experiences of American youth.

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Chapter 1
Introduction

Strong quantitative and analytical skills are increasingly important for youth who will be working in an economy that is technical in nature and global in scope. Yet cross-national research on mathematics and science achievement indicates that American youth in middle or high school grades are not faring as well as some of their international peers. For example, the 2003 Program for International Student Assessment (PISA) finds that 15-year-old students in the United States rank 24th of 29 nations in problem solving and mathematics literacy (Lemke et al. 2004). In science, while research indicates that U.S. middle school students are above the international achievement average (tied for 9th out of 44 nations) and have been gaining in recent years (Gonzales et al. 2004), some U.S. policymakers continue to express concern about the achievement and long-term competitiveness of its students in science (National Science Board 2006).

In response to concerns that students leave high school underprepared in mathematics and science, many states have increased their requirements for graduation. For example, between 1987 and 2004, the number of states requiring at least 2.5 credits in mathematics grew from 12 to 26, and the number of states requiring at least 2.5 credits in science grew from 6 to 23 (Council of Chief State School Officers [CCSSO] 2005). In 2004, 17 states required specific courses in math and 23 states required specific courses in science to graduate. These requirements appear to be reflected in high school student coursetaking (CCSSO 2005). Research using high school transcript data collected by the National Center for Education Statistics (NCES) shows that high school students have been taking a greater number of academic courses over the past 15 years (Legum et al. 1998; Levesque et al. 2000; National Commission on Excellence in Education 1983; Perkins et al. 2004; U.S. Department of Education 2000).

However, important questions remain about the mathematics and science coursetaking of American high school students. First, have documented increases in course credits in math and science continued in recent years? Second, have increases in course credits in math and science been accompanied by increases in advanced coursetaking in subjects such as calculus and physics? Third, have coursetaking differences between students from different backgrounds changed in conjunction with rising academic requirements? This report answers these questions by examining both the number of credits and the types of courses taken in mathematics and science by the high school graduating classes of 1982, 1992, and 2004—over two decades of coursetaking patterns.

Earlier research focused on the number of credits earned by students, regardless of the type or content of the courses. For example, if two students both earned three credits in mathematics, with one taking mostly basic courses and the other taking honors and Advanced Placement (AP) courses, the consequences for their learning might be quite different. To better understand the qualitative aspect of curricular experiences, researchers at the University of Michigan recently took a different approach to measuring coursetaking (Burkam 2003; Burkam and Lee 2003). Instead of following the number of course credits accumulated by students, this alternative approach focuses on the most advanced level of courses a student completed in high school or how far the student progressed along an academic-subject-area "pipeline." Thus far, coursetaking pipelines have been created for mathematics, science, English, and foreign language. While pipeline measures do not measure the quality of courses, they create an opportunity to examine students' coursetaking behaviors from the perspective of course progress.

The analysis reported here focuses on differences in credits and courses among various subgroups defined by sex, race/ethnicity, socioeconomic status,[1] educational expectations, and school sector, with a brief discussion of coursetaking trends overall. Coursetaking information for graduating seniors was derived from high school transcripts collected by NCES from three longitudinal studies: the High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B), the National Education Longitudinal Study of 1988 (NELS:88), and the Education Longitudinal Study of 2002 (ELS:2002). All coursetaking information is based on courses where credit was earned—meaning that the student received a passing grade according to his or her school's grading system. (See appendix A for details on the datasets used in this report.)

1.1 Credit Measures of Coursetaking

Previous studies on student coursetaking have focused primarily on the number of courses taken or Carnegie units earned. A Carnegie unit is a standard of measurement used for secondary education that represents the completion of a course that meets one period per day for 1 year. The number of units (or credits) accumulated in a subject is a good indicator of the total amount of instruction in that subject received and is a proxy measure for the continuity of that instruction. In a standard 9th-12th grade high school, four credits of math or science corresponds to a typical pattern of one unit each year—particularly in mathematics, where following specific course sequences may be typical and "doubling up" two courses in the same subject is more difficult. Credit counts thus provide a general overview of student involvement in specific subjects.

However, researchers and policymakers have pointed to some limitations of credit measures for investigating and understanding high school coursetaking experiences and the linkages between those experiences and a variety of outcomes of interest, such as student achievement and preparedness for college. The Congressional Budget Office (1987) offered student coursework trends as a possible explanation for the decline in achievement scores during the 1960s and 1970s but stressed that course content rather than completed credits should be analyzed to achieve a thorough analysis. Likewise, Schmidt (1983) found in his analysis of the National Longitudinal Study of the High School Class of 1972 (NLS-72) that more academic coursetaking was generally associated with higher performance on standardized assessments. However, Schmidt indicated that the NLS-72 data were limited because credit measures were less desirable than content measures for assessing educational experiences.

More recent research has used transcript data to better classify the content of courses and to assess the relation between curricular intensity and achievement (Chaney, Burgdorf, and Atash 1997; Cool and Keith 1991; Perkins et al. 2004; Rock and Pollack 1995; Shettle et al. 2007). For example, Meyer (1999) analyzed HS&B data using a qualitative measure (e.g., advanced mathematics versus nonadvanced mathematics) rather than a quantitative one (e.g., number of

[1] Each of the three NCES studies used in this report—High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B), National Education Longitudinal Study of 1988 (NELS:88), and Education Longitudinal Study of 2002 (ELS:2002)—used a standardized socioeconomic status variable based on a composite of education, income, and occupation and, in HS&B, household items. Household items (e.g., appliances, books) were sometimes used in NELS:88 when parent-reported income was missing. Household items were not used in ELS:2002. Instead, for this study, an imputation strategy was adopted for all missing elements.

mathematics courses taken or credits earned) and found that advanced mathematics courses were associated with achievement gains for both college and non-college-bound students and for students with low to high mathematics skills. Furthermore, his analysis indicated that low-level courses such as basic and general mathematics were not statistically significantly associated with students' development of mathematics skills in high school. These findings suggest that understanding curricular experiences requires measures that better capture the breadth and depth of course content. Credit counts provide some of the breadth needed to assess patterns of student coursetaking, and therefore remain useful alongside measures of specific courses taken.

1.2 Pipeline Measures of Coursetaking

In response to the desire to provide additional information about the course experiences of high school students, David Burkam and Valerie Lee from the University of Michigan developed a series of coursetaking measures called "pipeline" measures (Burkam 2003; Burkam and Lee 2003). The measures represent an initial attempt to capture students' coursetaking experiences in terms of course content. Using 1992 transcript data from NELS:88, they developed pipeline measures in four subject areas: mathematics, science, English, and foreign language. Although the measures vary by subject area, they share important characteristics: (1) the categories on the scale are ordinal, distinguishing lower, middle, and upper level courses; and (2) each measure indicates the highest level of courses that a student completed in a particular subject during high school. Since they are based on course labels indicated on transcripts, the pipeline measures do not represent differences in content or academic challenge of the courses taken by individual students. They may also not account for differences in coursetaking availability for students in some schools, or for self-selection into courses. Nevertheless, they permit an examination of student coursetaking patterns beyond credit counts.

1.2.1 Construction of the Pipeline Measures

The pipeline measures are built on the assumption that students who complete advanced-level coursework have mastered the skills of lower level courses and gained experience with more complex and advanced subject matter. In turn, these students should have a greater understanding of the subject area than their peers who reach only lower levels of the pipeline. Structured this way, the pipeline measures are better able to distinguish the degree of academic preparation and are hypothesized to be better predictors of student achievement than credit or Carnegie unit counts alone.

The pipeline measures quantify the purported difficulty or content of courses, operationally defined as the course label. That is, the measures distinguish between lower level courses, which are assumed to be less difficult, and upper level courses in the same academic area, which are assumed to be more challenging. The four pipeline measures in the academic subject areas of mathematics, science, English, and foreign language were constructed by Burkam and Lee (2003; Burkam 2003) using high school transcript data from NELS:88 (Ingels et al. 1995). The high school courses taken by members of the NELS:88 sample, as they appear on the transcript file, were coded using high school or district course catalogs in accordance with the Classification Scheme of Secondary School Courses (CSSC), updated for the 1990 National

Assessment of Educational Progress (NAEP) High School Transcript Study (Ingels et al. 1995).[2] Thus, the various levels of the pipeline measures were developed from the courses the NELS:88 students took in high school during 1989 through 1992, and these constructed pipeline frameworks were used to classify the coursetaking behaviors of high school graduates in HS&B and ELS:2002.

The purpose of the *mathematics pipeline measure* is to capture the nature of the most advanced-level mathematics course completed. To create this measure, Burkam and Lee examined the high school transcript component of NELS:88. They used the CSSC to identify all courses considered to be mathematics. In their analyses of these courses, they found that the mathematics curriculum in most schools followed a sequence of courses that increased in difficulty. Moreover, the mathematics curriculum was relatively homogenous: nearly 75 percent of NELS:88 sample members fit into one of five mathematics coursetaking patterns, with students who took more than one mathematics course taking sequentially more difficult and advanced-level courses than the preceding courses (e.g., algebra I only [a pattern taken by about 12 percent of the NELS:88 sample] versus algebra I, geometry, and algebra II [a pattern taken by approximately 21 percent of the NELS:88 sample]) (Burkam and Lee 2003).

For the mathematics pipeline measure, 47 high school courses (with nonzero enrollment) were initially assigned to one of four levels using their CSSC codes and a description of course content: nonacademic mathematics courses, low academic mathematics courses, middle academic mathematics courses, and advanced academic mathematics.[3] This initial four-level measure was expanded by Burkam and Lee (2003) to create a more detailed eight-level measure. The analysis presented in this report uses a condensed version of Burkam and Lee's eight-level measure where the lowest categories are combined to yield sufficient cell sizes for statistical estimation. This approach does not alter the distributions of the advanced course levels, which are of most concern to educators and policymakers. Additionally, the category titles differ from the original ones used by Burkam and Lee; these were changed so that clearer interpretations can be drawn from the analyses:[4]

- The no mathematics or low academic mathematics course level included
  - 1 = no mathematics or low academic mathematics (other general mathematics, mathematics 7, accelerated mathematics 7, mathematics 8, accelerated mathematics 8, general mathematics 1, general mathematics 2, science mathematics, mathematics in the arts, vocational mathematics, technical mathematics, mathematics review, mathematics tutoring, consumer mathematics, other actuarial sciences, other applied mathematics, basic mathematics 1, basic

[2] The CSSC is designed to describe course offerings in secondary education and to provide a coherent means for classifying these courses. Each CSSC code comprises six digits, with an associated course title, alternate titles, and a course description. The first two digits identify the main program area (e.g., mathematics), the second set of two digits represents a subcategory of courses within the main program area (e.g., pure mathematics), and the last two digits are associated with the specific courses in each of the main and subcategories (e.g., trigonometry).

[3] The number of mathematics courses included in the time series analysis in this report was expanded to 62 courses to accommodate additional courses identified in a review of transcripts from earlier (1982) and later (1998) years. New courses in the mathematics curriculum, as identified by the recent ELS:2002 transcript collection, have been assigned appropriate levels in the pipeline.

[4] For example, Burkam and Lee (2003) used middle academic mathematics I, middle academic mathematics II, advanced mathematics I, advanced mathematics II, and advanced mathematics III as the category titles for levels 2 through 6 presented here.

mathematics 2, basic mathematics 3, basic mathematics 4, pre-algebra, algebra I–part 1, algebra I–part 2, or informal geometry).

- Middle academic mathematics course levels included
  - 2 = algebra I/plane geometry (other pure mathematics, algebra I, plane geometry, solid geometry, unified mathematics 1, unified mathematics 2, geometry–part 1, geometry–part 2, unified mathematics 1–part 1, unified mathematics 1–part 2, pre-International Baccalaureate [IB] geometry, IB mathematics methods 1, IB mathematics studies 1, discrete mathematics, finite mathematics, algebra and geometry, or other mathematics);
  - 3 = algebra II (algebra II, unified mathematics III, or pre-IB algebra II/ trigonometry); and
  - 4 = algebra III/trigonometry/analytic geometry (algebra III, trigonometry, analytic geometry, trigonometry and solid geometry, algebra and trigonometry, algebra and analytic geometry, linear algebra, independent study, statistics, probability, probability and statistics, or Advanced Placement [AP] statistics).
- Advanced academic mathematics course levels included
  - 5 = precalculus (introductory analysis or IB mathematics studies 2); and
  - 6 = calculus (calculus and analytic geometry, calculus, AP calculus, IB mathematics studies/calculus, or AP calculus CD).

The percentages of graduates completing each individual course comprising the math pipeline measure is presented in appendix D—Course-Specific Completion Percentages (tables D-1, D-3, and D-5). The courses are arranged according to pipeline level.

The *science pipeline measure* was developed using an examination of the science coursetaking patterns of the NELS:88 students. Because high school science coursetaking typically occurs across different strands or disciplines of science—life science (e.g., biology), chemistry, physics, and physical science (e.g., earth science, geology)—capturing highest science course completed along a single continuum of difficulty is less straightforward than it is with mathematics. For example, it is not completely clear that a 12th-grade advanced biology course, after 3 years of lower level, but sequentially more difficult, life science courses, is less difficult than a 12th-grade physics course after a year of biology and a year of chemistry. Initial analyses of the NELS:88 transcript data, however, revealed that science coursetaking in U.S. high schools appears to follow a pattern. Among the 30 different science courses taken by NELS:88 students, only 7 courses were ever completed by 10 percent or more of students (Burkam and Lee 2003, p. 31).[5]

To develop the science pipeline measure, Burkam and Lee (2003) evaluated science courses using four criteria: (1) the subject matter of the course; (2) when the course was taken (e.g., freshman year, sophomore year, etc.); (3) whether the course was taken in conjunction with another science course; and (4) the complexity of the material likely taught in the course. Using

[5] The seven courses that 10 percent or more of students ever completed were general biology 1 (68 percent), chemistry 1 (41 percent), physical science (39 percent), earth science (18 percent), unified science (15 percent), and basic biology 1 (10 percent) (unweighted percentages).

these criteria, they created a seven-level science pipeline measure to capture the breadth and depth of students' coursetaking histories. The continuum reflects the order of the most common science curriculum used in schools where students take general science courses first, followed by biology, chemistry, physics, and advanced biology. The analysis in this report uses a modified six-level version that combines "no science" with the most basic science: "primary physical science." These categories are combined to yield sufficient cell sizes for statistical estimation. This method does not alter the distributions of the advanced course levels, which are of most concern to educators and policymakers. The categories are as follows:

- 1 = no science[6] or low academic science (unified science, physical science, applied physical science, other geological sciences, earth science, college preparatory earth science, or miscellaneous physical sciences);
- 2 = secondary physical science and basic biology (basic biology 1, basic biology 2, other biological and physical sciences, independent science study, outdoor education, other systems science, futuristics, environmental science, IB environmental studies, energy and environment, astronomy, other astronomy, other astrophysics, atmospheric sciences and meteorology, meteorology, introductory chemistry, chemistry in the community, organic biochemistry, physical chemistry, consumer chemistry, chemistry independent study, other chemistry, AP environmental science, geology, geology–field studies, mineralogy, oceanography, general physics, other physics, electricity and electronics science, acoustics, other planetary science, other rocketry and space science, or aerospace science);
- 3 = general biology (general biology 1, general biology 2, honors biology 1, other biology, pre-IB biology, ecology, marine biology, advanced marine biology, zoology, other zoology, vertebrate zoology, invertebrate zoology, animal behavior, human physiology, advanced physiology, pathology, comparative embryology, or other life sciences);
- 4 = chemistry I or physics I (chemistry 1, pre-IB chemistry, or physics 1);
- 5 = chemistry I and physics I (highest completed courses include one level I chemistry course [see above] and one level I physics course [see above]); and
- 6 = chemistry II or physics II or advanced biology (chemistry 2, IB chemistry 2, IB chemistry 3, AP chemistry, physics 2, IB physics, AP physics B, AP physics C: mechanics, AP physics C: electricity/magnetism, physics 2 without calculus, advanced biology, field biology, genetics, biopsychology, biology seminar, biochemistry and biophysics, biochemistry, botany, other botany, cell and molecular biology, cell biology, microbiology, microbiology other, other life sciences specialized areas, anatomy, IB biology 2, IB biology 3, or AP biology).

The percentages of graduates completing each individual course comprising the science pipeline measure is presented in appendix D—Course-Specific Completion Percentages (tables D-2, D-4, and D-6). The courses are arranged according to pipeline level.

[6] This category includes graduates who did not complete any courses in science or who completed only remedial-level science. It is possible for a graduate to have taken one or more courses in science but to be placed in the "no science" level.

1.2.2 Validity of the Measures

The pipeline measures were developed to measure the breadth and depth of preparation in key subject areas. The face validity of the measures depends on the proper classification of courses as described in the previous section—combining information about the timing, sequencing, and likely subject matter of math and science courses yields measures exhibiting strong face validity. In addition, these measures should have good predictive validity—that is, they should yield a strong association with academic achievement in their respective subject matters. Initial evaluations revealed that both pipeline measures meet these criteria.

Burkam and Lee (2003) showed that the mathematics pipeline variable correlated .74 with achievement on the NELS:88 twelfth-grade mathematics assessment (stronger than the .47 correlation between math credits and math achievement). Further, the mathematics pipeline measure continued to demonstrate a significant relationship with math achievement once background characteristics were held constant. The science pipeline variable was positively correlated with the number of science items answered correctly on the NELS:88 tenth- and twelfth-grade assessments (correlations ranging from .42 to .52).[7] The somewhat weaker science correlations are not surprising given that mathematics courses follow a hierarchical sequence more closely than do science courses. See Burkam and Lee (2003) and Burkam (2003) for more information.

1.3 Description of the Present Study

This report presents data on the quantity and level of mathematics and science courses taken by three groups of graduating high school seniors: the class of 1982, the class of 1992, and the class of 2004. This work complements earlier studies that looked at trends in the number of courses taken up to the year 2000 (Perkins et al. 2004; Tuma and Burns 1996) and updates the data using transcript information from a recent graduating class. Unlike earlier trend studies that primarily looked at participation in vocational education (Tuma and Burns 1996), this work examines trends in academic coursetaking with a special focus on advanced-level coursetaking in high school. Specifically, the following questions are examined in this report:

- Did the number of mathematics and science courses taken by graduating high school seniors change between 1982, 1992, and 2004? In other words, are recent high school graduates taking more, fewer, or about the same number of courses as their peers 22 years earlier?
- Did the level of mathematics and science courses taken by graduating high school seniors change between 1982, 1992, and 2004? In other words, apart from the number of courses taken, are recent high school graduates taking more advanced courses than their peers 22 years earlier?
- Were there any differences within and across various subgroups (race/ethnicity, sex, socioeconomic status, educational expectations, and school sector) in terms of advanced-level coursetaking? If so, how did the differences change over the years?

[7] Burkam and Lee did not correlate science credits with science achievement (for comparison to the science pipeline correlation with science achievement) in their analysis or conduct multivariate science coursetaking analyses as in the case of mathematics coursetaking.

For example, were differences between Blacks[8] and Whites in advanced-level coursetaking greater in 2004 than in 1982 or 1992?

- Did the number and level of mathematics and science courses taken by graduating high school seniors with high educational expectations change between 1982, 1992, and 2004?

The first two questions address general trends in coursetaking and demonstrate whether, on average, training in mathematics and science has changed over the past two decades. The third question assesses whether well-documented differences in educational experiences have increased, decreased, or persisted into the 21st century. The final question addresses the growing concern among researchers and policymakers that students who leave high school with lofty educational plans do not have the academic preparation to achieve them.

The data for this report come from surveys conducted by NCES between 1982 and 2004. These surveys are (1) the High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B), (2) the National Education Longitudinal Study of 1988 (NELS:88), and (3) the Education Longitudinal Study of 2002 (ELS:2002). The report focuses on three cohorts: the high school graduating class of 1982 (surveyed by HS&B), the high school graduating class of 1992 (surveyed by NELS:88), and the high school graduating class of 2004 (surveyed by ELS:2002). Only those graduates who had complete high school transcripts available in their respective dataset were included in the analysis. It is important to note that by including only high school graduates in this analysis, it is possible that the findings reflect the coursetaking histories of higher achieving students, since dropouts are more likely to be less academically proficient. The sample of graduates may exclude some of those who were most likely to take the lowest level courses (as well as some students, such as early graduates, who may have taken relatively more advanced courses). However, because comparison of the cohort dropout rates from sophomore to senior year for the three studies shows that the dropout rate declined from 1982 to 1992 and then remained relatively stable from 1992 to 2004, it is unlikely that reported trends simply are an artifact of school dropout rates.[9] Moreover, an analysis of NELS:88 found that increased course requirements were not associated with higher dropout rates (Hoffer 1997). Appendix A section A.4 includes a bias analysis of the samples used in this report.

Some caution in interpreting the report's findings should be considered because of differences in data collection methodology across the studies. Differences in the sampling frames, eligibility requirements, and transcript collection methodologies could possibly account for increases or decreases in the proportion of students taking advanced-level academic courses. Both NELS:88 and ELS:2002 high school transcript studies are based on a 12th-grade cohort; HS&B, however, is based on a 1980 sophomore cohort two years later (in 1982). HS&B excluded students with severe mental, physical, or linguistic barriers from its transcript collection, while NELS:88 included some of these students; ELS:2002, however, pursued

[8] In this report, Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native. Respondents who identified themselves as being of Hispanic origin are classified as Hispanic, regardless of race. Choosing more than one race was not permitted in HS&B and NELS:88.

[9] The spring sophomore to spring senior cohort dropout rate was 11.4 percent in 1982 (HS&B), 6.2 percent in 1992 (NELS:88), and 6.9 percent in 2004 (ELS:2002) (Kaufman, McMillen, and Sweet 1996; Ingels, Planty, and Bozick 2005). Event dropout rates based on Current Population Survey data show a similar trend of long-term decline but rough stability from about 1990 (Laird et al. 2006).

transcripts for all students eligible for its student questionnaire. Finally, both HS&B and NELS:88 collected transcripts from the last school attended by the students (which normally but not invariably included the full cumulative record), while ELS:2002 collected transcripts from the students' base-year school (i.e., the school from which they were originally sampled) and their final school if they transferred out of their base-year school. All of these issues are discussed in detail in section A.5 of appendix A.

Comparisons drawn in the text of this report have been tested for statistical significance at the .05 level using *t* statistics to ensure that the differences are larger than those that might be expected because of sampling variation. Given the large sample sizes for each of the three studies used in this report, some comparisons of relatively small differences are likely to meet this criterion of statistical significance. In order to focus the discussion, effect sizes are employed as a second criterion. In comparing means, the effect size is the standardized difference, which is expressed in terms of standard deviation units. A standardized difference of 0.2 (or one-fifth of a standard deviation) or larger was selected as the criterion for determining which statistically significant differences would be reported. For comparisons of proportions, a 5 percentage point or greater difference between estimates was established as the criterion for determining which statistically significant differences would be reported. Differences were reported in the text only if the comparison met the criteria of both statistical significance and substantive difference. See appendix A for further discussion of these criteria; see appendix B for the standard errors of the estimates used in these calculations.

Readers interested in learning more about trends in high school coursetaking should read the recently released publication *The High School Transcript Study: A Decade of Change in Curricula and Achievement, 1990–2000* (Perkins et al. 2004). *A Decade of Change* builds upon earlier NAEP High School Transcript Study trend reports (Roey et al. 2001) by extending the trend line to an examination of the coursetaking patterns of high school graduates as of 2000. It includes information about coursetaking patterns in 1990, 1994, 1998, and 2000, and may be used alongside of the current report's findings to examine the timing of coursetaking changes. However, because of differences in the purposes and designs of the longitudinal studies (HS&B, NELS:88, and ELS:2002) and NAEP, the current study and the NAEP-based studies report slightly different analyses. For example, the present analysis examines patterns in coursetaking by socioeconomic status and educational expectations—information not collected in NAEP. However, the most salient difference between the current analysis and the NAEP-based studies is the foci of the reports. *A Decade of Change* examines trends over time in the number of credits students earned in various subject areas, whereas the present report investigates the number of credits earned and changes over time in the level of courses taken by students, focusing primarily on changes in advanced-level coursetaking. For more recent studies that examine coursetaking, see *America's High School Graduates: Results from the 2005 High School Transcript Study* (Shettle et al. 2007) and *High School Coursetaking: Findings from The Condition of Education 2007* (Planty, Provasnik, and Daniel 2007). It should be pointed out that the Condition of Education report uses a wider range of graduation dates (September 1 of prior year to August 31 of graduation year) as compared to the spring-term senior definition of this report (January 1 to August 31 of graduating year). This results in slight differences in some estimates for the two studies.

Every effort has been made to make all variables used in this report as comparable as possible across the three studies. For both transcript variables (course credits and pipeline) and classification variables (e.g., sex, race/ethnicity), similar measures and procedures were used to ensure the maximum amount of cross-study comparability. Some subtle differences exist for some variables, however, in particular for the construction of socioeconomic status quartile. A glossary of variables is provided in section A.7 of appendix A.

Four appendixes are included in the report. Appendix A includes technical notes and documentation of methodology, including an account of the sources of the data, statistical procedures, and a bias analysis. Appendix B contains standard errors for all estimates, as well as standard deviations and rounded sample sizes for all means. Appendix C supplies rounded sample sizes for select subgroups. Finally, appendix D presents the percentage distribution of individual mathematics and science courses in which the three cohorts of graduating seniors earned credits.

Chapter 2
Trends in Mathematics Coursetaking: 1982–2004

This chapter examines changes in mathematics coursetaking in terms of accumulated credits in math and the level of math courses taken. Credits earned indicate both the total amount of mathematics preparation received in high school and the continuity of that instruction: four credits of math in high school equates to a full-year math course each year between 9th and 12th grade, and it represents a common ceiling on total possible math instruction in high school given other academic requirements and the sequential structure of most mathematics courses. Earlier recommendations for increased curriculum standards called for a minimum threshold of three credits in math required for graduation (National Committee on Excellence in Education 1983; Council of Chief State School Officers 2005). Inasmuch as states and districts have established credit minima consistent with these recommendations, but have not required or advocated four credits of math for high school graduation, credit counts may reflect relatively small variation between the three-credit floor and the four-credit ceiling.

In addition, as noted in chapter 1, credit counts say little about the content or difficulty of the courses taken, nor can they indicate if a student began high school later in the mathematics pipeline (with, for example, algebra I already completed). The mathematics coursetaking pipeline measure used here is an ordered, sequential measure moving from no or low academic coursework to middle-level courses (such as algebra I, plane geometry, algebra II, or algebra III) to advanced courses (such as precalculus or calculus). A graduate's assignment to a level represents the highest level of high school mathematics coursework he or she completed at the point on the curriculum continuum where the student exited the pipeline (i.e., precluding completion of mathematics courses at higher levels while in high school).[10]

The findings for mathematics are first reported overall and then by student subgroups (sex, race/ethnicity, socioeconomic status, educational expectations, and school sector). The principal findings of this chapter are consistent: from 1982 to 2004, graduates increased the number of math credits they accumulated, stopped much less often with lower level math courses, and repeatedly increased their involvement in higher level math courses.

2.1 Overall Trends in Mathematics Coursetaking

Overall, high school graduates earned more credits in mathematics in 2004 than in either 1992 or 1982; the average number of credits in mathematics students earned by the time of graduation rose from 2.7 credits in 1982 to 3.6 credits in 2004. This represents nearly one full academic year of additional mathematics by graduates, on average. Growth in number of credits earned by graduates, however, was greater between 1982 and 1992 (an increase of 0.6 credits) than between 1992 and 2004 (an increase of 0.3 credits), perhaps representing a ceiling effect.

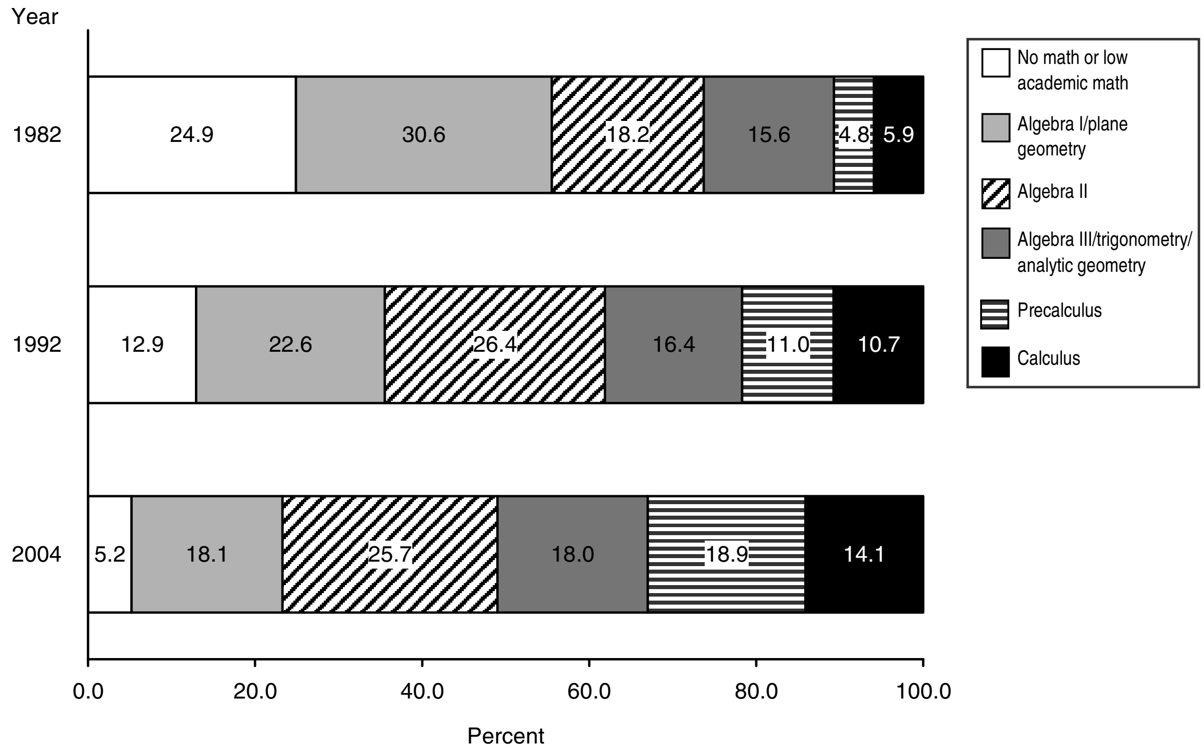
[10] Although it is logical to assume that a student exiting the pipeline at the middle or advanced level completed all earlier courses in the pipeline, this is not necessarily the case. For example, when students reach the advanced level, it means that they have completed at least one advanced-level course (precalculus or calculus) and may or may not have completed courses at levels below the advanced level. However, given the sequential nature of the high school mathematics curriculum, it is implied that students who have reached a certain level have an understanding of the mathematical concepts taught at lower levels.

In addition to overall increases in credits earned, graduates' coursetaking patterns increasingly included more upper-level courses. Figure 1 shows the distribution of the mathematics pipeline across the three studies. The overall pattern is a 33 percentage point growth from 1982 to 2004 in the top four mathematics course levels completed (from about 45 percent to 77 percent), with a corresponding drop in the two lowest math levels over that time period (56 to 23 percent). The largest percentage point decrease—20 points from 1982 to 2004—occurred for graduates taking no math or low academic math courses. Among the advanced courses, the largest shift occurred in precalculus: in 2004, 19 percent of graduates' highest course was precalculus, compared with 5 percent in 1982—a 14 percentage point increase.

Although growth in aggregate mathematics credits earned was higher between 1982 and 1992 than between 1992 and 2004, the increase in advanced coursetaking was comparable between the two time periods. For example, the percentage of seniors graduating high school with precalculus or calculus as their highest class grew by 11 percentage points between 1982 and 1992 and between 1992 and 2004. However, the decline in low-level mathematics courses (no or low math courses and algebra I/plane geometry) was greater in the first period (20 percentage points) than in the second (12 percentage points).

Although student coursetaking patterns shifted from 1982 to 2004 to include more challenging mathematics courses, the percentage of graduates who stopped taking mathematics at the level of algebra I or algebra II remained relatively high in 2004. The combined percentage of students completing either algebra I or algebra II was 49 percent in 1982, 49 percent in 1992, and 44 percent in 2004. Yet, whereas in 1982, a greater percentage of graduates left high school with algebra I (31 percent) than algebra II (18 percent) as their highest course, by 2004, this pattern was reversed; the percentage of students completing algebra II (26 percent) was higher than the percentage of students completing algebra I (18 percent). Thus, while the total percentage of students completing these two course levels declined by only 5 percent from 1982 to 2004, closer inspection of coursetaking at the middle level shows a shift toward more challenging courses.

Figure 1. Percentage of high school graduates who completed different levels of mathematics courses: 1982, 1992, and 2004



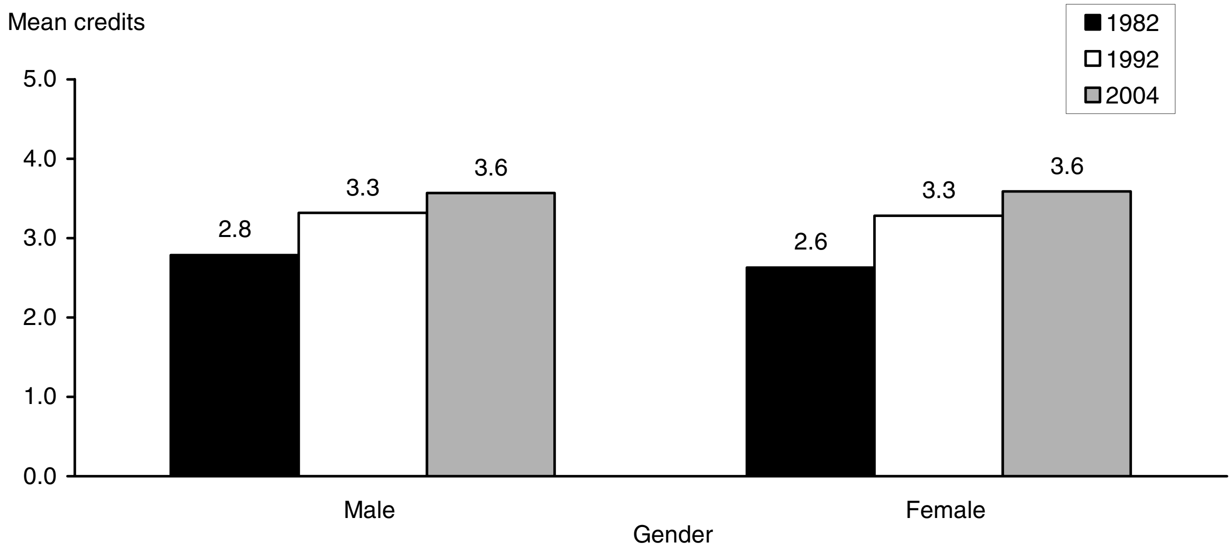
NOTE: Detail may not sum to totals because of rounding. See appendix table B-1 for standard errors for this figure.
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

2.2 Trends in Mathematics Coursetaking Among Student Subgroups

2.2.1 Sex

Figure 2 shows the distribution of mathematics credits by sex, and figure 3 shows the distribution of the mathematics pipeline by sex. Changes in mathematics coursetaking for males and females parallel the overall trend. The mean number of credits earned in mathematics by both groups increased from 1982 to 2004, with a larger increase between 1982 and 1992 than between 1992 and 2004. In all years, no differences were detected in the average math credits earned by females and those earned by males.

Figure 2. Mean credits earned in mathematics by high school graduates, by sex: 1982, 1992, and 2004

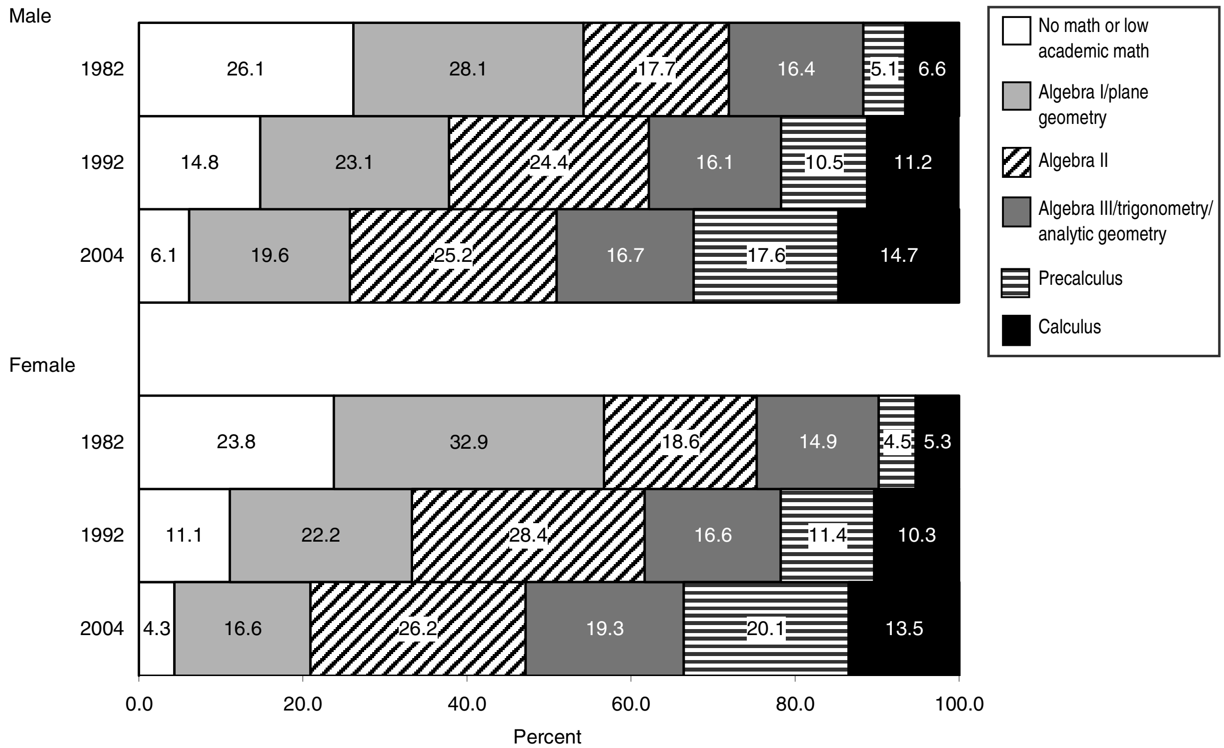


NOTE: See appendix table B-2 for standard errors for this figure.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

In the math pipeline, males and females maintained growth in advanced-level mathematics courses (figure 3). Between 1982 and 2004, males and females both were more likely to take algebra II, precalculus, or calculus and less likely to finish high school with only no or low academic math courses or algebra I/geometry. The largest increases for both males and females were in precalculus-level coursetaking (from 5 percent to 18 percent for males, and 5 to 20 percent for females), and the largest decreases were in the proportion taking no math or low academic math courses (from 26 to 6 percent for males, and 24 to 4 percent for females). In each of the cohorts, no differences were detected between females and males in the combined percentage completing advanced mathematics courses (figure 4). Thus, the coursetaking patterns for males and females are similar across all three cohorts.

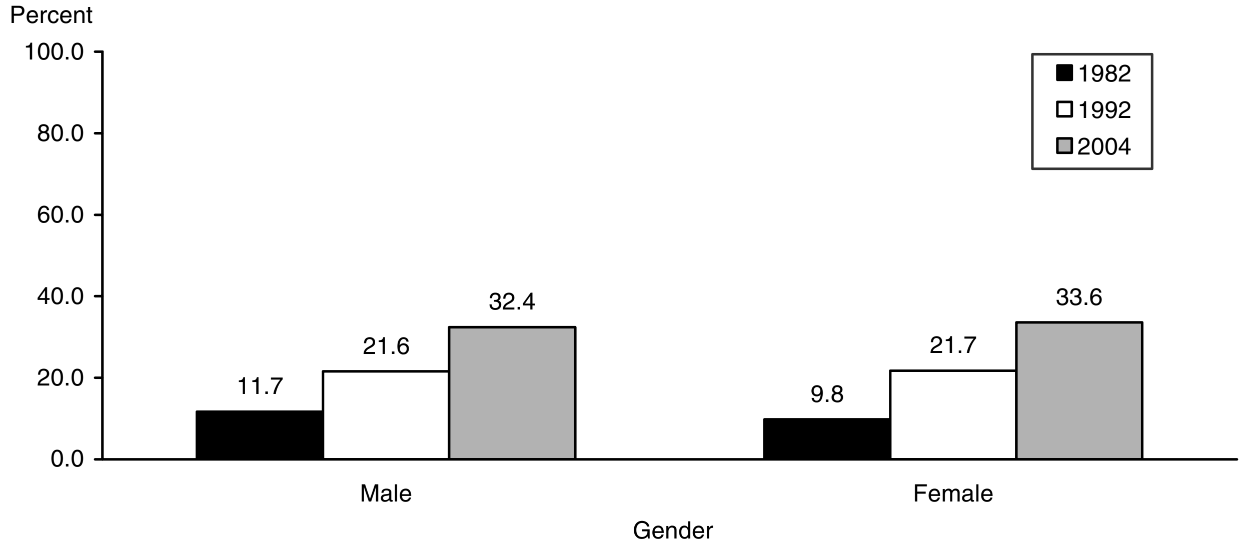
Figure 3. Percentage of high school graduates who completed different levels of mathematics courses, by sex: 1982, 1992, and 2004



NOTE: Detail may not sum to totals because of rounding. See appendix table B-3 for standard errors for this figure.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Figure 4. Percentage of high school graduates who completed precalculus or calculus, by sex: 1982, 1992, and 2004



NOTE: See appendix table B-3 for standard errors of these estimates.

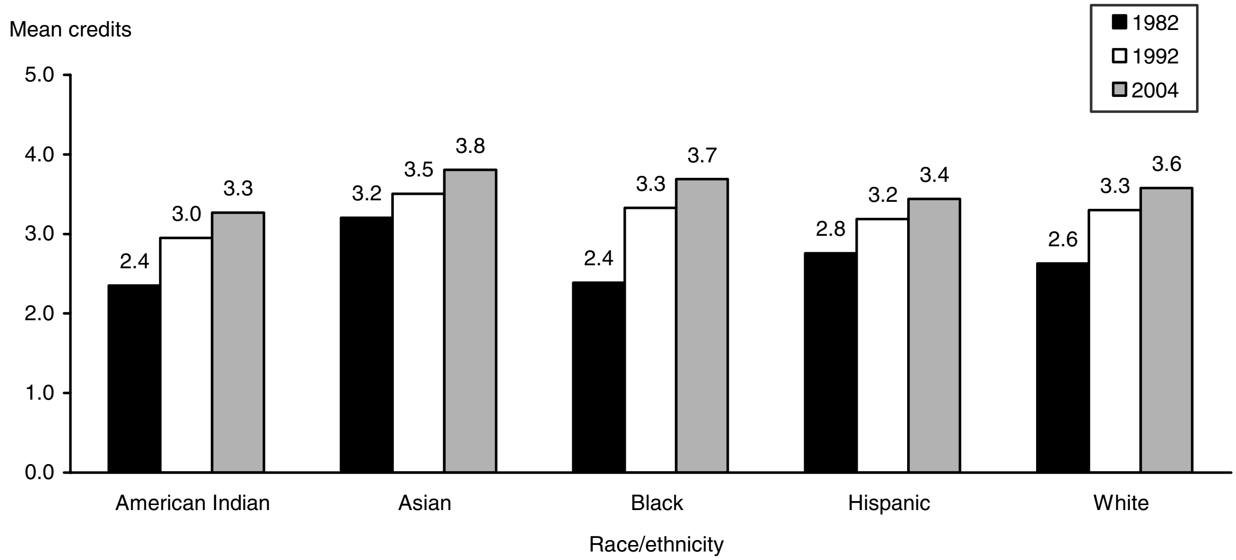
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

2.2.2 Race/Ethnicity

Figure 5 shows the distribution of mathematics credits by race/ethnicity, and figure 6 shows the distribution of the mathematics pipeline by race/ethnicity. Between 1982 and 2004, and in each time period (1982–1992 and 1992–2004), the mean number of credits earned by graduates from all racial/ethnic groups increased, except that the mean number of credits earned by Hispanic graduates did not show a measurable difference in the latter period of 1992 to 2004. The largest increase in the number of credits earned occurred among Blacks and Hispanics, whose mean credits grew from 2.4 to 3.7 credits for Blacks and from 2.8 to 3.4 credits for Hispanics between 1982 and 2004. In 1982, Asian students earned, on average, more credits in math than students in all other race/ethnic groups; by 2004, however, Asian students earned more credits than Hispanic or White students only. In addition, the credit gap between Asians and their White peers decreased between 1982 and 2004.[11]

[11] Since, as noted earlier in this report, cohort dropout rates have declined (since 1982) or held relatively steady (between 1992 and 2004), the overall trend of increased coursetaking in mathematics and science or higher level course enrollment in these subjects would not seem, in part or whole, to be an artifact of trends in early school leaving. However, in comparing one group to another at any of the three points in time, it is of note that dropout rates may differ substantially by subgroup, so that the proportion of the original cohort completing the high school curriculum is different for various race/ethnicity and sex groups. For example, in terms of a cohort dropout rate, 11 percent of NELS:88 1988 8th-graders were classified as dropouts 4 years later (spring term 1992), but proportions differed by race/ethnicity group: 18 percent of Hispanics were dropouts, as were 13 percent of Blacks, 9 percent of Whites, and 5 percent of Asians (McMillen, Kaufman, and Klein 1997).

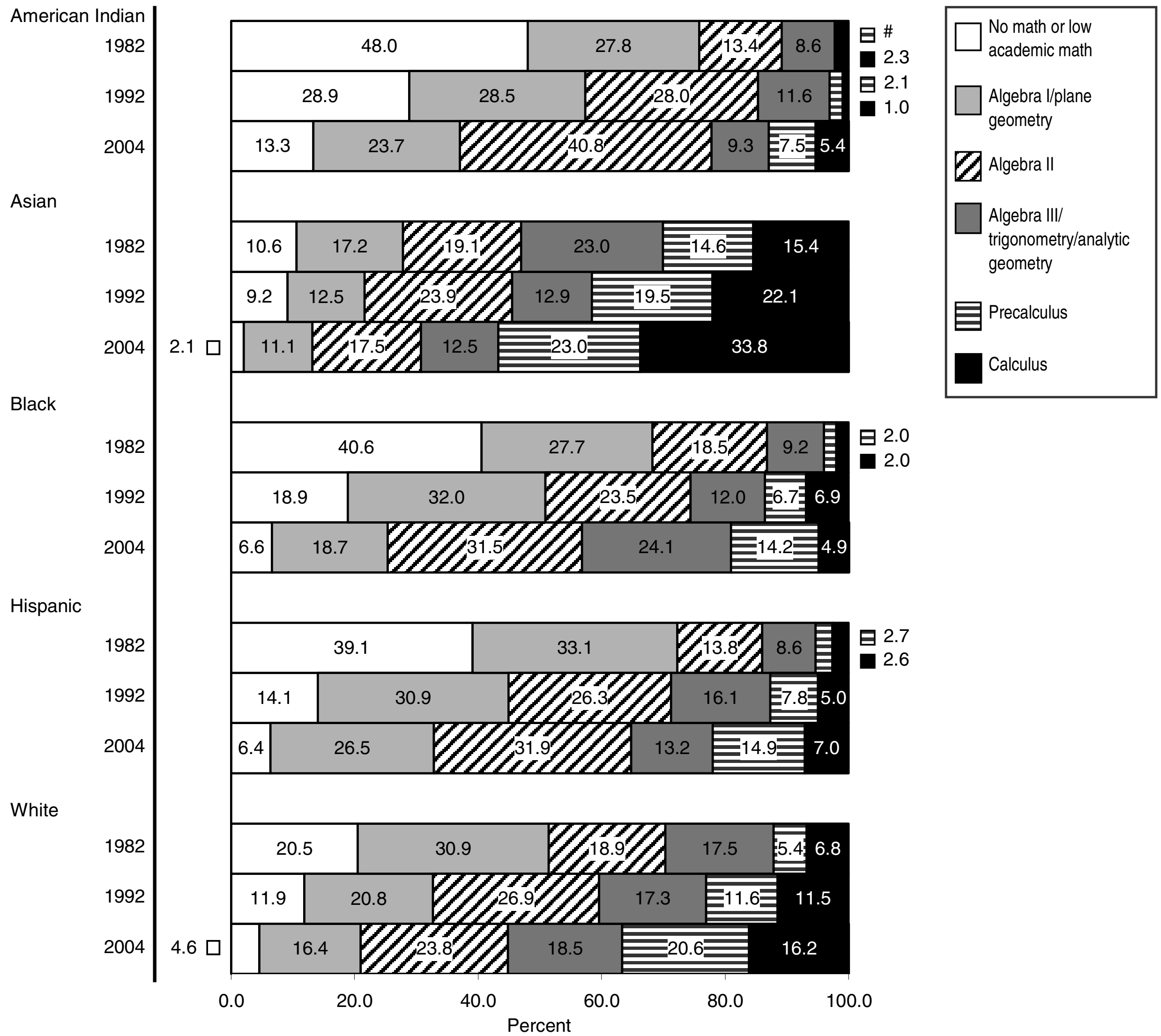
Figure 5. Mean credits earned in mathematics by high school graduates, by race/ethnicity: 1982, 1992, and 2004



NOTE: Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native. See appendix table B-4 for standard errors for this figure.
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), “High School Transcript Study”; National Education Longitudinal Study of 1988 (NELS:88/92), “Second Follow-up, Transcript Survey, 1992”; and Education Longitudinal Study of 2002 (ELS:2002), “First Follow-up, High School Transcript Study, 2004.”

Across all racial/ethnic groups, high school senior coursetaking patterns in each of the three studies increasingly included higher level mathematics classes (figure 6). Between 1982 and 2004, the percentage of seniors taking no mathematics or low academic mathematics courses for all racial/ethnic groups decreased. The most dramatic declines in the percentages of students taking no or low academic mathematics courses were seen among non-Asian minority groups: for American Indians, the decline was from 48 percent in 1982 to 13 percent in 2004; for Blacks, the decline was from 41 percent in 1982 to 7 percent in 2004; and for Hispanics, the decline was from 39 to 6 percent across the same period. For Blacks and Hispanics, these declines were greater between 1982 and 1992 than between 1992 and 2004.

Figure 6. Percentage of high school graduates who completed different levels of mathematics courses, by race/ethnicity: 1982, 1992, and 2004



Rounds to zero.

NOTE: Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native. Detail may not sum to totals because of rounding. See appendix table B-5 for standard errors for this figure.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), “High School Transcript Study”; National Education Longitudinal Study of 1988 (NELS:88/92), “Second Follow-up, Transcript Survey, 1992”; and Education Longitudinal Study of 2002 (ELS:2002), “First Follow-up, High School Transcript Study, 2004.”

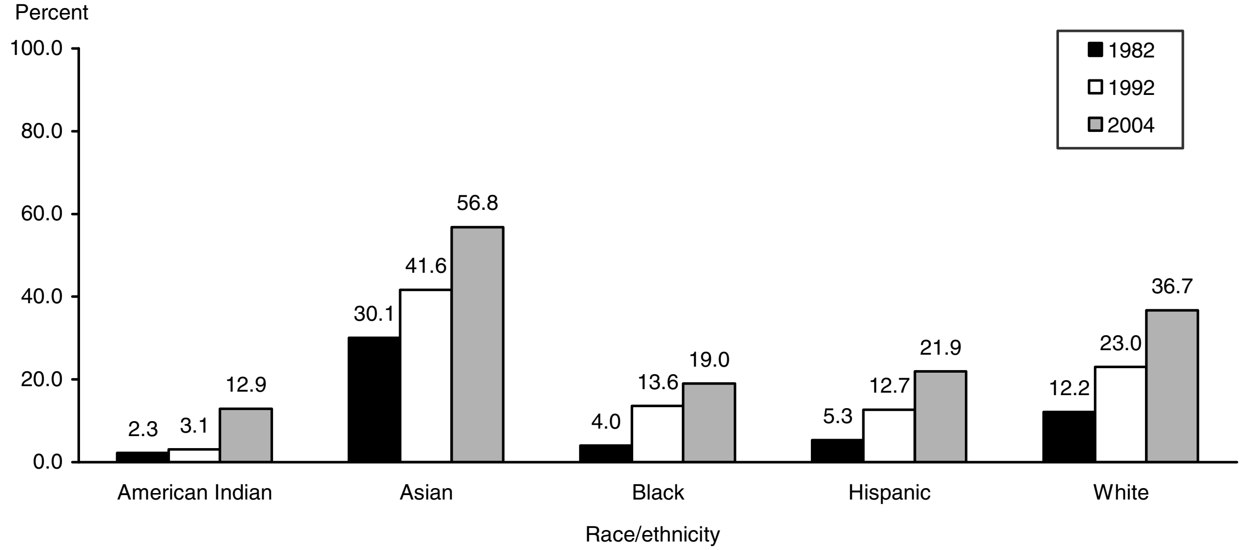
At the middle coursetaking level of algebra II, American Indian, Black, and Hispanic students made gains between 1982 and 2004. Whereas 13 percent of American Indian graduates left high school with algebra II as their highest course in 1982, 41 percent did so in 2004, a gain of 27 percentage points. Similarly, 31 percent of Black graduates completed algebra II as their highest course in 2004, compared with 19 percent in 1982. While 14 percent of Hispanic graduates completed algebra II as their highest course in 1982, 32 percent did so in 2004, an increase of 18 percentage points. Black graduates also completed algebra III/trigonometry/ analytic geometry at higher levels in 2004 than in 1982 (24 percent compared with 9 percent).

At the advanced levels of math coursetaking, all groups completed precalculus at a higher rate in 2004 than in 1982. Among non-Asian groups, in 1982, almost no American Indians, 2 percent of Blacks, 3 percent of Hispanics, and 5 percent of Whites graduated from high school with precalculus as their highest course, whereas in 2004, 8 percent of American Indians, 14 percent of Blacks, 15 percent of Hispanics, and 21 percent of Whites did so. In addition, Whites completed calculus at higher rates in 2004 than in 1982 (16 percent compared with 7 percent).

Compared to all groups except Whites, Asian graduates had higher percentages of students completing precalculus and calculus in all cohorts. In 1982, 15 percent of Asian graduates completed precalculus and 15 percent completed calculus as their highest level courses. By 2004, 23 percent of Asian students completed precalculus and 34 percent completed calculus. Compared to Whites, Asians also participated in precalculus and calculus at higher levels in 1982 and 1992. However, while Asians continued to complete calculus at higher levels than Whites in 2004 (34 percent compared with 16 percent), the rates of completion for precalculus for Asians and Whites were not significantly different in 2004 (23 and 21 percent, respectively). In contrast, only 7 percent of Hispanics, 5 percent of Blacks, and 5 percent of American Indians completed calculus in 2004. It is worth noting that in addition to completing calculus at higher levels than all other racial/ethnic groups, Asian graduates made the greatest gains in the percentage of students completing calculus between 1982 and 2004.

Despite the progress made by Black, Hispanic, and American Indian graduates in taking precalculus or calculus between 1982 and 2004, disparities remained across all three cohorts when comparing these students with their Asian and White counterparts. For example, in 2004, fully 57 percent of Asian graduates completed precalculus or calculus and 37 percent of Whites (a statistically lower percentage than that of Asians) completed one of these high-level courses (figure 7). In comparison, only 22 percent of Hispanics, 19 percent of Blacks, and 13 percent of American Indians completed either precalculus or calculus in 2004.

Figure 7. Percentage of high school graduates who completed precalculus or calculus, by race/ethnicity: 1982, 1992, and 2004



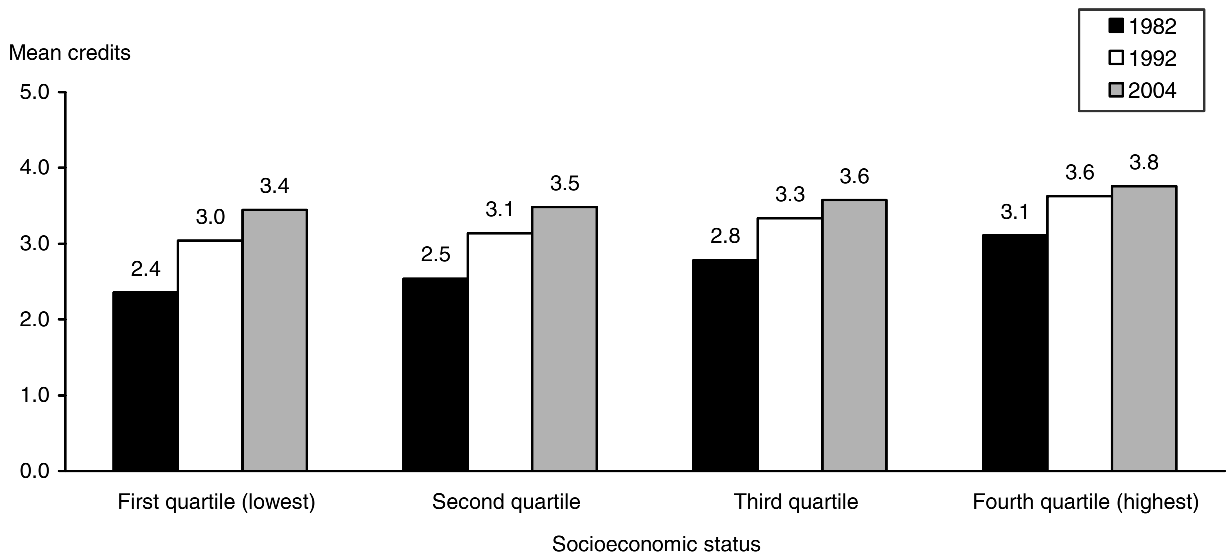
NOTE: Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native. See appendix table B-5 for standard errors for these estimates.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

2.2.3 Socioeconomic Status

Figure 8 shows the distribution of mathematics credits by socioeconomic status (SES), and figure 9 shows the distribution of the mathematics pipeline by SES (see appendix A, section A.7.1, for discussion of the construction of SES quartiles across the three studies). The mean number of credits earned by graduates across SES levels increased between 1982 and 2004. Students in the highest SES quartile earned, on average, the most number of credits in mathematics in 1982, 1992, and 2004 (3.1 credits, 3.6 credits, and 3.8 credits, respectively). Nevertheless, marked increases in credits earned occurred between 1982 and 2004 for students in the lowest two quartiles, rising from 2.4 in 1982 to 3.4 credits in 2004 for students in the first quartile and from 2.5 to 3.5 credits for students in the second quartile. Furthermore, by 2004, the gap between credits earned by students in the highest versus the lowest quartile declined from 0.8 credits in 1982 to 0.3 credits in 2004.

Figure 8. Mean credits earned in mathematics by high school graduates, by socioeconomic status: 1982, 1992, and 2004



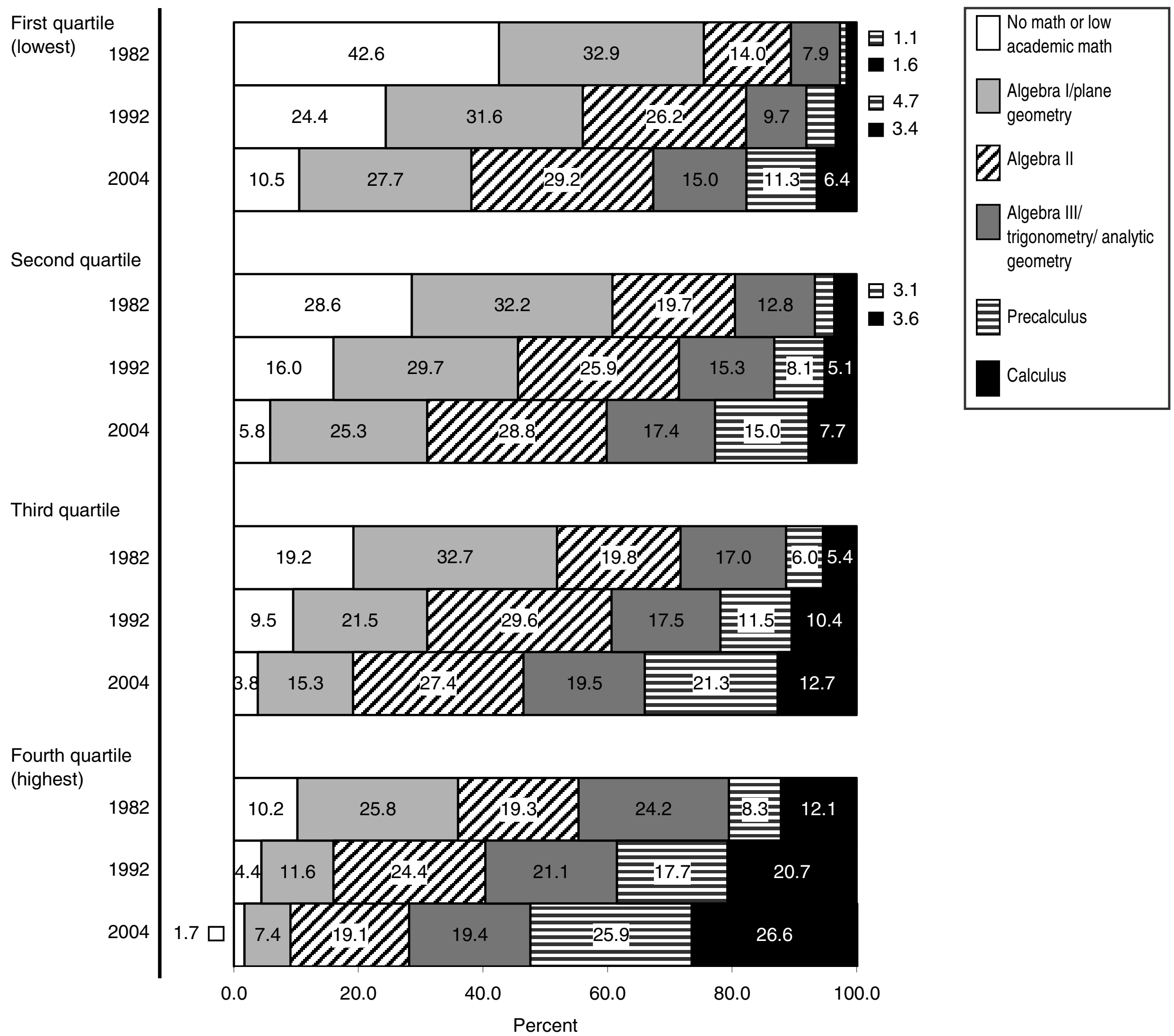
NOTE: See appendix table B-6 for standard errors for this figure.
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

As with the overall trends, students in all SES subgroups increasingly finished high school with upper level math courses and less often finished with only lower level math courses (figure 9). Smaller proportions of students completed only algebra I, low academic, or no mathematics courses in high school in 2004 than in 1982. In particular, the percentages of students in the lowest and second quartiles graduating without taking mathematics courses or taking only low academic courses dropped considerably from 1982 to 1992, and then again from 1992 to 2004. In 1982, 43 percent of students in the lowest quartile and 29 percent of students in the second quartile completed no or low academic mathematics courses. By 2004, these proportions had dropped to 11 percent and 6 percent, respectively.

At the middle level of math coursetaking, a greater proportion of students in the first (lowest), second, and third SES quartiles finished high school with algebra II-level courses; for example, the percentage of students in the first quartile exiting the pipeline at algebra II more than doubled from 1982 to 2004, increasing from 14 to 29 percent. In addition, a greater proportion of graduates from the first SES quartile also took algebra III-level courses. At the top SES quartile, however, a *smaller* proportion of students took algebra III-level courses in 2004 (19 percent) than in 1982 (24 percent), while no differences were detected over that period in the proportions of top SES quartile students taking algebra II as their highest course.

Instead, gains for the highest SES students occurred at the advanced mathematics levels (precalculus and calculus). The highest SES graduates completed calculus at a 15 percentage point higher rate over time, increasing from 12 percent in 1982 to 27 percent in 2004. Although students in all SES groups completed courses in precalculus and calculus at a greater rate in 2004 than in 1982, the percentages of graduates from quartiles below the fourth (highest) SES quartile completing calculus were much lower (e.g., 6 percent of first quartile graduates completed calculus in 2004) than those in the fourth SES quartile. In addition, fourth SES quartile students also increasingly outpaced their closest peers in the third SES quartile: the gap between the percentage of highest quartile and third quartile students completing calculus grew from a 7 percentage point gap to 14 percentage points between 1982 and 2004. Students in the highest SES quartile also made greater absolute gains in completing precalculus than did their peers in the first and second quartiles. For example, while the percentage of highest quartile students who left high school with precalculus as their highest course increased from 8 percent in 1982 to 26 percent in 2004, the lowest SES quartile students grew from 1 percent in 1982 to only 11 percent by 2004.

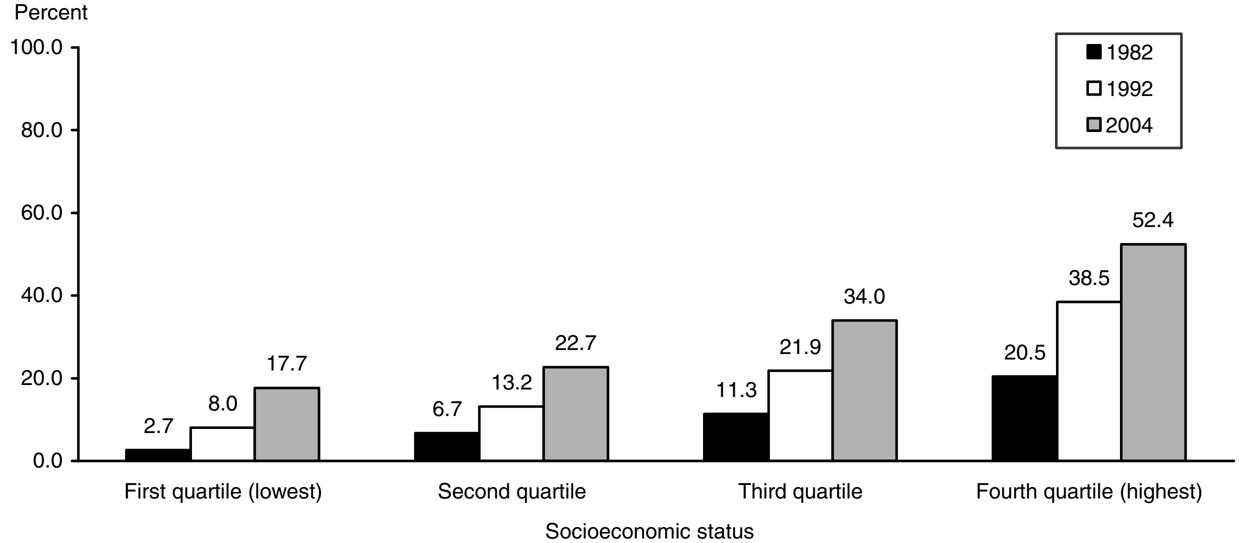
Figure 9. Percentage of high school graduates who completed different levels of mathematics courses, by socioeconomic status: 1982, 1992, and 2004



NOTE: Detail may not sum to totals because of rounding. See appendix table B-7 for standard errors for this figure.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Figure 10. Percentage of high school graduates who completed precalculus or calculus, by socioeconomic status: 1982, 1992, and 2004

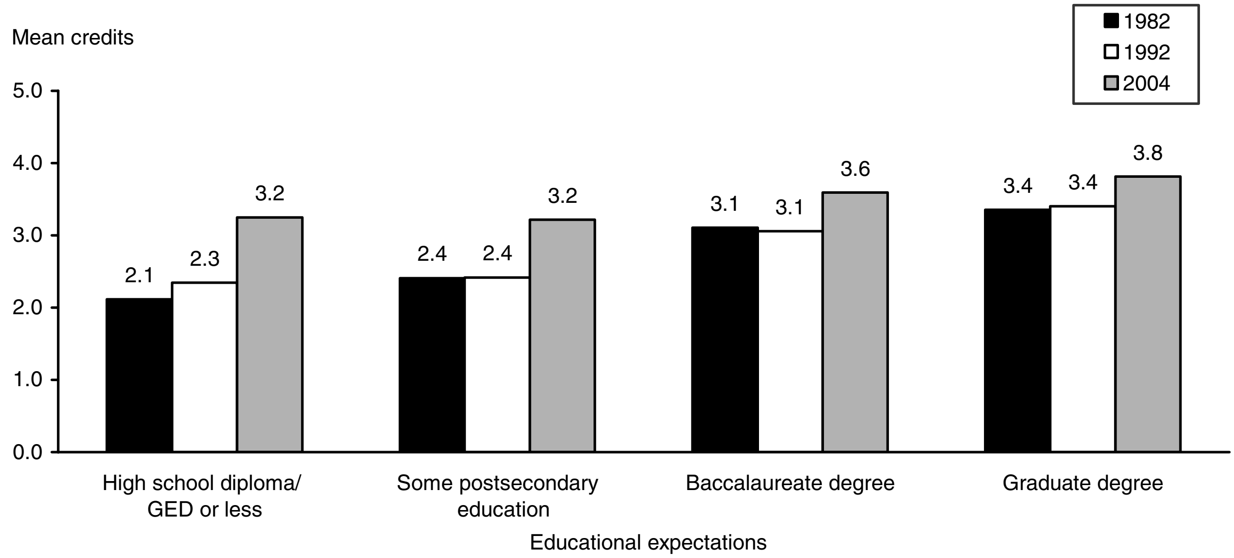


NOTE: See appendix table B-7 for standard errors for these estimates.
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), “High School Transcript Study”; National Education Longitudinal Study of 1988 (NELS:88/92), “Second Follow-up, Transcript Survey, 1992”; and Education Longitudinal Study of 2002 (ELS:2002), “First Follow-up, High School Transcript Study, 2004.”

2.2.4 Educational Expectations

Figure 11 shows the distribution of mathematics credits by educational expectations, and figure 12 shows the distribution of the mathematics pipeline by educational expectations. Not surprisingly, the number of credits earned is related to students’ expectations for their future education. In 1982, 1992, and 2004, students with the highest educational expectations earned more credits in mathematics than their peers with less ambitious expectations. However, from 1982 to 2004, the mean number of credits earned by graduating seniors across all levels of educational expectations increased. In addition, students expecting to earn no more than a high school diploma or General Educational Development (GED) certificate showed the greatest gain in credits earned, increasing from 2.1 credits in 1982 to 3.2 credits in 2004, a gain of 1.1 credits. This gain is associated with a smaller gap compared with graduates expecting to earn a graduate degree. For example, the difference in average credits between the two student groups (those who expected no more than a high school diploma versus those who expected a graduate degree) declined from 1.3 in 1982 to 0.6 credits in 2004. This decrease in disparity suggests that youth with different educational expectations are more uniformly exposed to mathematics content today than 22 years earlier.

Figure 11. Mean credits earned in mathematics by high school graduates, by educational expectations: 1982, 1992, and 2004



NOTE: See appendix table B-8 for standard errors for this figure.
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

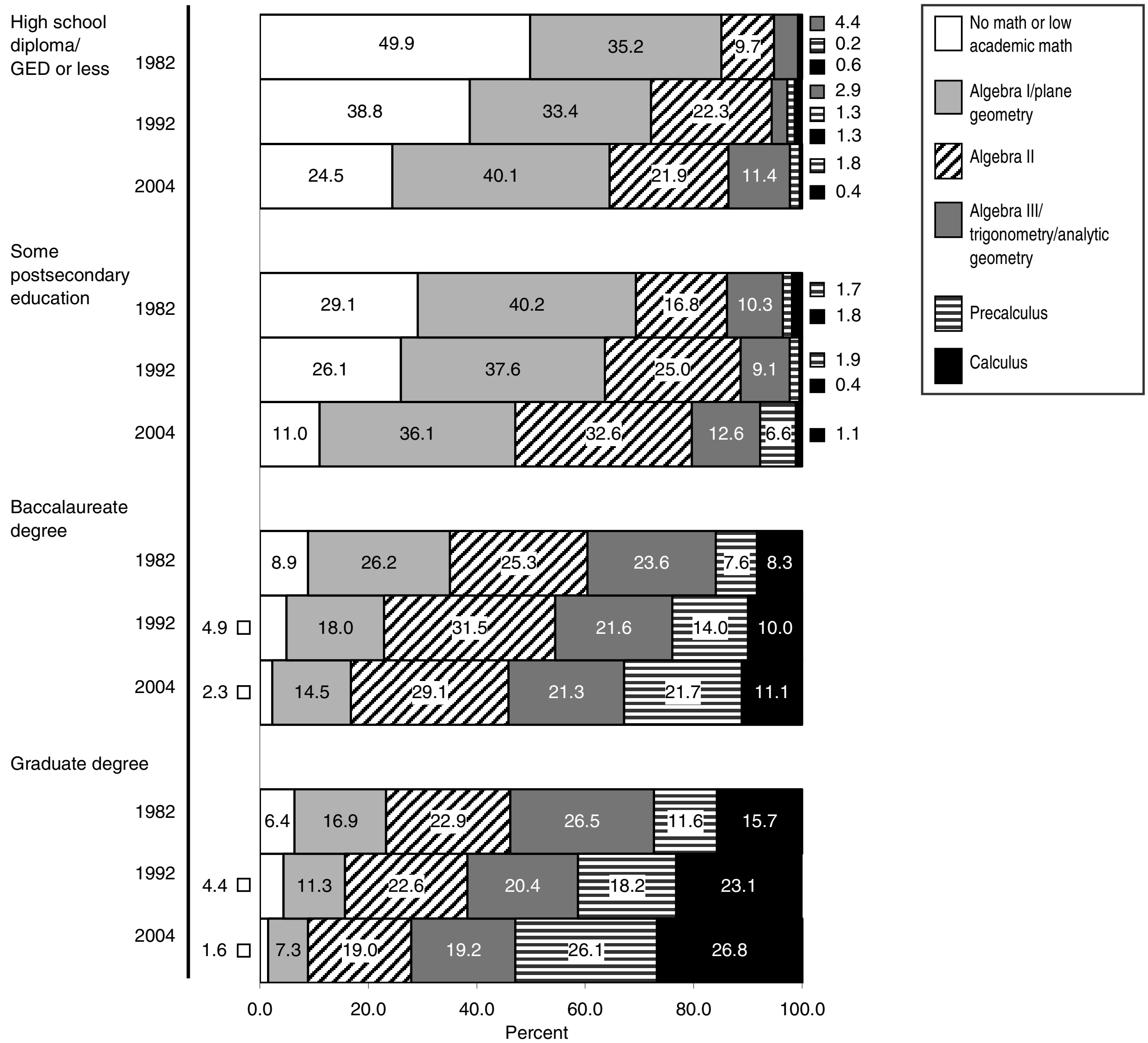
The pipeline results show that shifts in coursetaking from 1982 and 2004 are somewhat uneven for students with different educational expectations (figure 12). For students of all levels of educational expectations, there was a decrease in the proportions graduating without or with low academic math courses. For example, among graduates who expected a baccalaureate degree, the proportions completing high school with no or low academic math courses declined from 9 percent in 1982 to 2 percent in 2004. For all students except those expecting a high school diploma or less, there were declines between 1982 and 2004 in the proportions finishing with just algebra I/plane geometry.

Further up the pipeline, students expecting a high school diploma or less increased their enrollment—for example, moving from 10 percent finishing with algebra II in 1982 to 22 percent in 2004. Students with the highest expectations, however, finished high school with algebra II or algebra III-level courses less often, with increases more prominent in the advanced math courses. For example, among students expecting a graduate degree, algebra III-level-only completion declined from 27 percent in 1982 to 19 percent in 2004. At advanced mathematics levels, however, proportions of these students taking precalculus increased from 12 percent in 1982 to 26 percent in 2004. By contrast, there were no detectable differences between 1982 and 2004 in the proportions of students attaining calculus for students who expected no more than a high school diploma or only some postsecondary education. Thus, the pattern across expectation levels is a decline over time in the lowest level math courses, an increase in the highest level only for students expecting at least a college degree, and mixed results for courses in between.

In terms of differences over time between students with varying expectations, the results indicate that gaps in preparation persisted over time and in some cases grew. With each graduating class, graduates at the lowest two levels of educational expectations were more likely to exit the mathematics pipeline at the level of algebra I than their peers with higher educational expectations. In 2004, 40 percent of students expecting to obtain a high school diploma, GED, or less and 36 percent of students expecting to obtain some postsecondary education left high school with algebra I as their highest mathematics course, compared with 15 percent of students expecting to earn a baccalaureate degree and 7 percent of students expecting to earn a graduate degree. For the two lowest levels of math courses, this represents a slightly smaller gap (by 6 percentage points) than observed in 1982 between graduates expecting a high school diploma or less and those expecting a graduate degree.

By contrast, in all three cohorts, graduates who expected to earn a baccalaureate degree or graduate degree were more likely than their peers with lower educational expectations to complete precalculus or calculus (figure 13). Fifty-three percent of those expecting to earn a graduate degree completed precalculus or calculus in high school, and 33 percent of those expecting only a bachelor's degree did so. But only 8 percent of graduates expecting some postsecondary education only, and only 2 percent of graduates expecting a high school diploma or less, completed precalculus or calculus courses. These disparities persisted and grew much wider from 1982 to 2004: at these two highest course levels, the gap was about 27 percentage points in 1982 between those expecting, at most, a high school diploma and those expecting a graduate degree; in 2004, this gap was 51 percentage points.

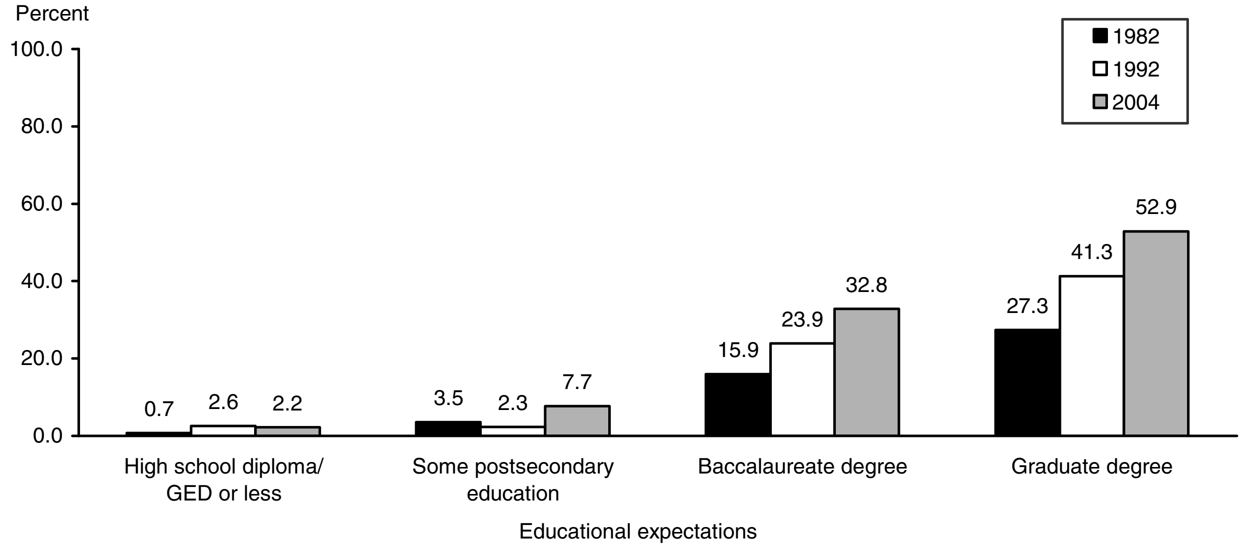
Figure 12. Percentage of high school graduates who completed different levels of mathematics courses, by educational expectations: 1982, 1992, and 2004



NOTE: Detail may not sum to totals because of rounding. See appendix table B-9 for standard errors for this figure.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Figure 13. Percentage of high school graduates who completed precalculus or calculus, by educational expectations: 1982, 1992, and 2004



NOTE: See appendix table B-9 for standard errors for these estimates.

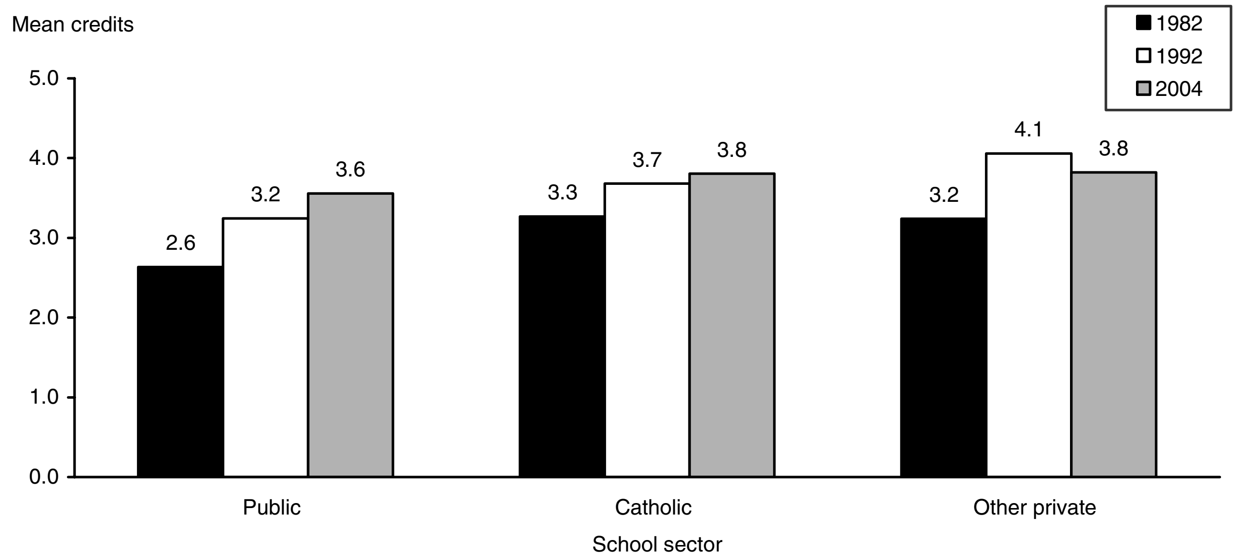
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

2.2.5 School Sector

Compared to student characteristics and expectations, school sector represents one aspect of the context in which coursetaking occurs. Students attending schools in separate sectors may be systematically exposed to different curricular opportunities and varying peer influences related to selecting courses. Some graduates may also have attended schools in different sectors over their high school career. The following results thus represent the profile of school sector graduates and not the curriculum of the schools themselves; the results should be interpreted with care.

Figure 14 shows the distribution of mathematics credits by sector, and figure 15 shows the distribution of the mathematics pipeline by sector. Between 1982 and 2004, students (on average) in each sector increased the number of mathematics credits earned by the end of high school (average credits showed no detectable differences for Catholic and other private school students between 1992 and 2004, however). In all three cohorts, public high school students earned fewer math credits than their Catholic or other private high school peers. No differences were detected in average math credits between Catholic and other private high school students in any year.

Figure 14. Mean credits earned in mathematics by high school graduates, by school sector: 1982, 1992, and 2004



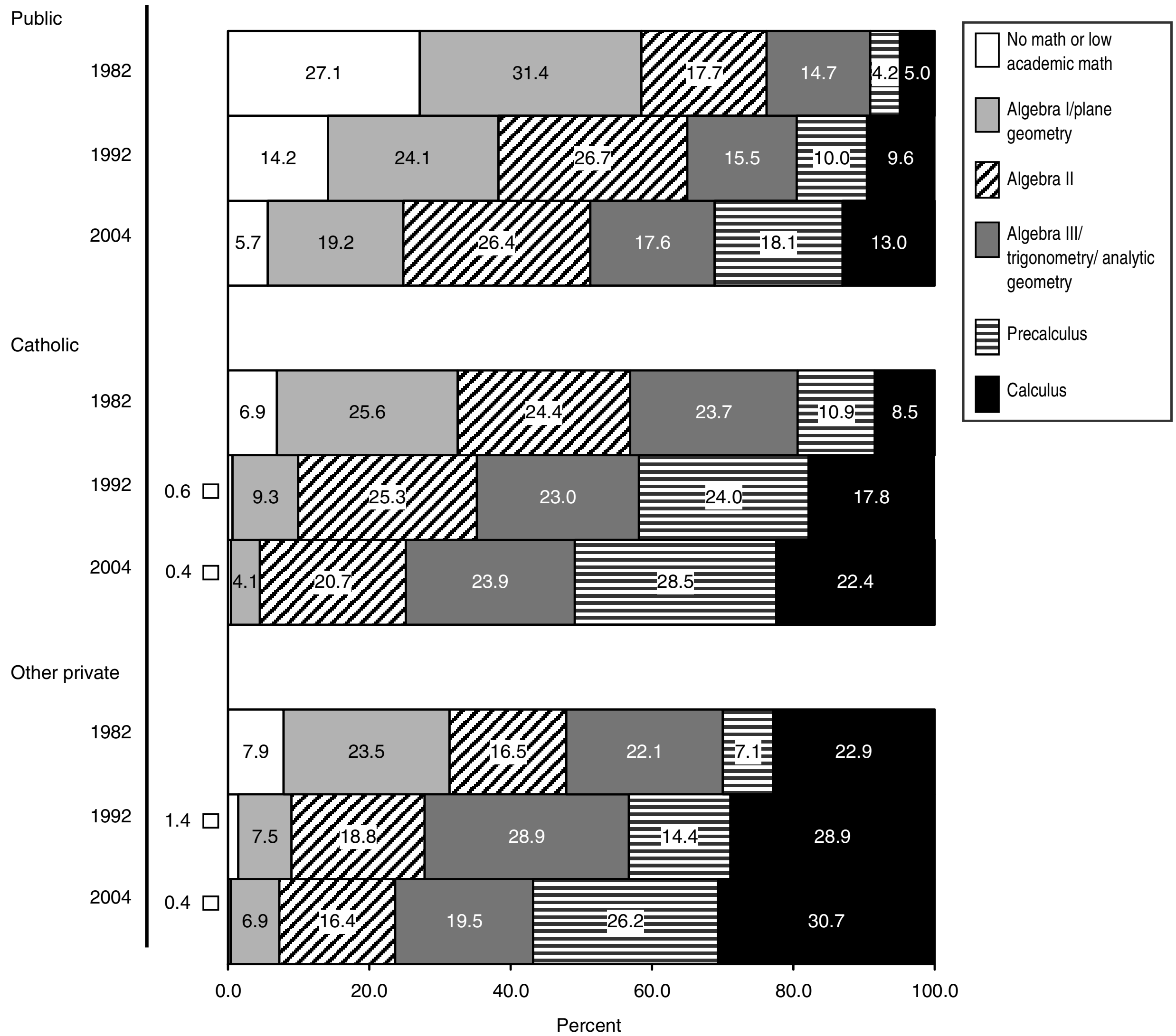
NOTE: See appendix table B-10 for standard errors for this figure.
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

In terms of the levels of courses completed by students from different school sectors, all groups saw a shift over time toward finishing high school with higher level courses (such as precalculus) and away from the two lowest levels of courses (no or low academic math or algebra I/plane geometry) (figure 15). All sectors saw significant decreases in the students exiting with only no math/low academic math and algebra I-level courses, and saw increases in precalculus and calculus coursetaking.

However, depending on the sector, the middle-level courses of algebra II and algebra III-level courses either increased, decreased, or remained stable. For example, among public school graduates, the proportions of students finishing high school with algebra II or algebra III-level courses increased between 1982 and 2004 (from 18 to 26 percent and from 15 to 18 percent, respectively). In contrast, Catholic and other private school students saw no detectable differences in the two middle categories of math coursetaking between 1982 and 2004. Overall, by 2004, public school graduates were more likely than their peers in Catholic or other private schools to exit the mathematics pipeline at algebra I and algebra II-level courses.

Across all school sectors, the greatest shift in advanced-level math coursetaking between 1982 and 2004 was in the percentage of students reaching precalculus as their highest course. In 1982, 4 percent of public school students graduated from high school with precalculus as their highest course, while in 2004, 18 percent did so. The percentage of Catholic school students graduating from high school with precalculus as their highest course was 11 percent in 1982 and 29 percent in 2004; the percentage of other private school students completing precalculus as their highest course was 7 percent in 1982 and 26 percent in 2004. At the lowest levels of coursetaking, the decline in the percentage of students taking no or low academic mathematics courses was greatest for the public school sector, falling from 27 percent in 1982 to 6 percent in 2004. The declines between 1982 and 2004 for Catholic and other private school graduates were greatest in algebra I/plane geometry (from 26 to 4 percent for Catholic school graduates and from 24 to 7 percent for other private school graduates), partly because no and low academic math coursetaking in 1982 was already very low for these groups.

Figure 15. Percentage of high school graduates who completed different levels of mathematics courses, by school sector: 1982, 1992, and 2004

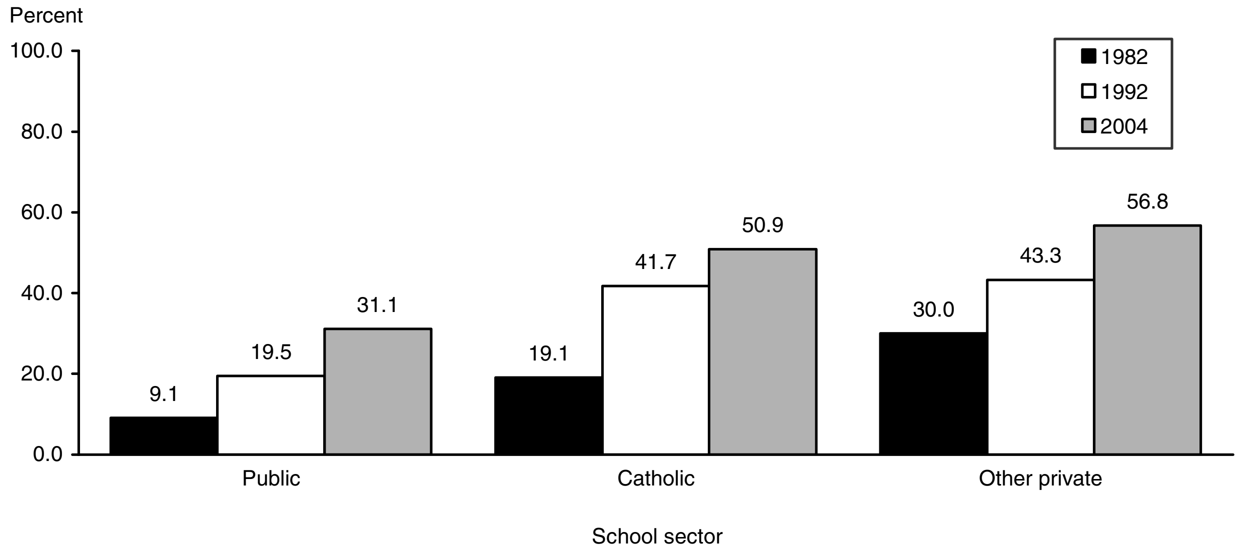


NOTE: Detail may not sum to totals because of rounding. See appendix table B-11 for standard errors for this figure.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), “High School Transcript Study”; National Education Longitudinal Study of 1988 (NELS:88/92), “Second Follow-up, Transcript Survey, 1992”; and Education Longitudinal Study of 2002 (ELS:2002), “First Follow-up, High School Transcript Study, 2004.”

Despite the growth in precalculus and calculus coursetaking among public school graduates, differences in levels of enrollment in calculus between this group and their private school (Catholic and other private school) peers persisted. In addition, by 2004, graduates of other private schools were more likely to complete precalculus than their public school peers; this gap did not exist in either 1982 or 1992. In 1982, 30 percent of graduates of other private schools completed precalculus or calculus, compared with 19 percent of graduates of Catholic schools and 9 percent of graduates of public schools (figure 16). By 2004, the percentage of other private school graduates completing precalculus or calculus was 57 percent, compared with 51 percent of Catholic school graduates and 31 percent of public school graduates.

Figure 16. Percentage of high school graduates who completed precalculus or calculus, by school sector: 1982, 1992, and 2004



NOTE: See appendix table B-11 for standard errors for these estimates.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), “High School Transcript Study”; National Education Longitudinal Study of 1988 (NELS:88/92), “Second Follow-up, Transcript Survey, 1992”; and Education Longitudinal Study of 2002 (ELS:2002), “First Follow-up, High School Transcript Study, 2004.”

2.3 Mathematics Coursetaking Summary

Across the graduating high school classes of 1982, 1992, and 2004, students increased their math coursetaking overall, coming closer to 4 full years of academic work in math in high school. In addition, higher proportions of graduates took advanced coursework over time: the percentage of graduates exiting the pipeline at precalculus increased nearly fourfold, and the percentage of graduates completing calculus more than doubled. By 2004, about a third (33 percent) of graduates took one of these two most advanced levels of mathematics (figure 1). This shift to advanced math coursetaking came at the expense of the lowest math course levels: the proportion of students completing only algebra I or lower dropped in half in the 22 years from 1982 to 2004.

This general pattern held for all student subgroups: males, females, every racial and ethnic group, students from different socioeconomic backgrounds, students attending different school sectors, and even students only expecting to finish high school all took lower level mathematics courses at substantially lower rates and, for the most part, advanced math courses at higher rates. Although the gaps between certain student subgroups tell a more varied story, with some gaps narrowing and others increasing over time, there is an overall shift to more mathematics courses and more courses completed at advanced math levels.

Some groups' mathematics attainment in high school remains fairly low, however, despite similar credit counts. For example, although there was no detectable difference between the number of credits earned in 2004 by Black and White high school graduates, 37 percent of White graduates in 2003 took precalculus and calculus while 19 percent of Black students did so (figure 6). In addition, some gaps among students from different backgrounds or with different educational expectations showed no decline or even grew. A growing gap between 1982 and 2004 occurred among graduates of different SES levels: those from the highest SES quartile made greater gains in completing precalculus or calculus than students from all other SES quartiles (figure 10), and a similar growing advantage held for students who expected a graduate degree versus those who expected a high school diploma or less (figure 13). Majorities of students who expect to attend postsecondary education institutions, even for obtaining bachelor's degrees, do not complete advanced mathematics courses. Finally, private school (Catholic and other private school) graduates had a higher completion rate of precalculus or calculus than did their public school peers in that cohort (figure 16).

Despite aggregate increases in coursetaking and advanced coursetaking (and, conversely, decreases in students taking no math or low-level math), several of these shifts took place between 1982 and 1992. For example, growth in number of credits earned by graduates was greater between 1982 and 1992 than between 1992 and 2004. It is possible that this reflects initial adoption of three credits as a minimum requirement in mathematics for high school graduation (for example, as advocated by the National Committee on Educational Excellence 1983) and less momentum in the latter period toward requiring more mathematics credits. It may also be the case that students are reaching the ceiling in terms of the number and level of courses they can take. Most high school students have the opportunity to take only four math courses, and thus, it is not possible for large increases once mean credits earned moves closer to four. However, as the pipeline measures showed (figure 1), the types of courses taken and when students stop taking them still show extensive variation in academic preparation in mathematics by the end of high school.

Chapter 3
Trends in Science Coursetaking: 1982–2004

This chapter discusses science coursetaking over three cohorts of high school graduates, with respect to both their overall number of science credits and the types of science courses taken. As with mathematics, the number of science credits students attain represents the total amount of science instruction received and the extent to which science courses are a regular feature of the high school experience. Four credits may be a typical upper ceiling on science coursetaking in high school, assuming one science course each year in grades 9 through 12, while three credits is consistent with curriculum standards advocated by policymakers (National Committee on Excellence in Education 1983; Achieve, Inc. 2005; National Governors Association 2005).

The science pipeline measure complements the credit counts by indicating how far along typical science course pathways a student progressed by the end of high school. This measure describes the point at which students exited the science coursetaking pipeline, completing no higher level science classes while in high school. Again, it does not necessarily mean that students took all lower level courses before exiting the pipeline, especially because scientific courses are not as strongly sequential as mathematics pipelines (Burkam and Lee 2003).

In general, the results from this chapter mirror the findings for mathematics: a clear, consistent growth in science coursetaking overall and for most subgroups, more graduates finishing with advanced courses, and far fewer finishing with low-level courses. However, at the most advanced level of science coursetaking, growth was stagnant or only occurred among already advantaged groups.

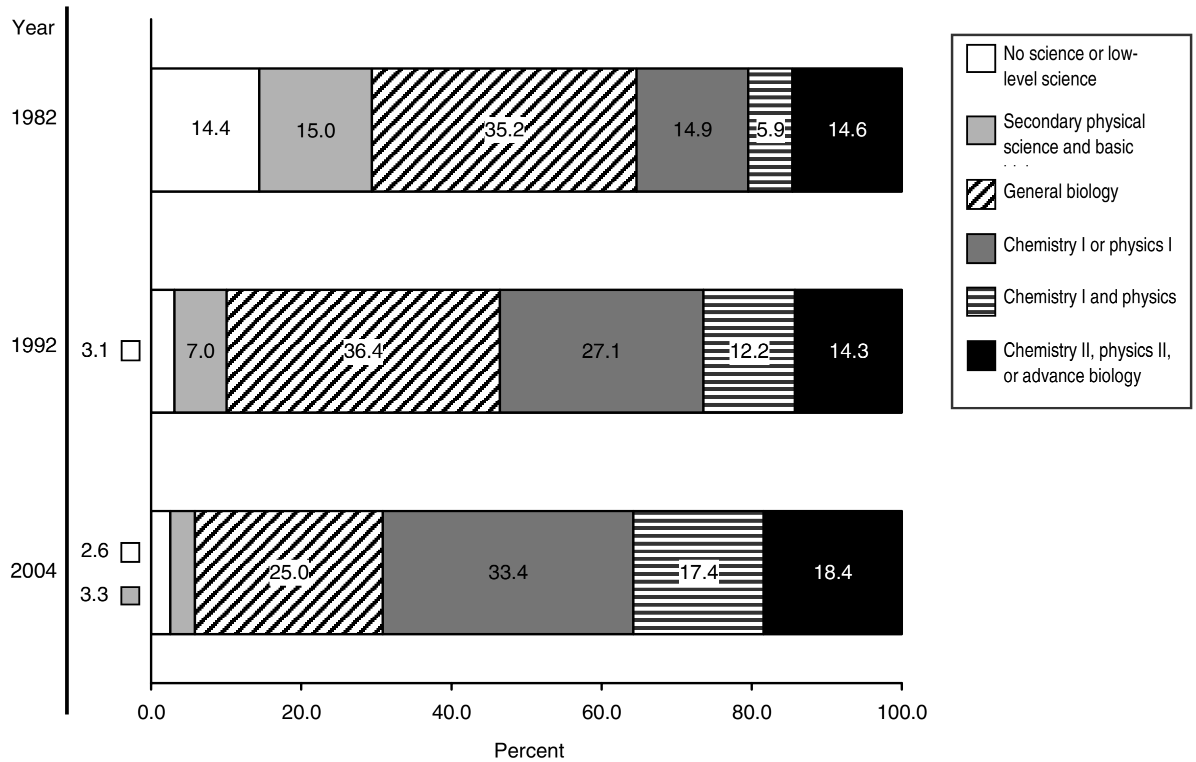
3.1 Overall Trends in Science Coursetaking

The average number of credits in science students earned by the time of graduation rose across the two decades, increasing from 2.2 credits in 1982 to 2.9 credits in 1992 and 3.3 credits in 2004. This represents about one additional academic year of science instruction being taken by high school graduates, on average. Like mathematics, which saw a rapid rise in credits earned between 1982 and 1992, increases in science credits earned were higher in the first period than in the second.

A marked change occurred in the distribution of science coursetaking among high school graduates between 1982 and 2004: across the 22 years, the distribution shifted to the upper end of the pipeline (figure 17). The percentage of graduates who either did not complete any science courses or completed only low-level science courses dropped from 14 percent in 1982 to 3 percent in 1992. Declines were also observed for the secondary physical science and basic biology level (from 15 percent in 1982 to 3 percent of graduates in 2004 completing only that level) and the general biology level (from 35 to 25 percent).

In the top three levels of science coursetaking, graduates increased their participation. The largest growth occurred for the proportion of graduates exiting the pipeline at chemistry I or physics I, which grew from 15 percent in 1982 to 33 percent in 2004. The corresponding percentages for those exiting the pipeline with both chemistry I and physics I moved from 6 percent to 17 percent. By contrast, at the most advanced level of science courses—chemistry II, physics II, or advanced biology—there was no substantive difference in participation between 1982 and 2004. Overall, the top three science coursetaking levels saw a doubling from 35 percent of graduates completing one of them in 1982 to 70 percent completing one of them in 2004.

Figure 17. Percentage of high school graduates who completed different levels of science courses: 1982, 1992, and 2004



NOTE: Detail may not sum to totals because of rounding. See appendix table B-12 for standard errors for this figure.

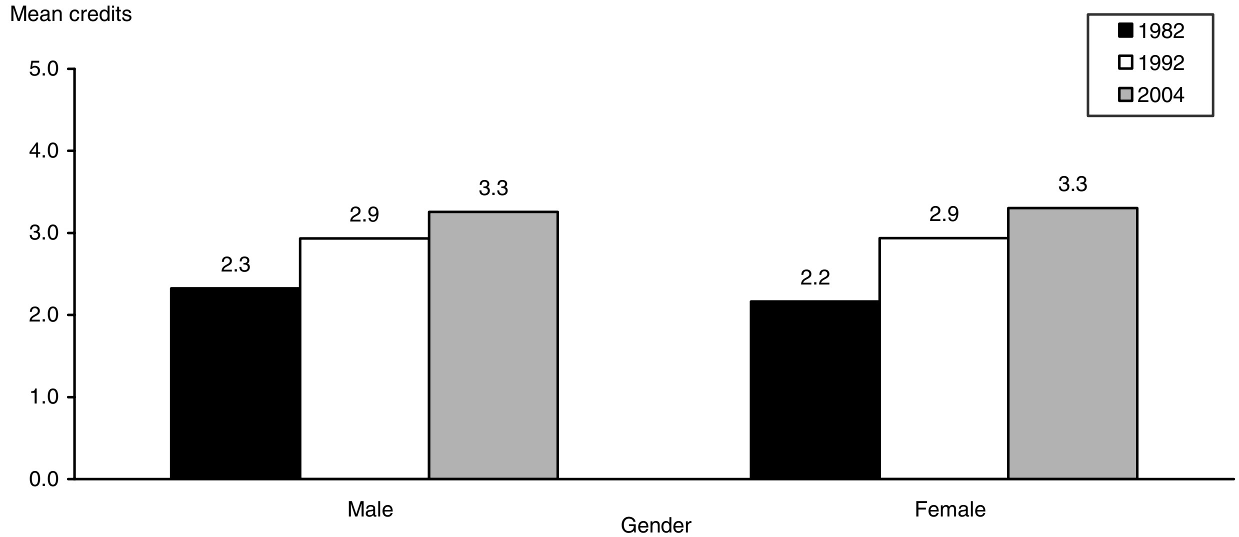
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), “High School Transcript Study”; National Education Longitudinal Study of 1988 (NELS:88/92), “Second Follow-up, Transcript Survey, 1992”; and Education Longitudinal Study of 2002 (ELS:2002), “First Follow-up, High School Transcript Study, 2004.”

3.2 Trends in Science Coursetaking Among Student Subgroups

3.2.1 Sex

Figure 18 shows the distribution of science credits by sex, and figure 19 shows the distribution of the science pipeline by sex. The mean number of credits earned in science by both males and females increased from 1982 to 2004. Males earned 3.3 credits in science in 2004, compared with 2.3 credits in 1982; females also earned 3.3 credits in science in 2004, compared with 2.2 credits in 1982. There were no detectable differences between males and females in the number of credits earned in science in the 1982, 1992, and 2004 cohorts.

Figure 18. Mean credits earned in science by high school graduates, by sex: 1982, 1992, and 2004



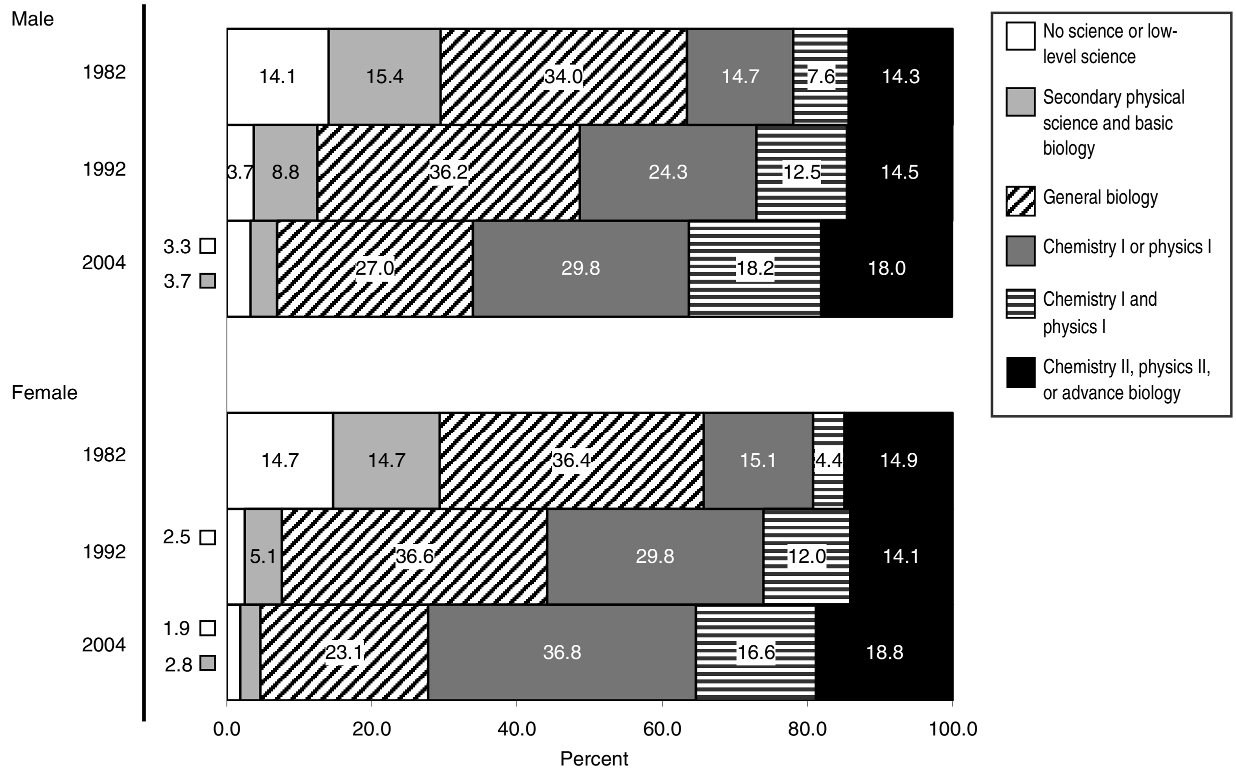
NOTE: See appendix table B-13 for standard errors for this figure.
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Changes in science coursetaking for males and females mirrored the overall trend. Between 1982 and 2004, students of both sexes became more likely to complete courses at the top three levels of science coursetaking, and they became less likely to exit the science coursetaking pipeline at the bottom three levels (figure 19). At the lowest end, the percentage of males taking no science or low-level science courses decreased from 14 percent in 1982 to 3 percent in 2004, while the percentage of females doing so dropped from 15 percent in 1982 to 2 percent in 2004.

In 1992 and 2004, there were no measurable differences between male and female participation rates in the top two most advanced levels of science courses (i.e., chemistry I and physics I; and chemistry II, physics II, or advanced biology), with 35 percent of females and 36 percent of males completing courses at this level in 2004. In the next lowest level of science coursetaking, chemistry I or physics I, 15 percent of males and females exited the pipeline in 1982, but by 1992, the rate of participation for females surpassed that of males, which remained true in 2004 as well: in the latest cohort, 37 percent of females completed either of these courses, compared with 30 percent of males.[12]

[12] This female advantage derives from an advantage in chemistry I, with more females than males completing it overall (66 percent of females versus 59 percent of males complete chemistry I at some point in high school—results not shown); in contrast, there is no substantive difference in the percentage of males and females completing physics I.

Figure 19. Percentage of high school graduates who completed different levels of science courses, by sex: 1982, 1992, and 2004

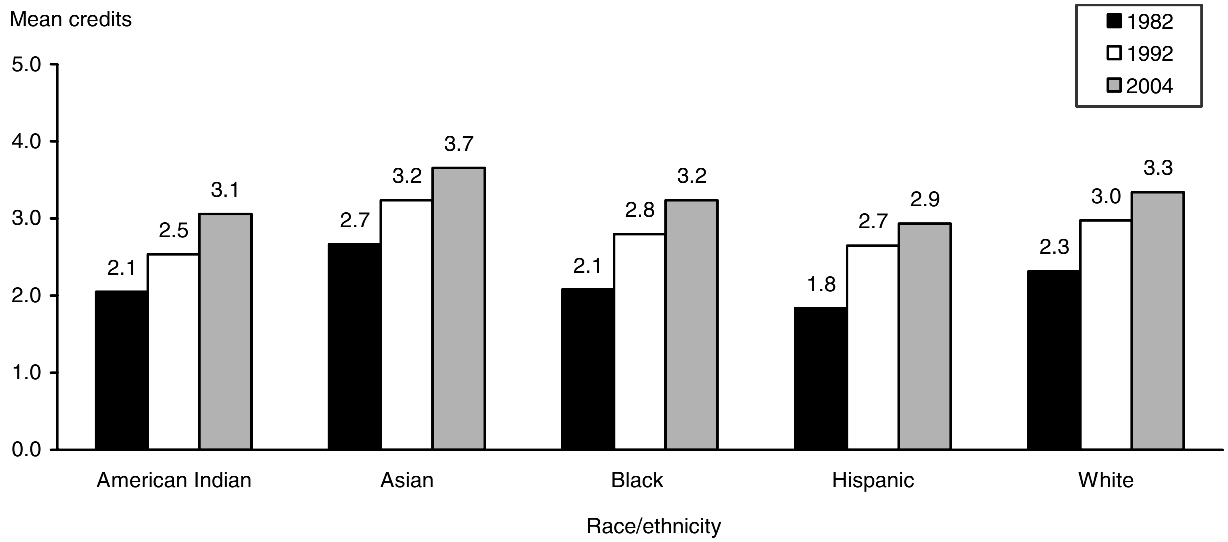


NOTE: Detail may not sum to totals because of rounding. See appendix table B-14 for standard errors for this figure.
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

3.2.2 Race/Ethnicity

Figure 20 shows the distribution of science credits by race/ethnicity, and figure 21 shows the distribution of the science pipeline by race/ethnicity. Between 1982 and 2004, the mean number of credits earned in science increased for all racial/ethnic groups. Asians earned the most number of credits across the 22-year period. In 2004, in addition to Asian graduates earning more credits on average (3.7) than other groups, Black and White graduates earned more credits than Hispanic graduates (3.2 and 3.3 compared to 2.9, respectively). Nevertheless, by 2004, all graduates earned, on average, 2.9 credits or more in science.

Figure 20. Mean credits earned in science by high school graduates, by race/ethnicity: 1982, 1992, and 2004



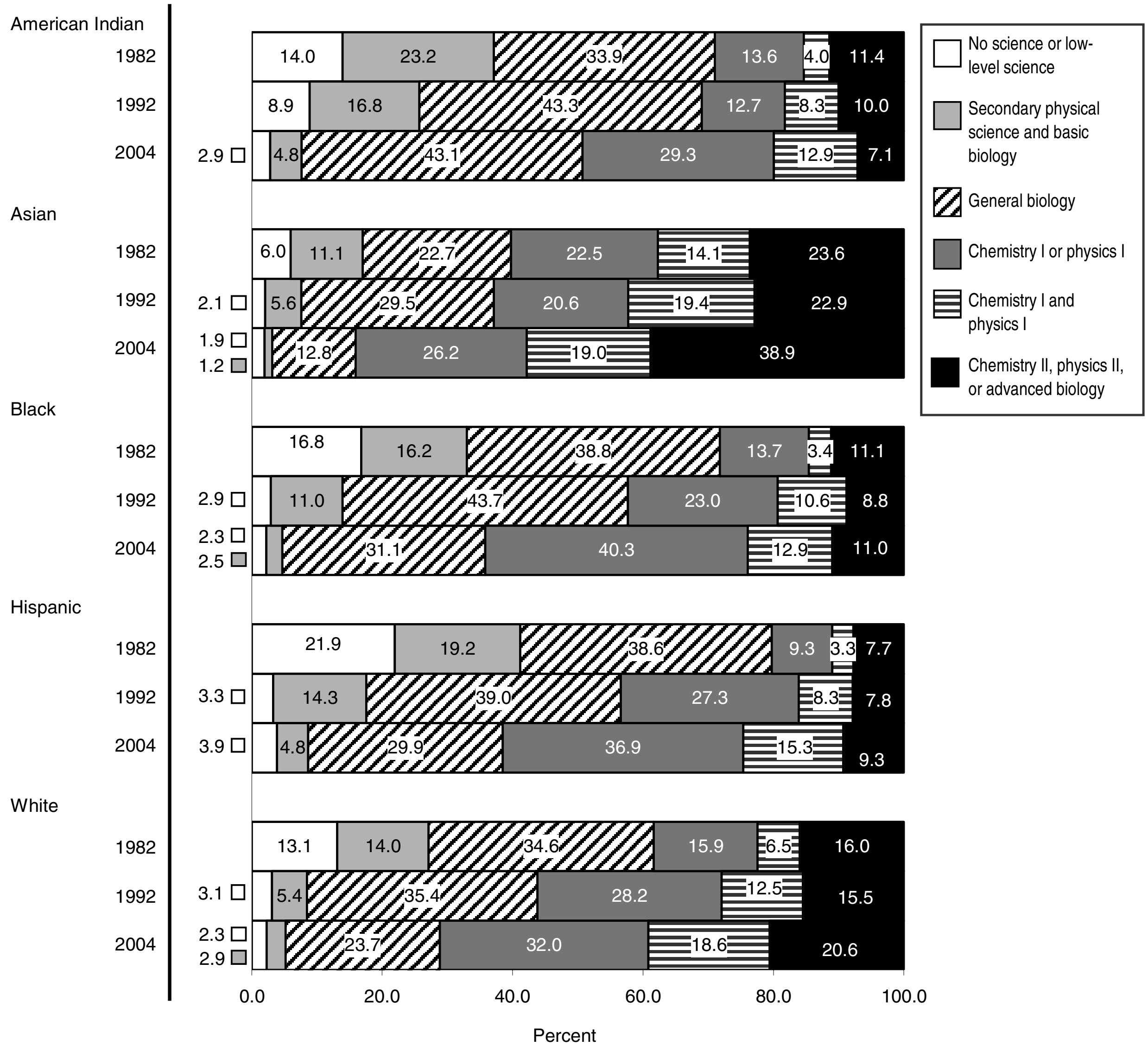
NOTE: Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native. See appendix table B-15 for standard errors for this figure.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

In terms of science coursetaking levels, each racial/ethnic group finished high school having completed higher science courses in 2004 than in 1982 (figure 21). Across all racial/ethnic groups except American Indians (where apparent differences were not statistically significant), smaller proportions of students completed only the two lowest levels (no or low-level science, and secondary physical science or basic biology). At the level of general biology, all groups except American Indians saw declines in completion rates. For example, the percentages of Hispanic students completing only the general biology level fell from 39 percent in 1982 to 30 percent in 2004.

In higher level science courses, greater proportions of students in all racial/ethnic categories, except for Asians, finished high school with chemistry I or physics I. Additionally, greater proportions of Blacks, Whites, and Hispanics completed the chemistry I and physics I level of coursetaking. For example, the percentages of Whites completing chemistry I and physics I rose from 6 percent in 1982 to 19 percent in 2004. However, at the most advanced course level (chemistry II, physics II, or advanced biology), only Asian and White students completed this level at higher rates in 2004 than in 1982. One of the most notable changes in advanced science coursetaking from 1982 to 2004 occurred among the percentages of Asian students completing chemistry II, physics II, or advanced biology. In 1982, nearly 24 percent of Asian graduates exited the science pipeline at this highest level. However, by 2004, the percentage increased to 39 percent—a 15 percentage point increase in an already high participation rate.

Figure 21. Percentage of high school graduates who completed different levels of science courses, by race/ethnicity: 1982, 1992, and 2004



NOTE: Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native. Detail may not sum to totals because of rounding. See appendix table B-16 for standard errors for this figure.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), “High School Transcript Study”; National Education Longitudinal Study of 1988 (NELS:88/92), “Second Follow-up, Transcript Survey, 1992”; and Education Longitudinal Study of 2002 (ELS:2002), “First Follow-up, High School Transcript Study, 2004.”

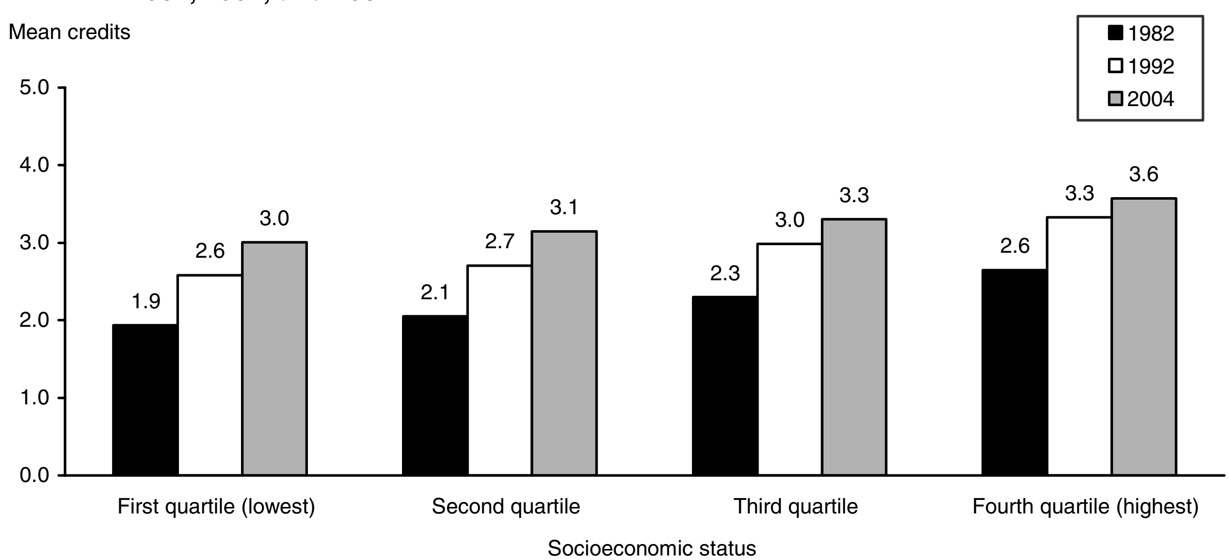
Racial/ethnic differences in graduates’ rates of enrollment in more challenging science courses persisted or grew across the 22-year period. For example, in 1982, Asians completed the most advanced level of science courses (i.e., chemistry II or physics II or advanced biology) at a higher rate than all other racial ethnic groups (24 percent of Asians compared with 8 percent of Hispanics, 11 percent of Blacks, 11 percent of American Indians, and 16 percent of Whites). These gaps between Asian and all other racial/ethnic groups increased overall between 1982 and 2004. By 2004, 9 percent of Hispanics, 11 percent of Blacks, 7 percent of American Indians, and 21 percent of Whites completed chemistry II, physics II, or advanced biology, compared with

39 percent of Asians. In addition, although White graduates continued to lag behind their Asian peers in completing this most advanced level of science courses in 2004, their participation rate was nevertheless higher than those of their non-Asian minority peers.

3.2.3 Socioeconomic Status

Figure 22 shows the distribution of science credits by socioeconomic status (SES), and figure 23 shows the distribution of the science pipeline by SES (see appendix A, section A.7.1, for discussion of the construction of SES quartiles across the three studies). Between 1982 and 1992 and between 1992 and 2004, the mean number of credits earned in science increased for students from all SES quartiles. As with the overall trend, increases were comparable for all SES groups over time. Graduates from the highest SES quartile earned the most number of credits relative to graduates from all other SES quartiles in 1982, 1992, and 2004. Graduates from each of the lowest two quartiles earned the least number of credits relative to graduates from each of the highest two SES quartiles in 1982 and 1992. These gaps persisted in 2004, except that the discrepancy in credits earned between second and third quartile students had closed. Nevertheless, by 2004 graduates from all SES quartiles earned, on average, 3.0 or more credits in science.

Figure 22. Mean credits earned in science by high school graduates, by socioeconomic status: 1982, 1992, and 2004



NOTE: See appendix table B-17 for standard errors for this figure.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

As with the overall trends in levels of science courses taken, smaller proportions of high school graduates in all SES quartiles exited the science pipeline at the three lowest levels of coursetaking (no or low-level science, secondary physical science and basic biology, and general biology) in 2004 than in 1982 (figure 23). In the first three SES quartiles, the three lowest level courses dropped from being a majority among students to a minority (for the highest SES quartile students, the first point of comparison in 1982 began with a minority proportion graduating high school with these courses). The largest percentage point drop within the lowest three science course levels occurred among the first (lowest) SES quartile group, where the percentage of graduates exiting high school with no or low-level science dropped from 23 percent in 1982 to 5 percent in 2004, an 18 point decline.

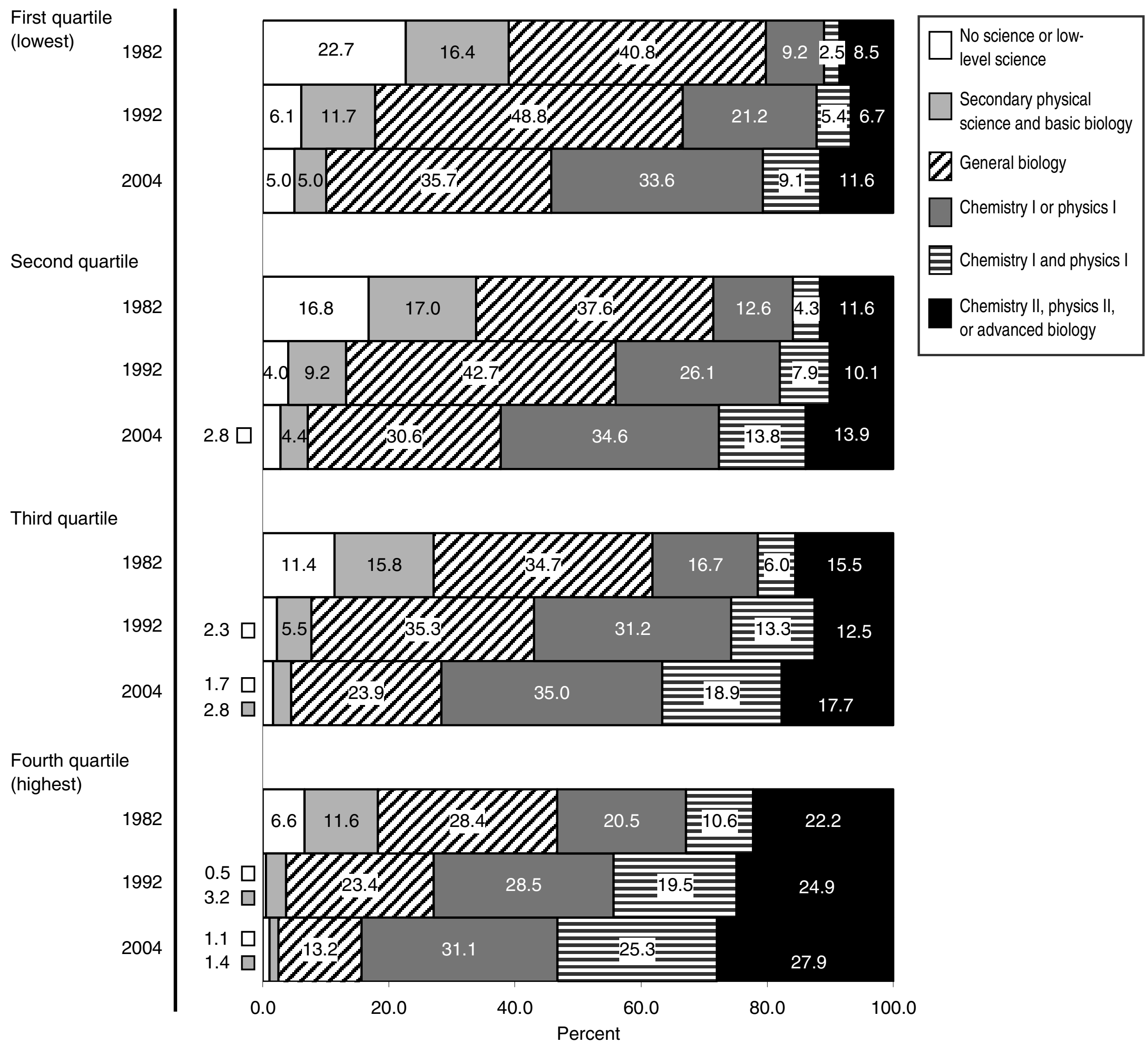
At two upper science course levels—chemistry I or physics I, and chemistry I and physics I—the percentages of students completing them increased over time for all SES groups. The largest increase among SES quartiles was again observed for the first (lowest) group compared to the third and fourth (highest) groups: among first SES quartile students, the percentages completing high school with chemistry I or physics I grew from 9 percent in 1982 to 34 percent in 2004. Graduates in the second and third SES quartiles also made greater gains at this level (chemistry I or physics I) than the fourth (highest) SES quartile students (from 13 to 35 percent for second SES quartile students, and from 17 to 35 percent for third SES quartile students, from 1982 to 2004). However, at the highest level (chemistry II, physics II, or advanced biology), only the highest SES quartile increased participation from 1982 to 2004, moving from 22 percent to 28 percent completing high school with at least one of these most advanced science courses.

Variations in science coursetaking patterns across SES quartiles persisted across the decades. In all three cohorts, students from the highest SES quartile were more likely than those from the lowest, second, and third quartiles to complete science courses at the two most advanced levels, that is, chemistry I and physics I, and chemistry II, physics II, or advanced biology. For example, in 2004, 28 percent of students from the highest SES quartile completed chemistry II, physics II, or advanced biology, compared with 18 percent of students from the third SES quartile, 14 percent of students from the second SES quartile, and 12 percent of students from the lowest SES quartile. Similarly, 25 percent of the highest SES quartile graduates exited the pipeline at chemistry I and physics I, compared with 19 percent of third SES quartile, 14 percent of second SES quartile, and 9 percent of first (lowest) SES quartile graduates.

3.2.4 Educational Expectations

Figure 24 shows the distribution of science credits by educational expectations, and figure 25 shows the distribution of the science pipeline by educational expectations. The mean number of credits earned in science by graduating seniors at all levels of educational expectations increased from 1982 to 2004. Although nearly all of the gaps in credits earned between students at different levels of educational expectations decreased from 1982 to 2004, students expecting to earn no more than a high school diploma or no more than some postsecondary education continued to earn fewer credits in science than their peers who expected to earn a college or graduate degree. In 2004, graduates at the two lowest levels of educational expectations earned 2.7 and 2.8 credits, respectively, while graduates at the two higher levels of educational expectations earned 3.3 and 3.6 credits, respectively.

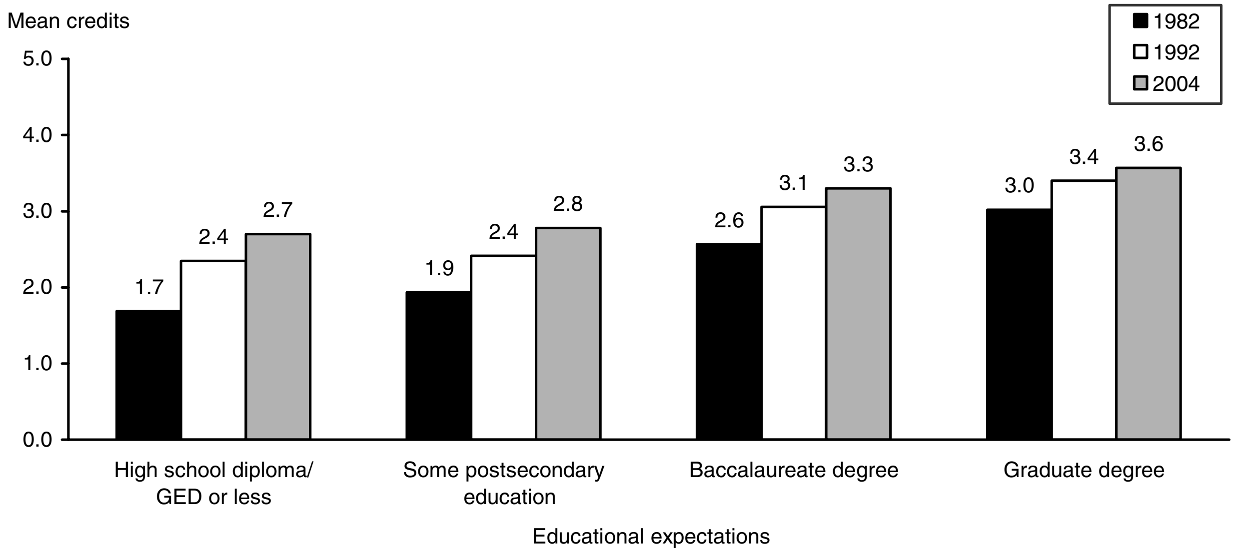
Figure 23. Percentage of high school graduates who completed different levels of science courses, by socioeconomic status: 1982, 1992, and 2004



NOTE: Detail may not sum to totals because of rounding. See appendix table B-18 for standard errors for this figure.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Figure 24. Mean credits earned in science by high school graduates, by educational expectations: 1982, 1992, and 2004



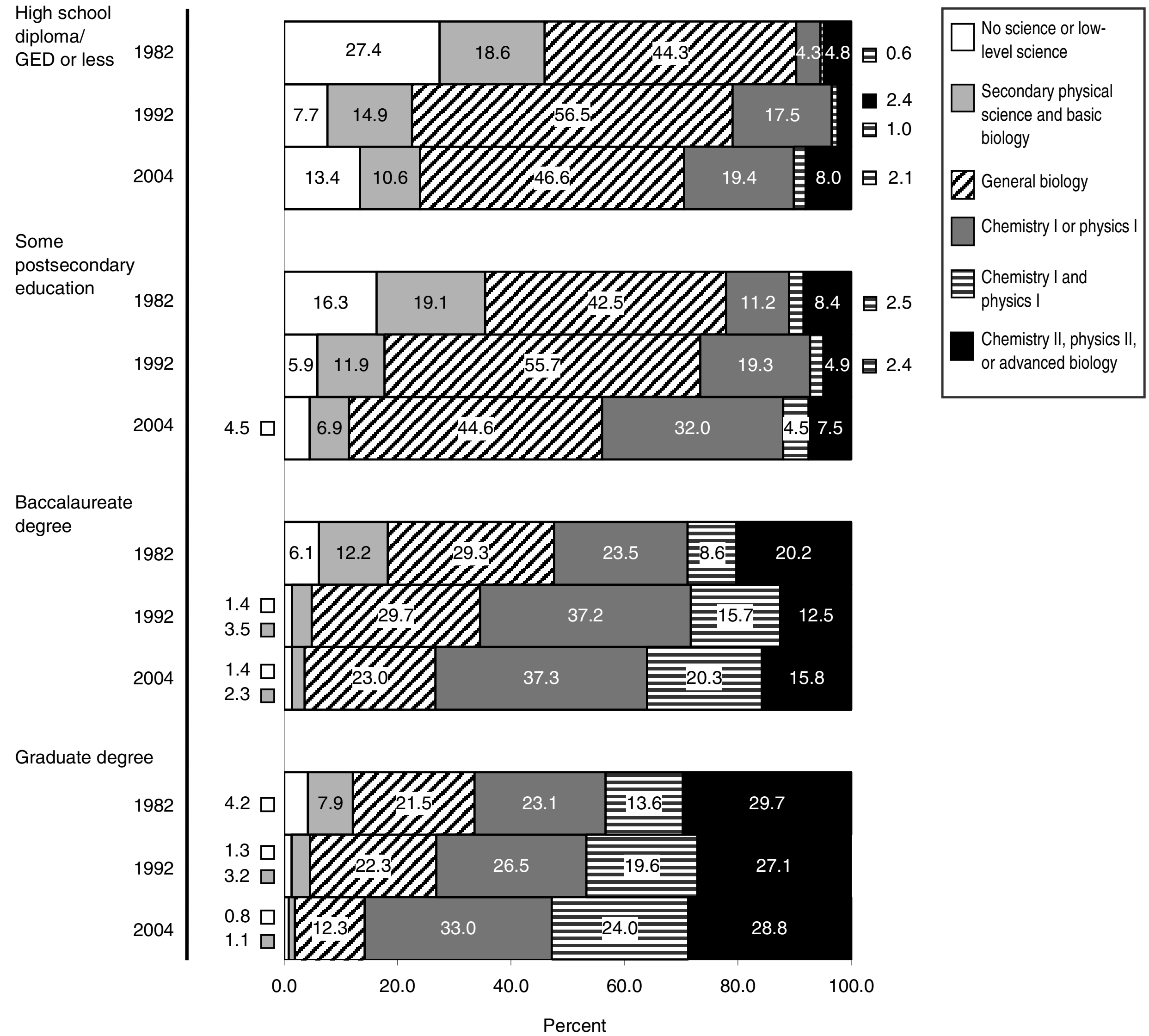
NOTE: See appendix table B-19 for standard errors for this figure.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Changes in science coursetaking for graduating high school students at all levels of educational expectations reflect the overall trend in science coursetaking patterns (figure 25). Between 1982 and 2004, graduating seniors across educational expectation levels became less likely to exit the science coursetaking pipeline having taken no or only low-level science courses and more likely to leave high school with chemistry I or physics I as their highest course level. Students expecting to earn a college or graduate degree were also more likely to complete chemistry I and physics I as their highest course in 2004 than in 1982. At the highest level of science courses—chemistry II, physics II, or advanced biology—there was little or no improvement for students at any level of educational expectations.

While the pattern of changes in science coursetaking within each group were largely similar, differences in levels of participation based on educational expectations persisted across the decades. In 1982 and 2004, students at the lowest level of educational expectations were more likely than students at all other levels of educational expectations to exit the science coursetaking pipeline having taken no or only low-level science courses. In 1982, 27 percent of students expecting to obtain a high school degree, GED, or less exited the pipeline at the level of no or low-level science courses. By 2004, this percentage had decreased to 13 percent. In comparison, in 2004, 5 percent of students expecting to obtain only some postsecondary education exited at this level, as did about 1 percent each of graduates expecting to earn a baccalaureate degree and graduates expecting to earn a graduate degree.

Figure 25. Percentage of high school graduates who completed different levels of science courses, by educational expectations: 1982, 1992, and 2004



NOTE: Detail may not sum to totals because of rounding. See appendix table B-20 for standard errors for this figure.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

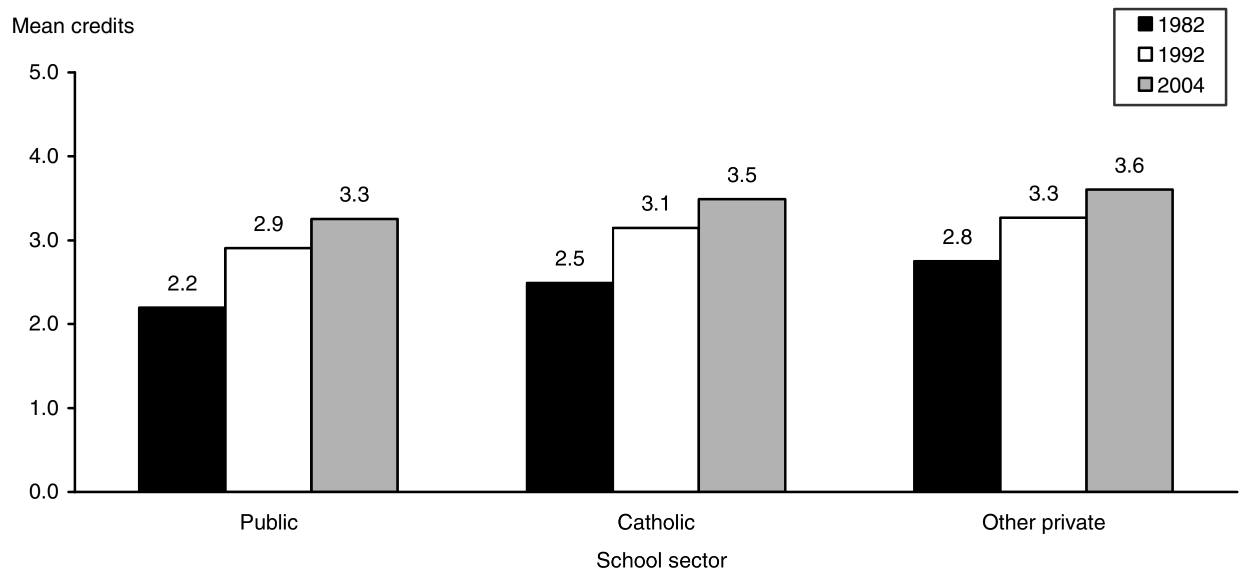
Additionally, in all three cohorts, students expecting to obtain a baccalaureate or graduate degree were more likely than students with lower educational expectations to complete science courses at the highest level. High school seniors who expected to earn a graduate degree continued to be most likely to complete chemistry II or physics II or advanced biology. Nearly 29 percent of students expecting to earn a graduate degree completed the most advanced level of science courses, compared with 16 percent of students expecting to earn a baccalaureate degree, 7 percent of students expecting to earn some postsecondary education, and 8 percent of students expecting to earn no more than a high school diploma or General Educational Development (GED) certificate.

3.2.5 School Sector

Compared to direct measures of student characteristics and expectations, school sector represents one aspect of the context in which coursetaking occurs. Not only may the characteristics and expectations of students in different sectors differ, but students attending schools in separate sectors may be systematically exposed to different curricular opportunities and varying peer influences related to selecting courses. Some graduates may also have attended schools in different sectors over their high school career. The following results thus represent the profile of school sector graduates and not the schools themselves; reasons for differences across students from different school sectors are not explored, and the results should be interpreted with caution.

Figure 26 shows the distribution of science credits by school sector, and figure 27 shows the distribution of the science pipeline by school sector. The mean number of credits earned in science by graduates of all school sectors increased from 1982 to 2004; in 2004, students in all school sectors earned, on average, more than 3.0 credits in science. However, differences in credits earned by public school graduates compared with Catholic and other private school graduates persisted across the two decades: in each of the three cohorts, private school students earned more credits in science than did their public school peers (in 2004, other private school graduates earned 3.6 credits and Catholic school students earned 3.5 credits in science, on average, while public school graduates earned 3.3 credits on average).

Figure 26. Mean credits earned in science by high school graduates, by school sector: 1982, 1992, and 2004



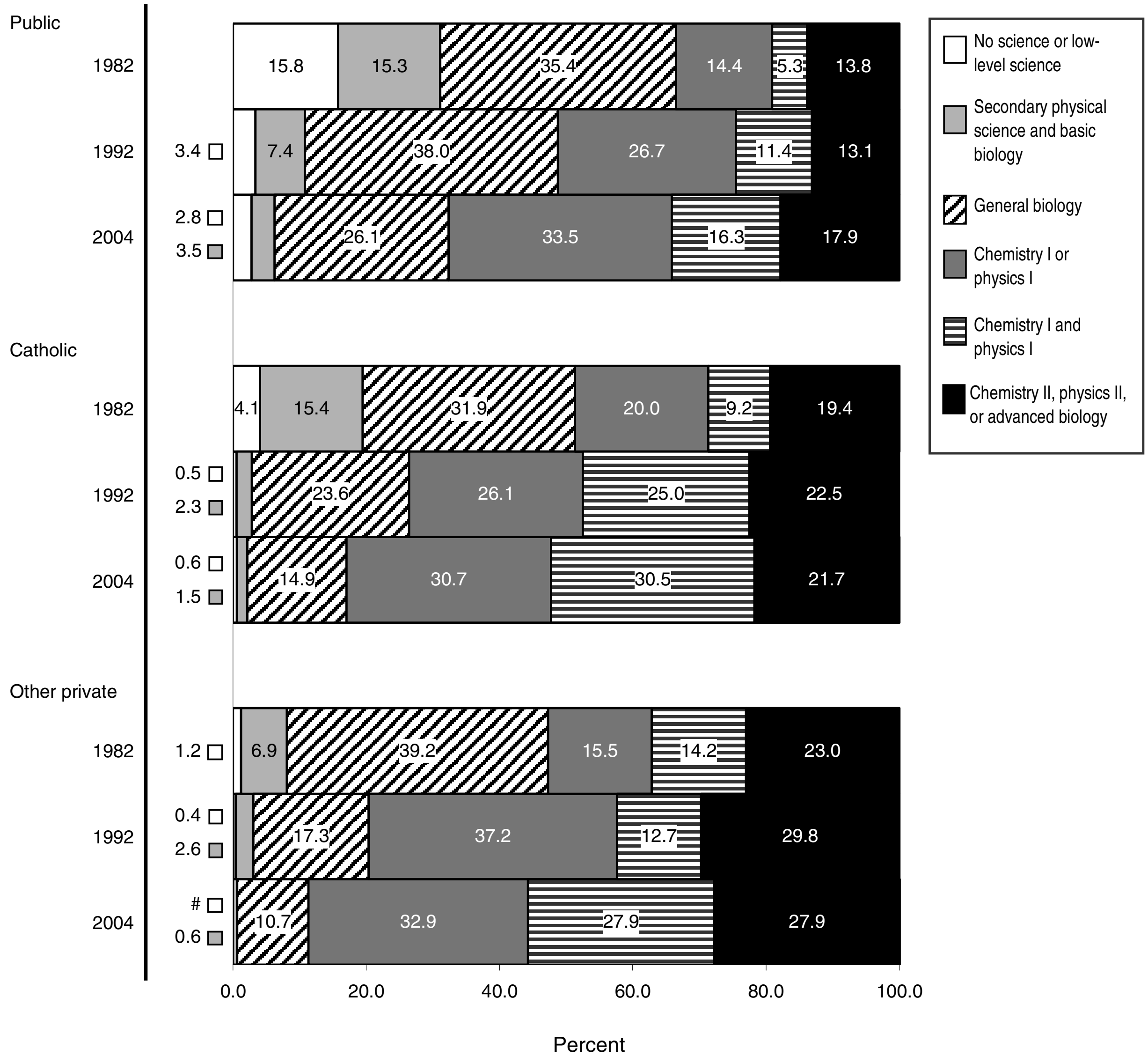
NOTE: See appendix table B-21 for standard errors for this figure.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

As with the overall trend, graduates of schools in different sectors finished high school taking more upper level and fewer lower level science courses in 2004 than in 1982 (figure 27). At the low end of science courses, all groups decreased their participation in the bottom three course levels (no or low-level science, secondary physical science or basic biology, and general biology), except for no or low-level science participation by other private school graduates (whose completion rates at that level were already low). For example, the largest drop observed here was among other private school graduates, whose percentage completing general biology declined from 39 percent in 1982 to 11 percent in 2004, a 29 (28.6) percentage point drop. At the upper level of science coursetaking, all groups increased their participation in two of the three levels: chemistry I or physics I, and chemistry I and physics I. Thirty-four percent of public school graduates, for example, finished high school with chemistry I or physics I in 2004, compared with 14 percent in 1982. However, at the highest level (chemistry II, physics II, or advanced biology), no differences of 5 percentage points or greater were observed over time in the participation rates of students in any school sector.

Despite the similar changes in coursetaking patterns over time, differences in completion rates persisted from 1982 to 2004 among school sector types. Graduates of other private high schools were more likely than their public high school counterparts to progress through the science pipeline into the highest level: in 2004, 28 percent of other private school students completed chemistry II, physics II, or advanced biology before leaving high school, compared with 18 percent of public school graduates. Graduates of Catholic and other private schools were also more likely than graduates of public schools to complete chemistry I and physics I in 2004. Similarly, Catholic and other private school graduates were less likely than their public school peers to exit the science pipeline at the level of general biology (15 percent and 11 percent, respectively, compared with 26 percent).

Figure 27. Percentage of high school graduates who completed different levels of science courses, by school sector: 1982, 1992, and 2004



Rounds to zero.

NOTE: Detail may not sum to totals because of rounding. See appendix table B-22 for standard errors for this figure.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

3.3 Science Coursetaking Summary

In 2004, high school graduates earned more science credits than in previous years—nearly a full year's worth, on average, compared with the graduating cohort of 1982. Most student subgroups accumulated 3.0 credits or more of science courses by 2004, bringing them in line with curriculum recommendations such as those established as the "New Basics" (National Commission on Excellence in Education 1983) or touted by other groups (Achieve, Inc. 2005; National Governors Association 2005).

In addition, graduates moved away from concentrating on low-level science coursework toward completing higher level science courses. However, unlike the trends in mathematics coursetaking, most of this shift occurred toward the middle science course levels of general biology or chemistry I or physics I. The course level with the greatest gain in proportions of students completing it was chemistry I or physics I, which rose from 15 percent to 33 percent from 1982 to 2004 (figure 17). This came at the expense of the two lowest course levels, which saw their combined percentages drop from 29 percent in 1982 to 6 percent in 2004. Changes were far more muted at the most advanced course levels and in particular at the highest level of chemistry II, physics II, or advanced biology, which saw no change of 5 percentage points or greater over time.

The general increase in science coursetaking was shared by all students examined in this study, regardless of sex, race/ethnicity, socioeconomic status, educational expectations, or school sector. In some student subgroups, however, the most advanced course level saw significant increases. For example, 39 percent of Asian graduates completed chemistry II, physics II, or advanced biology in 2004, an increase from a relatively high 24 percent in 1982 (figure 21).[13] White and Asian graduates each completed chemistry II, physics II, or advanced biology at higher rates than Black, Hispanic, and American Indian graduates.

Other disparities among various student subgroups persisted into 2004. There were no detectable differences between males and females completing the two highest levels of advanced science courses in 1982, 1992, and 2004 (figure 19). However, in 2004, females were more likely than males to finish high school with the chemistry I or physics I level of coursetaking. Also in 2004, males were more likely than females (34 percent for males versus 28 percent for females) to have completed only one of the three lowest levels of science as their highest course taken (no or low-level science, secondary physical science and basic biology, or general biology).

Completion rates for some of the most advanced course levels were also higher among graduates from private schools (Catholic and other private schools) and high SES backgrounds than among those from public schools or low SES backgrounds (figures 23 and 27, respectively). Finally, though students with educational expectations lower than a baccalaureate degree increased their participation in the middle level of chemistry I or physics I, those expecting at least a college degree continued to take courses at the two top levels at a higher rate, as much as or more than twice the rates of their lower expectation peers. Still, 64 percent of those expecting a baccalaureate degree fail to take both a standard chemistry and physics course by the end of high school (figure 25).

[13] Indeed, Asian graduates in 1982 outranked all other racial/ethnic groups from any year in the percentage taking the highest level science courses.

Chapter 4
Conclusions

Between 1982 and 2004, American high school students took an increasing number of academic courses in mathematics and science and were increasingly likely to complete advanced academic coursework in these subjects before they graduated from high school. This trend was most consistent over time at all levels of mathematics coursetaking and among middle-level science courses. The upward movement in coursetaking occurred not only among high school graduates nationwide but also in all student subgroups examined in this report, including those identified by sex, race/ethnicity, socioeconomic status (SES), and school sector. This bodes well for American youth in the aggregate—as the demand for quantitative and analytical skills increases, there is evidence that students are taking more advanced mathematics and science instruction.

In addition to this shift toward higher level courses, some preexisting gaps in mathematics and science preparation closed over time or even reversed themselves. For example, although Asian graduates continued to earn more credits in mathematics (figure 5) and science (figure 20) than graduates in most other racial/ethnic groups, the math credit gaps between this group and Whites and Hispanics narrowed between 1982 and 2004. Also, the gap in credits earned in mathematics between Whites and Blacks in 1982 (favoring Whites) showed no substantive difference in 2004, where Blacks earned, on average, 3.7 credits, and Whites earned 3.6 credits (figure 5). (However, as discussed below, the Black-White gap in advanced math course levels did not close.)

Despite some narrowing differences, other disparities remained among student subgroups and occasionally widened over time. Although patterns among males and females in advanced science coursetaking generally remained the same from 1982 to 2004, a gap in favor of females over males in completing chemistry I or physics I developed over time (figure 19). In 1982, 15 percent each of males and females exited the pipeline at chemistry I or physics I. Yet by 2004, 37 percent of females were taking chemistry I or physics I prior to graduating from high school, but only 30 percent of males were doing so. However, no differences were detected in the completion rates for the two most advanced levels of science courses (chemistry I and physics I, and chemistry II, physics II, or advanced biology).

In addition, White and Asian graduates were more likely to enroll in advanced mathematics (figure 6) and science (figure 21) courses than their Black, Hispanic, and American Indian peers, and Asian graduates in particular extended their advantage over all other groups in taking precalculus; calculus; and chemistry II, physics II, or advanced biology. Further, students from high-SES backgrounds completed advanced courses in mathematics (figure 9) and science (figure 22) at higher rates than did those from low-SES backgrounds. The highest SES group substantially widened its advantage over other groups in completing precalculus and calculus; chemistry I and physics I; and chemistry II, physics II, or advanced biology. Students expecting a baccalaureate or graduate degree were more likely than their peers with lower educational expectations to complete precalculus or calculus (figure 14) or to complete chemistry II, physics II, or advanced biology (figure 25). Finally, Catholic school and other private school graduates were more likely than their public school peers to persist in the coursetaking pipeline longer and to complete advanced courses in mathematics (figure 16) and science (figure 27).

This study shows that, on average, American youth are taking more mathematics and science courses, as well as more advanced mathematics and science courses. Future research will be needed to assess the extent to which these advanced courses present challenging material and translate into proficiency in mathematics and science, as well as to address the persistent gaps in coursetaking demonstrated in this study.

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Appendix A
Technical Notes and Methodology

A.1 Sources of Data

The data for this report came from three surveys begun by the National Center for Education Statistics (NCES) between 1982 and 2004. These surveys are the High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B), the National Education Longitudinal Study of 1988 (NELS:88), and the Education Longitudinal Study of 2002 (ELS:2002).

For all transcripts and samples used in this report, a course identification code number, based on the Classification of Secondary School Courses (CSSC), was assigned to each course taken by a student. A report by Bradby and Hoachlander (1999), *1998 Revision of the Secondary School Taxonomy,* further classified these CSSC codes into subject (e.g., mathematics) and program (e.g., academic) areas. This taxonomy served to standardize all transcript data included in the analysis.

The analysis sample from each survey was restricted to a subset of sample members who were high school graduates and had a complete set of transcripts. High school graduates were defined as spring term senior cohort members[1] who graduated with an honors or standard diploma by the end of the summer (August 31) of their graduating year (1982 for HS&B, 1992 for NELS:88, and 2004 for ELS:2002 graduates). A complete transcript was defined as one that recorded 16 or more Carnegie units (a Carnegie unit is equivalent to a course taken every day, one period per day, for a full school year), with a positive, nonzero number of credits completed in English. These criteria for defining the analysis samples also served to make them comparable across the different years and studies. According to Hoachlander (1991) and Ingels and Taylor (1995), one solution for making transcript samples comparable is to select graduating seniors with 16 to 32 credit hours. This methodology acts to exclude the more extremely disabled and language minority students from the more eligibility-liberal ELS:2002, bringing HS&B and NELS:88 into line with ELS:2002. (ELS:2002 has a comparatively low rate of survey exclusion and, additionally, systematically collects the transcripts of students with disabilities and students who are not proficient in English). The comparability of the samples is examined and discussed in section A.4 of this appendix. The sections immediately following provide a brief description of each survey.

A.1.1 High School and Beyond

The HS&B longitudinal survey was first administered in 1980 to a stratified, nationally representative sample of approximately 30,000 high school sophomores and 28,000 high school seniors from more than 1,000 high schools. Follow-up surveys were administered in 1982, 1984, 1986, and 1992. This report used the 1980 sophomore cohort sample. As part of the first follow-up study, conducted in 1982, high school transcripts were collected for a probability subsample of 18,500 members of the 1980 sophomore cohort. For this report, the demographic characteristics of the 1982 graduates were drawn from the first follow-up data file, and their coursetaking information was drawn from the transcript data file. The analysis sample included approximately 11,200 sophomores who graduated in 1982 and had complete transcripts.

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[1] Spring term of the cohort's respective graduating year. A small number of early graduates (not enrolled in the spring term of the typical graduating year) are excluded on this basis. A slightly different convention may be used for basic reporting in which all early graduates are explicitly accounted for; however, the current report follows the spring term definition in order to provide coursetaking results for 4-year on-time high school graduates.

Excluded students were those who dropped out of school or were still working for their diploma or those who did not have complete transcript data. More information on the first follow-up and transcript data files can be found in *High School and Beyond, 1980 Sophomore Cohort, First Follow-up (1982), Data File User's Manual* (Jones et al. 1983) and *High School and Beyond Transcripts Survey (1982), Data File User's Manual* (Jones et al. 1984).

High school transcripts for HS&B were collected in the first follow-up (1982) for members of the 1980 sophomore cohort only, when the majority of sophomore cohort members were seniors. (Transcripts were collected in September following their senior year.) According to NCES Statistical Standards (Seastrom 2003), in an analysis using data from only the first follow-up student questionnaire and transcript surveys, the overall unit response rate is a function of the base-year school unit response rate (first stage of selection for the study) and the unit response rate for sample members eligible for both the first follow-up student survey and the high school transcript survey. In the base year, of the 1,122 schools initially selected to participate in the study, 811 schools agreed to do so, for a school cooperation rate (not school questionnaire response rate) of 72 percent (the base year student questionnaire response rate was 84 percent, unweighted). In the first follow-up, of the subsample of 18,500 sophomores for whom transcript data were requested in 1980 (and who were eligible for the first follow-up student survey), transcripts were received for 16,200 students, for a unit response rate of 88 percent (the first follow-up student questionnaire response rate was 95 percent, unweighted). This translates into an overall unit response rate of 64 percent (0.723 x 0.880 = 0.636). Because the classification variables used in this report could be drawn from either base year or first follow-up data, we also provide the response rates for questionnaire completion in both these rounds. In the base year, 84 percent of sample members completed the student questionnaire; in the first follow-up, 95 percent completed a questionnaire. Based on questionnaire completion, the unweighted two-stage response rates for the study are 61 percent for the base year (0.841 x 0.723 = 0.608) and 68 percent for the first follow-up (0.945 x 0.723 = 0.683).

The overall unit response rate of 64 percent, resulting in an overall unit nonresponse rate of 36 percent, does not mean that the magnitude of nonresponse bias for the analysis sample used in this report is large. Nonresponse bias will be small if the nonrespondent strata constitute only a small portion of the survey population or if the differences between respondents and nonrespondents are small. With a school response rate of 72 percent, the biggest contributor to possible nonresponse bias is nonresponse on the part of schools in the base year. However, nonresponse analyses conducted in the first follow-up of HS&B found that nonresponse had little effect on base-year and first follow-up estimates. The results of these nonresponse analyses showed that the school-level component of the bias affected base-year and first follow-up estimates by 2 percent or less (Tourangeau et al. 1983; Zahs et al. 1995).[2]

For this analysis, item response rates ranged from a low of 96 percent for incomplete transcripts to a high of 100 percent. Only two demographic items registered less than 100 percent item response: race/ethnicity, with a 99 percent item response rate, and socioeconomic status, with a 97 percent item response rate.

[2] Neither HS&B publication specified whether the response rates presented were weighted or unweighted.

A.1.2 National Education Longitudinal Study of 1988

NELS:88 is another major longitudinal study sponsored by NCES. The base-year survey was administered in 1988 to about 24,000 8th-graders in more than 1,000 schools. The first and second follow-ups revisited the same sample of students in 1990 and 1992, when most of the 1988 8th-graders were in the 10th grade and 12th grade; then for the third and fourth times in 1994 and 2000, which were 2 and 8 years after their scheduled graduation from high school. Unlike HS&B, for each in-school follow-up (i.e., 1990 and 1992), the student sample was "freshened" to obtain a representative, cross-sectional grade-cohort (i.e., 10th-graders in 1990 and 12th-graders in 1992). In addition, as a part of the second follow-up, high school transcripts were collected for all students attending a subset of second follow-up schools selected for the transcript study, all dropouts and dropouts attending alternative programs who had attended high school for a minimum of one term, all early graduates, and sample members with disabilities that precluded them from completing a student questionnaire and cognitive test battery in the base year and the first and second follow-ups. For this report, the demographic characteristics of 1992 high school graduates came from the NELS:88 second follow-up data file, and their coursetaking information from the survey's transcript data file. The analysis sample was drawn from the transcript sample. Of the approximately 17,300 students in the transcript file, about 13,500 were identified as high school graduates with complete transcripts. For more information on the NELS:88 second follow-up transcript study, see *NELS:88 Second Follow-up: Transcript Component Data File User's Manual* (Ingels et al. 1995).

The overall unit response rate for the NELS:88 analysis sample used in this report is derived as it was for the HS&B analysis sample—as a function of the base-year school unit response rate (first stage of selection for the study) and the unit response rate for sample members eligible for both the second follow-up student survey and the high school transcript survey (the NELS:88 analysis sample used for this report is a freshened senior cohort). In the base year of NELS:88, of the 1,002 schools initially selected (and eligible) to participate in the study, 698 schools agreed to do so, for a school cooperation rate (not school questionnaire response rate) of 70 percent. In the second follow-up, of the subsample of 19,320 students for whom transcript data were requested (and who were eligible for the second follow-up student survey), transcripts were received for 17,285 students, for a weighted unit response rate of 88 percent or an unweighted unit response rate of 90 percent (Ingels et al. 1995). This translates into an overall unit response rate of 61 percent (0.697 x 0.878 = 0.6119). Because the classification variables used in this report could be drawn from the base year, first follow-up, or second follow-up, we also provide the response rates for student questionnaire completion in each of those rounds. In the base year, 93 percent of sample members completed the student questionnaire; in the first follow-up, 94 percent completed a questionnaire; and in the second follow-up, 93 percent completed a questionnaire. Based on questionnaire completion, the unweighted two-stage response rates for the study are 65 percent for the base year (0.931 x 0.697 = 64.9 percent), 66 percent for the first follow-up (0.942 x 0.697 = 65.7 percent), and 65 percent for the second follow-up (0.925 x 0.697 = 64.5 percent).

A unit nonresponse bias analysis similar to that conducted for HS&B was conducted for NELS:88. The analysis found a magnitude of bias of 5 percent (Spencer et al. 1990). For analyses in this report, item response rates ranged from a low of 97 percent for socioeconomic status to a high of 100 percent. Ninety-nine percent of transcripts were complete. No other NELS:88 items used in this analysis registered less than a 100 percent item response.

A.1.3 Education Longitudinal Study of 2002

ELS:2002 began with a national probability sample of high school sophomores in 2002. Individual students are expected to be followed until about age 30; the base-year schools have been surveyed twice (they were surveyed in 2002 and again in 2004). A second follow-up was completed in the summer of 2006. In the high school years, ELS:2002 is an integrated, multilevel study involving multiple respondent populations, including students, their parents, their teachers, and their schools (from which data are collected at three levels: from the principal, the librarian, and on a facilities checklist). This multilevel focus supplies researchers with a comprehensive picture of the home, community, and school environments that provide context for understanding student educational processes and outcomes. The ELS:2002 base-year study was carried out in a national probability sample of 752 public, Catholic, and other private schools in the spring term of the 2001–02 school year. Of 17,591 eligible selected sophomores, 15,362 completed a base-year questionnaire, as did 13,486 parents, 7,135 teachers, 743 principals, and 718 librarians. The unweighted response rate at the school level was 62 percent and at the sophomore baseline level was 87 percent. Data weights were adjusted for nonresponse at each level.

The overall unit response rate for the ELS:2002 sample used in this report is derived as a function of the base-year school response rate (first stage of selection for the study) and the unit response rate for sample members eligible for the high school transcript survey (transcript eligibility was normally[3] conditioned on questionnaire completion in the ELS:2002 base year, or first follow-up, or both; the ELS:2002 analysis sample used for this report was a freshened senior cohort). In the base year of ELS:2002, of the 976 eligible schools initially selected to participate in the study, 631 schools agreed to do so, for an unweighted school cooperation rate of 65 percent. In the first follow-up, of the approximately 16,400 students for whom transcript data were requested, transcripts were received for about 14,290 students, or an unweighted 87 percent of the total transcript sample. [For the senior cohort used in this report, 93 percent (13,424) had transcripts (Bozick et al. 2006, Table 5)]. This translates into an overall unit response rate of 56 percent (0.647 x 0.871 = 0.564).[4] Because the classification variables used in this report could be drawn from either base year or first follow-up data, we also provide the response rates for questionnaire completion in both the 2002 and the 2004 rounds. In the base year, 88 percent of sample members completed the student questionnaire; in the first follow-up, 91 percent completed a questionnaire. Based on questionnaire completion, the two-stage unweighted

[3] While for questionnaire-eligible sample members, transcript eligibility was based on participation (completing at least the student questionnaire) in either or both rounds, transcripts were also collected for questionnaire-ineligible sample members (i.e. the small number of individuals who could not be surveyed because of severe disability or language barrier, and who appear only on restricted use files).

[4] Calculation of overall unit response for the three studies is constrained by the limitations in the documentation of HS&B and NELS:88. Alternative calculations are possible for ELS:2002, because of its greater richness of documented information. For example, instead of basing the school response rate on the subset of participating schools that were part of the original pool, one can calculate the response rate based on the total pool of schools (including replacements) used in achieving the final sample. Likewise, instead of basing calculations on unweighted rates, one can employ the design weight to generate a weighted response rate. The weighted completion rate for ELS:2002, based on all schools drawn into the sample and contacted is, weighted, 67.8 percent. The weighted transcript response rate is 90.7 percent. Thus the two-stage response becomes, not 56.4 percent, but 61.5 percent (0.678 x 0.907 = .615). Also, if restricted to simply the senior cohort, the transcript response rate (weighted) goes up to 93.1 percent (0.678 x 0.931 = 63.1 percent). Readers may see different ELS:2002 response rate information than is reported in trend analyses, in reports based solely on the one study.

response rates for the study are 57 percent for the base year and 59 percent for the first follow-up (0.647 x 0.877=56.7 percent; 0.647 x 0.908= 58.7 percent).

A.2 Accuracy of Estimates

The estimates in this report are derived from a sample and are subject to two broad classes of error: nonsampling and sampling errors. Nonsampling errors occur not only in sample surveys but also in complete censuses of entire populations. Nonsampling errors can be attributed to a number of factors: inability to obtain complete information about all students in all institutions in the sample (some students or institutions refused to participate, or students participated but answered only certain items); ambiguous definitions; differences in interpreting questions; inability or unwillingness to give correct information; mistakes in recording or coding data; and other errors of collecting, processing, sampling, and imputing missing data. Although nonsampling errors due to questionnaire and item nonresponse can be reduced somewhat by adjusting sample weights and imputation procedures, correcting all the forms of nonsampling errors that may be operating, or gauging the effects of these errors, is usually difficult.

Sampling errors occur because observations are made only on samples of students, not on entire populations. Surveys of population universes are not subject to sampling errors. Estimates based on a sample will differ somewhat from those that would have been obtained by a complete census of the relevant population using the same survey instruments, instructions, and procedures. The standard error is a measure of the variability due to sampling when estimating statistics. Standard errors can be used as a measure of the precision expected from a particular sample. If all possible samples were surveyed under similar conditions, intervals of 1.96 standard errors below to 1.96 standard errors above a particular statistic would include the true population parameter being estimated in about 95 percent of the samples. In addition, the standard errors for two sample statistics can be used to estimate the precision of the difference between the two statistics and to help determine whether the difference based on the sample is large enough to represent the population difference.

Because HS&B, NELS:88, and ELS:2002 data were collected using a complex sampling design, the sampling errors of the estimates from these surveys are typically larger than would be expected if the sample were a simple random sample and the observations were independent and identically distributed random variables. Not taking the complex sample design into account can lead to an underestimate of the sampling variance associated with an estimate. To generate accurate standard errors for the statistics reported in this study, the Taylor series approximation method was used. In particular, standard errors of estimates from the HS&B, NELS:88, and ELS:2002 data were computed using the Taylor series approximation. For more information about these methods, see Wolter (1985). SUDAAN (Research Triangle Institute) and AM (American Institutes for Research) were the statistical software packages used to generate estimates and standard errors.

A.3 Statistical Procedures

Two types of statistical tests were used in this report. First, *t* tests ensured that reported differences (e.g., difference between two means/percentages and difference between differences) are larger than those that might be expected because of sampling variance. Second, effect sizes were calculated and only those differences large enough to meet preset criteria were discussed.

Differences were reported in the text only if the comparison met the criteria of both statistical significance and substantive difference. These procedures are discussed in this section.

A.3.1 Testing the Difference between Two Means or Percentages

The student's *t* statistic was used to test the likelihood that the differences between two independent means or percentages were larger than would be expected because of sampling error. The Student's *t* values can be computed for comparisons using the estimates in the report's tables with the following formula:

$$t = \frac{E_1 - E_2}{\sqrt{\left(se_1^2 + se_2^2\right)}}$$

where E_1 and E_2 are the estimates to be compared, and se_1 and se_2 are their corresponding standard errors. Generally, whether a difference is considered statistically significant is determined by comparing this *t* value or "test statistic" with published tables of *t* values or "critical values" and their corresponding alpha levels. The alpha level is an a priori statement of the probability of inferring that a difference exists when in fact, it does not. The alpha level used in this report is .05; differences discussed in the text have been tested and found significant at this level. Two-tailed tests were performed.

A.3.2 Testing the Difference between Differences

Another statistical test used in this report assessed the difference between two difference estimates. For example, to test whether the gender gap in a specific year (e.g., 1982) differed significantly from the gender gap in another year (e.g., 2004), a test of differences between differences was performed using the following formula:

$$t = \frac{(E_{11} - E_{21}) - (E_{12} - E_{22})}{\sqrt{\left(\sqrt{se_{11}^2 + se_{21}^2}\right)^2 + \left(\sqrt{se_{12}^2 + se_{22}^2}\right)^2}}$$

where E_{11} and E_{21} are the estimates for the two comparison groups at time 1 (i.e., $E_{11} - E_{21}$ is the difference between males and females at time 1), E_{12} and E_{22} are the estimates for the two comparison groups at time 2 (i.e., $E_{12} - E_{22}$ is the difference between males and females at time 2), and se_{11}, se_{21}, se_{12}, and se_{22} are their corresponding standard errors. After the *t* value was obtained, it was compared with the *alpha* level to determine whether the differences between the comparison groups changed significantly between the two time points.

A.3.3 Substantive Difference

With large samples, such as ELS:2002, even very small differences may be statistically significant. Therefore, differences that met our criterion for statistical significance were also examined using effect size calculations.

For differences between means (in this report, credits earned in mathematics or science), effect sizes (or standardized mean difference, expressed as Cohen's *d* [Cohen 1988]) were calculated. The effect size is interpreted as the number of standard deviations separating the means of the two groups. Effect sizes were calculated as the difference in mean numbers of credits divided by the pooled standard deviation. The formula for computing the pooled standard deviation was

$$\sqrt{\frac{(n_1 - 1)\,\sigma_1^2 + (n_2 - 1)\,\sigma_2^2}{n_1 + n_2 - 2}}.$$

Whether an effect size is small, moderate, or large depends on the variables being studied and the research context. Cohen (1988) provided some general guidelines for the behavioral sciences, suggesting that "…when no better basis for estimating the ES index is available" (p. 25), effect sizes of .2 or less could be considered small, those around .5 medium, and those of .8 or greater could be considered large. Based on these guidelines, an effect size of .2 was selected as a cut-point for determining which mean differences would be discussed in this report.[5] While tables of effect sizes are not provided in the report, standard deviations are reported for mean credits earned, should readers wish to calculate an effect size. Because some readers may choose the pooled standard deviation approach, sample sizes (rounded to protect confidentiality) are reported in appendix D.

For proportions, this report has adopted a simple convention of considering differences that are 5 percentage points or greater as being substantively different. Though such differences may be differentially meaningful depending on the initial percentage (a 5 to 10 percent growth may be substantively different from a 55 to 60 percent growth), this rule limits discussion of very small group differences.

A.4 Bias Analysis

This analysis report investigated the mathematics and science coursetaking patterns of high school students who graduated in 1982, 1992, and 2004. A graduate was defined as a student who had received either a standard or an honors diploma. Additionally, only the coursetaking histories of graduates for whom complete transcripts were available were analyzed. A full or complete transcript was defined as a transcript that reported at least 16 credit hours for the graduate, with some of the 16 credit hours including credit hours in English. The Classification of Secondary School Courses (CSSC) and the *1998 Revision of the Secondary Schools Taxonomy* (SST) (Bradby and Hoachlander 1999) were used to code transcripts and identify credit hours, called Carnegie units.

Because of the need to apply the additional criterion—only graduates for whom *complete transcripts were available*—a bias analysis was undertaken to determine the extent to which the final analysis samples from HS&B, NELS:88, and ELS:2002 differed from, and thus may not generalize to, the target population of American high school graduates. To do this, all student sociodemographic characteristics examined in this report—gender, race/ethnicity, school sector, socioeconomic status, and educational expectations—were compared for all 12th-grade graduates (the full sample for the target population) and 12th-grade graduates with complete transcripts (the analytic sample). If the distribution of student characteristics was different between these groups, the generalizability of the estimates presented here could be compromised. Estimates are considered different if the difference exceeds 5 percentage points—the effect size

[5] For more information about these cutoffs and effect sizes, see Cohen (1988), Murphy and Myers (2004), and Seastrom (2003).

criterion used in this report to assess substantive difference. The variables used to identify each final analysis sample and the analysis weights used are described at the end of this appendix.

The results of this bias analysis are shown in Table A-1. The table displays the three high school transcript samples and selected sociodemographic characteristics (row variables) by the full target population sample and the analytic sample (sample size figures have been rounded to protect confidentiality). Not surprisingly, the analysis reveals no within-sample bias. None of the differences in estimates exceed the five percentage point criterion. This is likely because very few graduating seniors were excluded from the analysis.

As an analysis note, this bias analysis is not an analysis of survey nonresponse for the population of graduating seniors. That is, it does not investigate the possibility of bias owing to the fact that there may be systematic differences between responding seniors and nonresponding seniors. For an analysis of nonresponse bias, readers should consult the data file user's manuals of the studies used in this report. The analysis conducted here evaluated the possibility of biased analytic samples resulting from the exclusion of seniors who otherwise participated in the studies but for whom transcripts were either missing or did not meet the criteria for inclusion in the analysis samples (i.e., transcripts reported at least 16 credit hours for each senior, of which some were credit hours in English). For the bias analysis reported here, weights that correct for nonresponse bias were used.[6]

Additionally, some bias in coursetaking trends may result from differences in subgroup graduation rates over time. This report describes the coursetaking of spring-term graduating high school seniors and does not include very late graduates (i.e., beyond August 31 of their graduating year), those who obtained alternative credentials other than a high school diploma, or dropouts. Differences in dropout rates over time, or by subgroup, may qualify the conclusions of reports based on seniors. For example, if dropout rates were increasing over time, this might artificially augment a seeming trend in increases in the proportion of students taking advanced courses (presuming that the remaining non-dropouts are more likely to take advanced courses in each cohort). The fact that sophomore cohort dropout rates were considerably higher in 1982 (11 percent; Kaufman, McMillen, and Sweet 1996) than in 1992 (6 percent; Kaufman, McMillen, and Sweet 1996) or 2004 (7 percent; Ingels, Planty, and Bozick 2005) offers some reassurance that observed trends of increase in advanced math and science coursetaking are not an artifact of changing dropout rates.

[6] Though nonresponse-adjusted weights are used, bias remains a possibility because the weights do not adjust for the subsettings invoked to create the analysis sample. Some cases have been removed from the target population (seniors) owing to incomplete transcripts or transcripts that do not meet the criteria for inclusion (e.g., zero credit hours in English; receipt of a certificate of attendance, special education diploma, or no diploma; and lack of a minimum of 16 earned Carnegie units).

Table A-1. Selected characteristics of all high school graduates versus high school graduates with full transcripts: 1982, 1992, and 2004

Characteristic	12th-grade graduates (full target population sample) Sampled	Weighted estimate (percent)	Standard error	12-grade graduates with full transcripts (analysis sample) Sampled	Weighted estimate (percent)	Standard error	Difference in characteristic between full sample and analysis sample (percent)
HS&B							
Total	11,700	100.0	†	11,200	100.0	†	†
Gender							
Male	5,600	47.9	0.60	5,300	47.3	0.63	0.58
Female	6,100	52.1	0.60	5,800	52.7	0.63	–0.58
Race/ethnicity							
American Indian	160	1.1	0.20	150	1.1	0.21	0.02
Asian	320	1.4	0.15	310	1.4	0.16	–0.03
Black	1,500	10.6	0.61	1,500	10.3	0.61	0.25
Hispanic	2,300	11.1	0.41	2,200	10.9	0.41	0.16
White	7,200	74.9	0.81	7,000	75.2	0.81	–0.36
School sector							
Public	8,900	89.1	0.66	8,400	88.8	0.60	0.32
Catholic	2,100	7.1	0.35	2,100	7.5	0.37	–0.35
Other private	750	3.8	0.60	730	3.8	0.51	0.03
Socioeconomic status							#
Lowest quartile	3,000	23.3	0.71	2,800	23.1	0.72	0.20
Middle two quartiles	5,200	50.1	0.79	5,000	49.7	0.80	0.35
Highest quartile	3,100	26.7	0.84	3,000	27.2	0.88	–0.55
Educational expectations							
High school diploma/GED or less	2,000	21.6	0.64	1,800	20.9	0.66	0.76
Some postsecondary education	3,300	33.0	0.64	3,100	32.9	0.65	0.11
Baccalaureate degree	2,800	25.4	0.63	2,700	26.0	0.64	–0.55
Graduate degree	2,500	19.9	0.58	2,400	20.2	0.60	–0.32

See notes at end of table.

Table A-1. Selected characteristics of all high school graduates versus high school graduates with full transcripts: 1982, 1992, and 2004—Continued

Characteristic	12th-grade graduates (full target population sample)			12-grade graduates with full transcripts (analysis sample)			Difference in characteristic between full sample and analysis sample (percent)
	Sampled	Weighted estimate (percent)	Standard error	Sampled	Weighted estimate (percent)	Standard error	
NELS:88							
Total	13,600	100.0	†	13,500	100.0	†	†
Gender							
Male	6,800	50.1	0.91	6,700	50.0	0.92	0.08
Female	6,900	50.0	0.91	6,800	50.0	0.92	–0.08
Race/ethnicity							
American Indian	130	0.9	0.16	130	0.9	0.16	–0.01
Asian	1,000	4.4	0.34	1,000	4.3	0.35	0.01
Black	1,100	11.0	0.83	1,100	11.0	0.83	–0.04
Hispanic	1,400	9.1	0.75	1,400	9.0	0.75	0.03
White	9,900	74.3	1.17	9,800	74.3	1.18	–0.01
School sector							
Public	11,600	90.5	0.96	11,500	90.6	0.96	–0.06
Catholic	780	5.7	0.52	780	5.7	0.52	#
Other private	1,200	3.8	0.69	1,200	3.7	0.69	0.07
Socioeconomic status							
Lowest quartile	2,300	17.6	0.76	2,300	17.5	0.76	0.01
Middle two quartiles	6,400	52.1	1.06	6,400	52.1	1.06	0.01
Highest quartile	4,500	30.4	1.20	4,400	30.4	1.20	–0.02
Educational expectations							
High school diploma/GED or less	530	4.7	0.37	520	4.7	0.37	#
Some postsecondary education	2,800	25.4	0.89	2,800	25.5	0.89	–0.07
Baccalaureate degree	4,300	36.6	1.00	4,300	36.6	1.01	0.01
Graduate degree	4,500	33.2	1.05	4,500	33.1	1.04	0.06

See notes at end of table.

Table A-1. Selected characteristics of all high school graduates versus high school graduates with full transcripts: 1982, 1992, and 2004—Continued

Characteristic	12th-grade graduates (full target population sample)			12-grade graduates with full transcripts (analysis sample)			Difference in characteristic between full sample and analysis sample (percent)
	Sampled	Weighted estimate (percent)	Standard error	Sampled	Weighted estimate (percent)	Standard error	
ELS:2002							
Total	10,900	100.0	†	10,800	100.0	†	†
Gender							
Male	5,300	49.0	0.61	5,300	48.9	0.60	0.10
Female	5,600	51.0	0.61	5,500	51.1	0.60	–0.10
Race/ethnicity							
American Indian	80	0.8	0.20	80	0.8	0.20	#
Asian	1,200	4.6	0.32	1,100	4.6	0.31	#
Black	1,200	12.1	0.68	1,200	12.1	0.68	#
Hispanic	1,400	14.0	0.83	1,400	14.0	0.84	#
White	6,600	64.5	1.05	6,600	64.6	1.06	–0.10
School sector							
Public	8,300	91.4	0.41	8,300	91.5	0.41	–0.10
Catholic	1,600	4.9	0.26	1,600	4.9	0.26	#
Other private	1,000	3.6	0.33	1,000	3.6	0.33	#
Socioeconomic status							
Lowest quartile	2,100	20.8	0.69	2,100	20.8	0.69	#
Middle two quartiles	5,200	50.5	0.72	5,200	50.5	0.72	#
Highest quartile	3,500	28.7	0.84	3,500	28.7	0.84	#
Educational expectations							
High school diploma/GED or less	410	4.5	0.28	400	4.5	0.28	#
Some postsecondary education	1,600	18.6	0.58	1,600	18.5	0.57	0.10
Baccalaureate degree	3,800	37.7	0.61	3,800	37.8	0.61	–0.10
Graduate degree	4,300	39.1	0.69	4,300	39.1	0.69	#

† Not applicable.
# Rounds to zero.
NOTE: Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native.
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

While subgroup generalizations based on graduating seniors provide a valid trend line, they may also blunt or mask differences between groups. Cohort dropout rates in HS&B, between 10th and 12th grade, were 10 percent for Whites and 19 percent for Hispanics. In NELS:88 ten years later, the Hispanic rate had dropped to 12 percent while the White rate was 5 percent. Event dropout rates show considerable variability not only by race but also by family income (Laird et al. 2006) (indeed, race differences diminish as SES is controlled for). A deeper accounting of subgroup differences in coursetaking might take into account not only overall change in dropout rates over time but also change in relative position of subgroups.

A.5 Comparability Across HS&B, NELS:88, and ELS:2002

Though the within-cohort bias is negligible, readers should keep in mind that there are key differences among the studies that could potentially influence the interpretations of the trends presented in this report. Differences in the sampling frames, eligibility requirements, and transcript collection methodologies could possibly account for increases or decreases in the proportion of students taking advanced-level academic courses. Each of these are discussed in turn.

Both the National Education Longitudinal Study of 1988 (NELS:88) and the Education Longitudinal Study of 2002 (ELS:2002) include a nationally representative sample of 12th-graders, of which a subset is 12th-grade graduates that constitute a naturally occurring nationally representative sample of 12th-grade graduates. High School and Beyond (HS&B), on the other hand, is a nationally representative sample of 1980 sophomores, and of the 1980 sophomore cohort 2 years later (1982) when the HS&B transcript study was conducted. HS&B imperfectly represents the nation's 1982 graduating seniors primarily because 1982 seniors who were not sophomores in 1980 are not included in the sample. The potential bias arising from comparing full senior samples from NELS:88 and ELS:2002 to a longitudinal senior sample of HS&B sophomores is explored in section A.5.1 below.

In addition to differences in sampling the target populations, study eligibility requirements could influence the results of this analysis. HS&B and NELS:88 excluded students with severe mental, physical, or linguistic barriers to completing survey forms, at a rate ranging from approximately 3 to perhaps 6 percent. In NELS:88, exclusion was primarily in the 8th-grade base year (5 percent of the 8th-grade sample) but a subsample of excluded 8th-graders was followed to high school and incorporated into the study when their status had changed (e.g., if an excluded student had since become proficient in English). Thus, about 3 percent of the NELS:88 high school sample was excluded for eligibility reasons. In ELS:2002, no students were formally excluded from the study, but some students with physical, mental, or linguistic barriers to participation were classified as "questionnaire-ineligible." For these students, basic demographic information, contextual and records information (parent questionnaire, school administrator questionnaire, high school transcript) were collected, but the student was not administered a questionnaire.

HS&B did not collect transcripts for students excluded from the questionnaire and test components of the study. NELS:88 collected transcripts for a probability subsample of its cohorts, which included 8th-grade ineligible students whose eligibility had changed by high school and a special methodological sample of "triple ineligibles"; it did not otherwise include the ineligible sample in the transcript collection. ELS:2002, however, pursued transcripts both for questionnaire-eligible and questionnaire-ineligible sample members. Thus, all three samples fall short of representing American high school 12th-graders by the small amount (from less than 1 percent to possibly as much as 6 percent) of excluded students during the years in focus, and for HS&B and NELS:88 (but not ELS:2002) this undercoverage affects the transcript studies. However, the studies underrepresent graduating 12th-graders to a lesser degree, since only a portion of excluded students were seniors who graduated on time.[7]

Procedures for collecting transcripts differed very slightly across studies. Both HS&B and NELS:88 collected transcripts from the last school attended by the student (which normally but not invariably included the full cumulative record), while ELS:2002 collected transcripts from the student's base-year school (i.e. the school from which they were originally sampled) and their final school if they transferred out of their base-year school.

Readers interested in a more extensive discussion of comparability across NCES transcript studies should see either the National Center for Education Statistics (NCES) Working Paper, *National Education Longitudinal Study of 1988: Conducting Cross-Cohort Comparisons Using HS&B, NAEP, and NELS:88 Academic Transcript Data* (Ingels and Taylor 1995) or appendix A in the *Education Longitudinal Study of 2002: First Follow-up Transcript Component Data File Documentation* (Bozick et al. 2006).

A.5.1 Cross-study Bias Analysis

The lack of a freshened senior cohort in HS&B's 1982 follow-up survey to the 1980 sophomore survey may introduce bias with respect to cross-study comparisons of HS&B to NELS:88 and ELS:2002. To assess the presence and extent of bias arising from the different cohort definitions, this section presents results from an analysis of the differences between freshened and unfreshened samples in NELS:88 and ELS:2002, differences between the HS&B senior and sophomore cohorts, and an analysis of the differences in substantive results when using freshened and unfreshened analysis samples in NELS:88 and ELS:2002.[8]

There are two complementary approaches that may be used for assessing the impact of freshening. The first approach is to look at differences in student characteristics between freshened and unfreshened senior samples (for NELS:88 and ELS:2002) and differences in student characteristics between the 1980 and 1982 senior samples (of HS&B). Since HS&B's 1980 sophomore survey does not have a freshened senior cohort sample for 1982, but there is a 1980 senior survey, they may be compared profitably. Both survey samples are nationally representative (in 1980) and were drawn from the same schools, heightening the prospect that the true 1982 senior cohort and the observed 1982 senior cohort (measured as 1980 sophomores two years later) are similar. With the (relatively strong) assumption that the 1980 senior and sophomore cohorts were similarly composed with respect to student demographics, a finding of few differences between the 1980 senior cohort and the 1980 sophomore cohort in 1982 would suggest that the 1982 seniors fairly represent the population of seniors at that time. The assumption of cohort similarities limits the ability to draw positive conclusions, but the findings

[7] For the longitudinal studies—HS&B, and NELS:88, and ELS 2002—"on time" means graduated by August 31 of their respective graduating years.

[8] An additional question of interest, but not explored here, is the effect of sample definitions that filter cases based on curricular minima and graduation requirements, and which have been used to compare longitudinal study results to NAEP results. The hypothetical effect of such filters would be to make freshened and unfreshened samples more similar, given the known characteristics (typically high school grade repeaters) of the freshened samples.

may be used alongside the other approaches in this section to provide an overall picture of potential bias.

For NELS:88 and ELS:2002 within-study comparisons, the analyses are more straightforward. Here we compare (for each study) the freshened senior sample, the longitudinal sample of seniors, and the combination of the two. Few differences in student characteristics between the different sample definitions in these studies would suggest, by analogy, that the lack of freshening as present in HS&B does not substantially distort HS&B estimates. The main difference between NELS:88 and ELS:2002 is the fact that key item statistical imputation was performed for the latter.

The second approach is to look at the impact of the sample differences on actual estimates and their standard errors. For this approach, a selection of NELS:88 and ELS:2002 transcript estimates are reported with the freshened students removed and compared to the results from the main parts of this report. The impact is examined in terms of both the statistical significance of the difference between with- and without-freshened estimates, as well as the systematic direction of any bias.

Characteristics of freshened versus unfreshened senior samples in NELS:88 and ELS:2002. Table A-2 shows selected student characteristics from both the full (freshened) senior samples and the longitudinal (unfreshened) samples of seniors who were sophomores two years earlier (using the transcript weight). The latter samples are analogous to the HS&B 1980 sophomore cohort two years later, in terms of selection into the sample. The NELS:88 sophomores were surveyed in 1990 and are a nationally representative sample of sophomores in that year; the NELS:88 seniors were surveyed in 1992 and include both sophomores surveyed in the previous wave (in 1990) and an additional supplement of seniors that together are a nationally representative sample of seniors in 1992. Similarly, ELS:2002 sophomores are nationally representative of high school sophomores in 2002, when they were surveyed, and the ELS:2002 senior cohort includes both sophomores surveyed in the previous study wave as well as additional seniors in 2004.

For NELS:88, no statistically significant differences were observed between the alternatively defined senior cohorts in terms of student characteristics of sex, race/ethnicity, socioeconomic status (SES) quartile, school sector, region, or senior year math test score. For ELS:2002, only one statistically significant difference was observed: a two percentage-point difference in the percentage of seniors who were non-Hispanic White. Sixty-four percent of sophomores who were seniors two years later were White in 2004, while 62 percent of all seniors were White in 2004.

Table A-2. Percentage distribution of selected student characteristics and mean math IRT score for freshened versus unfreshened samples (transcript weight) of NELS:88 and ELS:2002 seniors: 1992 and 2004

Characteristic	NELS:88: 1992		ELS:2002: 2004	
	Seniors who were sophomores two years earlier	Full senior cohort (freshened sample)	Seniors who were sophomores two years earlier	Full senior cohort (freshened sample)
Sex				
Male	50.3	50.3	49.6	49.9
Female	49.7	49.7	50.4	50.1
Race/ethnicity				
Asian	4.1	4.3	4.2	4.5
Hispanic	9.8	10.0	14.1	15.0
Black	12.0	12.0	13.1	13.3
White	72.9	72.1	63.7	62.2 *
American Indian	1.1	1.2	0.9	0.9
More than one race	—	—	4.1	4.1
SES				
1st (low) quartile	18.6	18.8	22.2	22.3
Middle 2 quartiles	52.2	52.0	50.8	50.7
4th (high) quartile	29.2	29.2	27.0	27.0
School control				
Public	90.4	91.0	91.8	91.9
Catholic	5.7	5.2	4.7	4.5
NAIS private	1.6	1.5	—	—
Other private	2.3	2.2	3.6	3.6
Region				
Northwest	20.2	20.4	18.7	18.7
Midwest	25.9	25.6	24.9	24.5
South	35.0	34.4	34.4	34.0
West	18.9	19.6	22.1	22.7
Math test (mean IRT score)	48.9	48.7	48.8	48.5

— Not available.
* Statistically significantly different from sample based on seniors who were sophomores two years earlier (p<.05).
NOTE: IRT = item response theory. SES = socioeconomic status. NAIS = National Association of Independent Schools. Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native. NELS:88 did collect “more than one race” information. For NELS:88, F2TRSCWT was the transcript weight used. For ELS:2002, F1TRSCWT was the transcript weight used.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, 2004."

To the extent that the difference observed in ELS:2002 might apply to the differences between a hypothetical HS&B full (freshened) senior cohort in 1982 versus the actual 1980 HS&B sophomore cohort two years later, this suggests that the HS&B survey could have a small overrepresentation of Whites. Since White seniors in HS&B were more likely to have completed more and higher levels of math and science coursetaking than students overall, this could have inflated overall estimates of coursetaking in the HS&B sample used for the current report, making the actual growth in coursetaking between 1982 and 2004 somewhat greater. However, the lack of any other differences either in ELS:2002 or NELS:88 suggests that a sophomore cohort two years later is a good approximation for a fully representative senior cohort.[9]

Characteristics of HS&B sophomore cohort as seniors (in 1982) versus senior cohort (in 1980). Another way of examining the potential bias in using the 1980 HS&B sophomore cohort two years later as an approximation of 1982 seniors is to compare this senior sample to the nationally representative senior cohort surveyed in 1980. Table A-3 presents selected student and school characteristics from these two senior samples.[10]

In contrast to the NELS:88 and ELS:2002 results, comparison of the two temporally close HS&B samples shows that the longitudinal sample of seniors (who were sophomores in 1980) may somewhat underestimate, in particular, the percentage of White and low socioeconomic status (SES) students, and somewhat overestimate the percentage of seniors in the middle SES quartiles: there were 4 percentage points fewer Whites, 5 percentage points more Hispanics, 3 percentage points fewer low-SES seniors, and 2 percentage points more middle-SES seniors among the longitudinal sample of 1982 seniors than the cross-sectional 1980 senior sample. An additional but smaller difference was observed in the mean number of math test items answered correctly (about one-half a test question less [0.4] in the longitudinal sample; an examination of the distribution of correct answers shows that about a half-percentage point fewer seniors in the longitudinal sample scored in the middle and upper quartile of items answered correctly).

The smaller proportions of Whites and low-SES seniors, and the higher percentage of Hispanics, in the longitudinal sample may be attributable to cohort differences between the two groups of seniors measured two years apart. Indeed, the shifts are consistent with the overall decline in the proportion of Whites, the increase in Hispanics, and the shifts in SES from the 1980 HS&B to the 1992 senior cohort of NELS:88 (see table A-2). However, differences due to the sampling procedure (a longitudinal versus full cross-sectional cohort) cannot be ruled out. With respect to the trend analysis presented in the current report, these underestimates may have balanced each other, as Whites were more likely, and lower SES students and Hispanics less likely, to take some higher level courses in 1982.

[9] A similar analysis for both NELS:88 and ELS:2002 was conducted using the full sample weights appropriate to each wave. Though the transcript weight is most germane to the analysis used in this report, the full weights did produce two additional differences between freshened and unfreshened senior samples: in NELS:88, there was a similar one-point higher percentage of Whites in the unfreshened sample as in the freshened sample; and in ELS:2002, there was a one point lower percentage of Hispanic seniors in the unfreshened sample compared to the freshened sample.

[10] The HS&B analysis samples used here are based on base year and first follow-up files, not on the four-round longitudinal files currently available as an Electronic Codebook (ECB) from NCES.

Table A-3. Percentage distribution of selected student characteristics and mean math score for 1980 senior cohort and 1980 sophomore cohort two years later (in 1982) of HS&B: 1980 and 1982

Characteristic	Senior cohort of 1980	Sophomore cohort of 1980, as seniors in 1982
Sex		
Male	48.1	49.4
Female	51.9	50.6
Race/ethnicity		
Asian	1.3	1.4
Hispanic	6.3	11.7*
Black	11.5	11.2
White	79.0	74.5*
American Indian	0.7	1.0
Other	1.2	0.3
SES		
1st (low) quartile	27.4	23.8*
Middle 2 quartiles	48.1	50.2*
4th (high) quartile	24.5	26.0
Region		
New England	6.9	7.0
Mid Atlantic	16.0	16.5
South Atlantic	15.4	16.3
East south central	5.3	5.4
West south central	9.7	9.9
East north central	19.9	20.3
West north central	8.7	8.2
Mountain	5.1	4.8
Pacific	13.0	11.5
Math test (mean number right)	10.8	10.4*

* Statistically significantly different ($p < .05$) from senior cohort of 1980.

NOTE: SES = socioeconomic status. Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82); and High School and Beyond Longitudinal Study of 1980 Seniors (HS&B-Sr:80).

Coursetaking results for freshened versus unfreshened senior samples in NELS:88 and ELS:2002. The final analysis examines the impact of freshening on the coursetaking estimates presented in this report; it compares the full (freshened) senior samples to the longitudinal (unfreshened) samples of NELS:88 and ELS:2002 (in the case of NELS:88, the relevant longitudinal sample is the representative cohort of 10th graders in 1990 two years later, not the 8th-grade cohort in 1988 four years later). For each survey, estimates were computed for mathematics and science coursetaking, both in average number of credits earned and the level (pipeline) of courses taken. These estimates included estimates for both the full sample and for student subgroups defined by sex, race/ethnicity, socioeconomic status, school sector, and educational expectations. The statistical difference between each pair of estimates was tested; a summary of the results is presented in table A-4.

For both NELS:88 and ELS:2002 surveys, no statistical differences in estimates were observed in comparisons between the freshened senior cohort and the unfreshened senior cohort. Though there is an apparent tendency for the unfreshened estimates to be slightly larger than the freshened estimates (particularly in the NELS:88 estimates of course credits earned), none of these differences were statistically significant. Questions about the direction or magnitude of bias are thus not applicable to the unfreshened versus freshened coursetaking estimates, as no statistical bias was observed.

Conclusion. Very few differences were observed in student characteristics, and no differences in actual coursetaking estimates were observed, when available full senior cohorts (freshened samples) were compared to longitudinal senior cohorts (unfreshened samples based on seniors who were sophomores two years earlier). These findings suggest that bias resulting from the lack of cohort freshening in HS&B is not of major concern for this report.

Table A-4. Summary of comparisons of coursetaking estimates computed from freshened and unfreshened senior samples of NELS:88 and ELS:2002: 1992 and 2004

Summary	Mathematics	Science	Overall
	NELS:88		
All comparisons			
Total number of comparisons	132	132	264
Number of statistically significant differences	0	0	0
Percentage of comparisons significantly different ($p < .05$)	0	0	0
Percentage of statistically significant differences in which unfreshened estimate > freshened estimate	†	†	†
Comparisons of means (course credit estimates)			
Number of means comparisons	24	24	48
Percentage of comparisons in which unfreshened estimate > freshened estimate (all differences statistically nonsignificant)	79.2	79.2	79.2
Comparisons of percentages (course level estimates)			
Number of percentage comparisons	108	108	216
Percentage of comparisons in which unfreshened estimate > freshened estimate (all differences statistically nonsignificant)	61.1	54.6	57.9
	ELS:2002		
All comparisons			
Total number of comparisons	138	138	276
Number of statistically significant differences	0	0	0
Percentage of comparisons significantly different ($p < .05$)	0	0	0
Percentage of statistically significant differences in which unfreshened estimate > freshened estimate	†	†	†
Comparisons of means (course credit estimates)			
Number of means comparisons	24	24	48
Percentage of comparisons in which unfreshened estimate > freshened estimate (all differences statistically nonsignificant)	50.0	79.2	64.6
Comparisons of percentages (course level estimates)			
Number of percentage comparisons	114	114	228
Percentage of comparisons in which unfreshened estimate > freshened estimate (all differences statistically nonsignificant)	55.3	48.2	51.8

† Not applicable

NOTE: NELS:88 unfreshened senior sample based on 10th-grade (first follow-up) freshened cohort. Transcript weights used in both NELS:88 and ELS:2002.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

A.6 Procedures for Selecting the Final Analysis Transcript Samples

The following filters were used to identify high school senior cohort graduates, who graduated on time and with a set of full transcripts.

A.6.1 High School and Beyond (HS&B)

The weight used with the 1982 HS&B sample was the transcript weight TRWT. Filters were added to ensure that only students in school and in 12th grade were used. HS&B did not freshen its 1982 12th grade sample.

- Sample members were kept in the analysis if the reason that they left school was graduation (IF RESNLEFT = 1). The variable is a transcript variable from the last school the student attended.
- Sample members were kept if they graduated during the 1981–82 school year or prior to the 1982–83 school year (using a combination of YEARLEFT and MONLEFT). YEARLEFT and MONLEFT are transcript variables obtained from the graduating school. SAS code is reproduced below.

```
IF 80 < YEARLEFT < 83 THEN DO;
IF YEARLEFT = 81 AND MONLEFT < 08 THEN DELETE;
ELSE IF YEARLEFT = 82 AND MONLEFT > 10 THEN DELETE;
END;
ELSE
DELETE;
```

- The following code was added to ensure selection of students who graduated, graduated with a standard or honors diploma, and not a diploma/special education. Legal values are 1 through 6. Values 1 (special education) and 4 (special and bilingual) are removed.

```
IF ENROLLED IN(2,3,5,6);
```

- Filters using composite variables were also used. RTOT and RI3 are composite variables created using the Secondary School Taxonomy (SST) definitions of the transcript variable CSSC (Classification of Secondary School Courses). RTOT is the total of earned standard Carnegie credits. A value of 16 was used to identify a full set. This limit does not include any lump sum transfer credits. RI3 is the total of earned credits in English. It was thought that a student must have some English credits to graduate.

```
IF RTOT >= 16;
IF RI3 > 0;
```

A.6.2 National Education Longitudinal Study of 1988 (NELS:88)

The weight used with the 1992 NELS:88 sample was the second follow-up transcript weight, F2TRSCWT. Additional filters were added to ensure that only students in school and in grade were used. NELS:88 freshened its 1992 senior sample; these cases are included in the analysis sample.

- A flag was used to identify those students in the survey who also participated in the transcript study (IF F2TRSCFL = 1).

- A transcript variable was used to identify those students who were part of the 12th-grade cohort. Only spring and other 1992 cohort members were kept (IF 1 <= G12RCHRT <= 2).
- A filter was used to identify students who had an exit status from school being a standard or honors diploma (IF 1 <= F2RTROUT <= 2).
- Filters using composite variables were also used. RTOT and RI3 are composite variables created using SST definitions of transcript variable CSSC. RTOT is the total of earned standard Carnegie credits. A value of 16 was used to identify a full set. This limit does not include any lump sum transfer credits. RI3 is the total of earned credits in English. It was thought that a student must have some English credits to graduate.

  IF RTOT >= 16;
  IF RI3 > 0;

A.6.3 Education Longitudinal Study of 2002 (ELS:2002)

The weight used for the 2004 ELS:2002 sample was the transcript weight F1TRSCWT. Additional filters were added to ensure that only students in school and in grade were used. ELS:2002 freshened its 2004 senior sample; these cases are included in the analysis sample.

- A flag was used to identify those students in the survey who also participated in the transcript study (IF F1RTRFLG >= 1).
- A transcript variable was used to identify those students who were part of the 12th-grade cohort (IF G12COHRT = 1).
- A filter was used to identify those students having an exit status from school being a standard or honors diploma (IF 1 <= F1RTROUT <= 4).
- A filter was used to identify students having an exit status during 2004 (IF 20040000 <= F1RDTLFT <= 20041231).
- Filters using credit variables were also used. F1RHTUN is the total of earned standard Carnegie credits. A value of 16 was used to identify a full set. F1RENG_C is a composite variable created using SST definitions of transcript variable CSSC that indicates the total of earned credits in English. It was thought that a student must have some English credits to graduate.

  IF F1RHTUN >= 16;
  IF F1RENG_C > 0;

A.7 Glossary of Classification and Transcript Variables

This glossary gives further information about the following classification variables for this report: educational expectations, race/ethnicity, school sector, sex, and socioeconomic status (SES). It also provides information about transcript variables employed.

A.7.1 Classification Variables.

Educational expectations (as of spring term senior year). All three studies asked (in slightly variant ways) about students' expectations for future educational attainment. For this report, the more extensive original categories were collapsed into four: high school or less, two or fewer years of college, attainment of a bachelor's degree, and attainment of a graduate or professional degree. In ELS:2002 (but not HS&B or NELS:88) missing educational expectations data were statistically imputed.

Race/ethnicity. The race categories used in this report are: American Indian or Alaska Native; Asian or Pacific Islander; Black or African American; Hispanic or Latino; More than one race; White. Hispanic ethnicity was asked separately from race, and Hispanic respondents may have been of any race. The category "more than one race" applies only to ELS:2002. It is unknown how an individual in this category in ELS:2002 would have been placed in a race or ethnicity category of the two prior studies. In all three studies, race was self-reported, and based on a response in the student questionnaire.

School sector (as of 12th grade). Public, Catholic, and Other Private are the school sector categories used in this report. All three studies oversampled non-public schools to some degree, the better to represent this comparatively rare population.

Sex. Consistently across the three studies, respondents were asked whether their sex was female or male. In NELS:88 and ELS:2002, name was used to impute sex in the rare cases this information was not supplied by the respondent.

Socioeconomic status (SES). The socioeconomic status (SES) variable offers a good example of the subtle differences that may exist between the same variable in different studies, despite efforts to maximize cross-cohort consistency of measures. Continuities and differences in SES constituents and construction in the three studies are summarized in tables A-5 and A-6. Note that socioeconomic status is a continuous variable. However, a categorical version is also available for all three studies and was employed in this report. The categorical version provides the quartiles into which the continuous version falls, based on the weighted marginal distribution.

Table A-5. Elements of the socioeconomic status (SES) composite, HS&B and NELS:88: 1980 and 1992

HS&B (primarily student reported)	NELS:88 (primarily parent reported)	NELS:88 student substitutions if missing from parent
Father's occupation	Father's occupation	Father's occupation
—	Mother's occupation	Mother's occupation
Father's education	Father's education	Father's education
Mother's education	Mother's education	Mother's education
Family income	Family income	Household items
Household items	—	—

— Not available.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; and National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992."

Table A-6. Elements of the socioeconomic status (SES) composite, ELS:2002: 2004

Preferred source (parent reported)	Student report substitution if missing from parent	Imputed if still missing
Father's occupation	Father's occupation	Father's occupation
Mother's occupation	Mother's occupation	Mother's occupation
Father's education	Father's education	Father's education
Mother's education	Mother's education	Mother's education
Family income	—	Family income

— Not available.

SOURCE: Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

In all three studies, the composite is based on five equally weighted, standardized components; however, these components differ somewhat. In HS&B, the household items (e.g., appliances, books) were directly used; in NELS:88, they were used only as a proxy for missing income data. In HS&B, mother's occupation was available from the data set but was not used in calculating SES. In NELS:88 and ELS:2002, both mother's and father's occupation are elements of SES. In HS&B, student data were used to construct this composite. In NELS:88 and ELS:2002, parent data were used to construct the SES composite. In both NELS:88 and ELS:2002, student data were substituted where parent data were missing. However, for parent education and occupation, where both parent and student reports were missing, ELS:2002 education and occupation values were imputed. Family income was not asked of students in NELS:88 or ELS:2002. While in NELS:88 a student-provided household item index (see below for more information about the household item scale), which served as an income proxy, was substituted when income data were missing, a different procedure was followed in ELS:2002: when parent data on income were missing, income was statistically imputed.

The impact of imputation on the intercohort comparability of the SES composite was investigated by comparing two versions of 2002 SES, one based on the ELS:2002 specifications, the other on NELS:88 specifications. The basic finding was of no impact or extremely small impact on estimates. Details are given in Ingels et al. (2005), appendix C. The impact of imputation on other aspects of trend estimation was also considered in the same source.

Some differences in the treatment of SES across the studies are based on differences in design. The studies had different starting points. HS&B base-year respondents were sophomores or seniors. NELS:88 base-year respondents were 8th-graders. ELS:2002 base-year respondents were sophomores. A parent interview was sought for all NELS:88 and ELS:2002 base-year student respondents. HS&B had a parent survey, but it only encompassed a modest subsample of student respondents. Because the quality of reporting on parental occupation and education increases with student age or grade, it may be of concern whether reports were gathered at grade 8, 10, or 12. However, since parent reports are markedly superior to student reports in these matters, it may be of concern that only in NELS:88 and ELS:2002 are the data primarily parent reported. Likewise, students are poor reporters of family income, but the income question was asked of students in HS&B and of parents alone in NELS:88 and ELS:2002.

A.7.2 Transcript Variables.

Mean course credits: total Carnegie units in mathematics. A Carnegie unit represents the completion of a course (i.e., receipt of a passing grade) that meets one period per day (45-60 minutes) for 1 academic year. "Mathematics" includes courses in (among other areas) general mathematics, consumer mathematics, pre-algebra, algebra 1, geometry, algebra 2 and 3, trigonometry, analytical geometry, mathematical analysis, precalculus, calculus, Advanced Placement (AP) calculus, International Baccalaureate (IB) mathematics, probability and statistics, unified mathematics (an integrated course sequence usually taught over 2 or 3 years) and occupationally related mathematics.

Mean course credits: total Carnegie units in science. A Carnegie unit represents the completion of a course (i.e., receipt of a passing grade) that meets one period per day (45-60 minutes) for 1 academic year. "Science" includes courses in (among other areas) survey science, biological science (including biology and related specialized courses such as botany, zoology, anatomy and physiology), chemistry, physics, astronomy, geology, earth science, physical science, and engineering.

Math and science course-taking pipeline. An ordinal composite variable was constructed to indicate the highest level of math for which the student received non-zero credit while in high school. For this report, the eight levels were collapsed into six to report the highest level of math taken in high school: (1) No math or low academic math; (2) Algebra I/plane geometry; (3) Algebra II; (4) Algebra III/trigonometry/analytic geometry; (5) Pre-calculus; (6) Calculus.

An ordinal composite variable indicates the highest level of science for which the student received non-zero credit while in high school. This variable captures the "breadth and depth" of a student's science coursetaking histories using four criteria: (1) subject matter taken, (2) when taken (e.g., freshman, sophomore, junior, or senior year), (3) whether taken with another science course, and (4) academic difficulty. The continuum reflects the order of the most common science curriculum used in schools where students take general science courses first, followed by biology, then chemistry, and finally physics. Recent analyses of science coursetaking using NCES data have realigned the positioning of advanced biology. The current science coursetaking pipeline measure contains eight categories, collapsed to six for purposes of this report: (1) No science or low-level science; (2) Secondary physical science and basic biology; (3) General biology; (4) Chemistry I or physics I; (5) Chemistry I and physics I; (6) Chemistry II, physics II, or advanced biology.

Appendix B
Standard Error Tables

This appendix presents standard errors of all estimates in this report. By definition, a standard error represents the deviation of the sample estimate from the true population estimate or a measure of the accuracy of the estimate; thus, the smaller the standard error, the more accurate the estimate.

Table B-1. Standard errors for figure 1: Percentage of high school graduates who completed different levels of mathematics courses: 1982, 1992, and 2004

Levels of mathematics	1982	1992	2004
No math or low academic math	0.75	0.61	0.33
Algebra I/plane geometry	0.75	0.78	0.68
Algebra II	0.61	0.95	0.75
Algebra III/trigonometry/analytic geometry	0.64	0.77	0.78
Precalculus	0.37	0.60	0.63
Calculus	0.44	0.77	0.55

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table B-2. Standard errors for figure 2: Mean credits earned in mathematics by high school graduates, by sex: 1982, 1992, and 2004

	Male			Female		
Year	Sample (n)	SE	SD	Sample (n)	SE	SD
1982	5,300	0.03	1.16	5,800	0.02	1.03
1992	6,700	0.04	0.93	6,800	0.02	0.83
2004	5,300	0.02	0.94	5,500	0.02	0.90

NOTE: SE = standard error; SD = standard deviation.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table B-3. Standard errors for figure 3: Percentage of high school graduates who completed different levels of mathematics courses, by sex: 1982, 1992, and 2004

	Male			Female		
Levels of mathematics	1982	1992	2004	1982	1992	2004
No math or low academic math	1.00	0.95	0.45	0.92	0.65	0.40
Algebra I/plane geometry	1.00	1.14	0.81	0.99	0.92	0.79
Algebra II	0.81	1.38	0.89	0.77	1.19	0.95
Algebra III/ trigonometry/analytic geometry	0.81	1.14	0.83	0.79	0.88	0.96
Precalculus	0.49	0.65	0.72	0.44	0.84	0.84
Calculus	0.60	1.23	0.74	0.49	0.72	0.64

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table B-4. Standard errors for figure 5: Mean credits earned in mathematics by high school graduates, by race/ethnicity: 1982, 1992, and 2004

	1982			1992			2004		
Race/ethnicity	Sample (n)	SE	SD	Sample (n)	SE	SD	Sample (n)	SE	SD
American Indian	150	0.13	0.12	130	0.09	0.88	80	0.13	0.89
Asian	310	0.09	0.99	1,000	0.07	0.77	1,100	0.04	0.98
Black	2,200	0.04	1.02	1,400	0.05	0.86	1,200	0.05	0.93
Hispanic	7,000	0.02	1.01	9,800	0.05	0.83	1,400	0.04	0.96
White	1,500	0.04	0.93	1,100	0.03	0.88	6,600	0.02	0.99

NOTE: Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native. SE = standard error; SD = standard deviation.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table B-5. Standard errors for figure 6: Percentage of high school graduates who completed different levels of mathematics courses, by race/ethnicity: 1982, 1992, and 2004

	American Indian			Asian			Black			Hispanic			White		
Levels of mathematics	1982	1992	2004	1982	1992	2004	1982	1992	2004	1982	1992	2004	1982	1992	2004
No math or low academic math	8.45	5.60	5.21	2.32	1.95	0.50	2.35	1.74	1.09	1.72	1.69	1.04	0.80	0.71	0.36
Algebra I/plane geometry	5.93	5.19	4.84	2.82	1.73	1.30	1.80	3.16	1.62	1.59	2.12	2.02	0.90	0.80	0.74
Algebra II	4.22	4.64	6.17	3.17	3.12	1.96	2.03	2.21	1.92	1.12	2.79	1.63	0.71	1.14	0.92
Algebra III/trigonometry/ analytic geometry	2.43	3.65	4.55	2.92	1.86	1.32	1.06	1.90	2.30	0.88	2.96	1.58	0.78	0.89	0.86
Precalculus	†	1.07	3.27	3.21	2.84	1.89	0.43	1.54	1.44	0.68	1.00	1.39	0.45	0.68	0.80
Calculus	1.16	0.67	2.72	2.47	2.38	2.50	0.60	1.73	0.69	0.48	0.86	0.87	0.53	0.97	0.68

† Not applicable.

NOTE: Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table B-6. Standard errors for figure 8: Mean credits earned in mathematics by high school graduates, by socioeconomic status: 1982, 1992, and 2004

	First quartile (lowest)			Second quartile			Third quartile			Fourth quartile (highest)		
Year	Sample (n)	SE	SD	Sample (n)	SE	SD	Sample (n)	SE	SD	Sample (n)	SE	SD
1982	2,800	0.04	1.10	2,500	0.03	1.02	2,500	0.03	1.09	3,000	0.03	1.04
1992	2,300	0.03	0.87	3,000	0.03	0.84	3,300	0.03	0.84	4,400	0.05	0.84
2004	2,100	0.03	0.95	2,500	0.03	0.95	2,700	0.03	0.90	3,500	0.03	0.85

NOTE: SE = standard error; SD = standard deviation.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), “High School Transcript Study”; National Education Longitudinal Study of 1988 (NELS:88/92), “Second Follow-up, Transcript Survey, 1992”; and Education Longitudinal Study of 2002 (ELS:2002), “First Follow-up, High School Transcript Study, 2004.”

Table B-7. Standard errors for figure 9: Percentage of high school graduates who completed different levels of mathematics courses, by socioeconomic status: 1982, 1992, and 2004

Levels of mathematics	First quartile (lowest)			Second quartile			Third quartile			Fourth quartile (highest)		
	1982	1992	2004	1982	1992	2004	1982	1992	2004	1982	1992	2004
No math or low academic math	1.52	1.48	0.89	1.46	1.01	0.62	1.08	0.78	0.49	0.85	1.28	0.36
Algebra I/plane geometry	1.46	1.55	1.43	1.35	1.81	1.22	1.32	1.19	0.98	1.29	1.00	0.68
Algebra II	1.04	1.83	1.36	1.20	1.95	1.21	1.03	1.49	1.21	1.12	1.99	1.02
Algebra III/trigonometry/analytic geometry	0.71	1.36	1.15	0.92	1.42	1.20	1.13	1.13	1.12	1.34	1.60	1.14
Precalculus	0.19	0.66	0.86	0.49	0.86	0.99	0.69	1.03	1.04	0.88	1.24	1.11
Calculus	0.29	0.40	0.70	0.54	0.53	0.64	0.61	1.14	0.76	1.10	2.08	1.08

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table B-8. Standard errors for figure 11: Mean credits earned in mathematics by high school graduates, by educational expectations: 1982, 1992, and 2004

Year	High school diploma/GED or less			Some postsecondary education			Baccalaureate degree			Graduate degree		
	Sample (n)	SE	SD	Sample (n)	SE	SD	Sample (n)	SE	SD	Sample (n)	SE	SD
1982	1,800	0.03	0.87	3,100	0.02	0.95	2,700	0.03	0.97	2,400	0.05	1.14
1992	520	0.06	0.86	2,800	0.03	0.78	4,300	0.04	0.83	4,500	0.04	0.81
2004	400	0.06	0.93	1,600	0.03	0.91	3,800	0.02	0.87	4,300	0.03	0.88

NOTE: GED = General Educational Development certificate; SE = standard error; SD = standard deviation.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table B-9. Standard errors for figure 12: Percentage of high school graduates who completed different levels of mathematics courses, by educational expectations: 1982, 1992, and 2004

Levels of mathematics	High school diploma/ GED or less			Some postsecondary education			Baccalaureate degree			Graduate degree		
	1982	1992	2004	1982	1992	2004	1982	1992	2004	1982	1992	2004
No math or low academic math	1.68	3.34	2.35	1.15	1.80	1.07	0.85	0.52	0.33	0.68	0.54	0.28
Algebra I/plane geometry	1.70	3.59	2.97	1.30	1.75	1.60	1.25	1.09	0.82	1.23	0.92	0.53
Algebra II	1.08	4.46	2.51	0.86	1.62	1.58	1.27	1.91	1.04	1.41	1.49	0.93
Algebra III/trigonometry/analytic geometry	0.61	0.69	1.94	0.74	1.14	1.09	1.28	1.53	1.16	1.49	1.31	1.05
Precalculus	0.11	0.55	0.67	0.29	0.27	0.79	0.76	1.18	1.00	1.15	1.15	1.04
Calculus	0.25	0.81	0.31	0.38	0.12	0.28	0.78	1.03	0.65	1.27	1.95	1.04

NOTE: GED = General Educational Development certificate.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table B-10. Standard errors for figure 14: Mean credits earned in mathematics by high school graduates, by school sector: 1982, 1992, and 2004

Year	Public			Catholic			Other private		
	Sample (n)	SE	SD	Sample (n)	SE	SD	Sample (n)	SE	SD
1982	8,400	0.02	1.09	2,100	0.07	0.99	730	0.13	1.00
1992	11,500	0.02	0.86	800	0.06	0.68	1,200	0.26	1.09
2004	8,300	0.02	0.93	1,600	0.03	0.66	1,000	0.07	0.77

NOTE: SE = standard error; SD = standard deviation.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table B-11. Standard errors for figure 15: Percentage of high school graduates who completed different levels of mathematics courses, by school sector: 1982, 1992, and 2004

	Public			Catholic			Other private		
Levels of mathematics	1982	1992	2004	1982	1992	2004	1982	1992	2004
No math or low academic math	0.81	0.65	0.36	1.31	0.47	0.16	2.77	1.09	0.24
Algebra I/plane geometry	0.80	0.81	0.74	2.67	2.06	0.87	3.91	2.91	1.57
Algebra II	0.65	1.00	0.80	1.96	3.21	2.23	3.53	4.86	2.27
Algebra III/trigonometry/ analytic geometry	0.65	0.73	0.83	2.47	3.43	2.25	5.17	8.97	3.04
Precalculus	0.35	0.63	0.67	2.05	2.65	2.49	3.01	3.62	2.83
Calculus	0.37	0.49	0.56	1.59	3.64	1.86	6.38	10.93	3.96

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), “High School Transcript Study”; National Education Longitudinal Study of 1988 (NELS:88/92), “Second Follow-up, Transcript Survey”; and Education Longitudinal Study of 2002 (ELS:2002), “High School Transcript Study.”

Table B-12. Standard errors for figure 17: Percentage of high school graduates who completed different levels of science courses: 1982, 1992, and 2004

Levels of science	1982	1992	2004
No science or low level science	0.68	0.29	0.29
Secondary physical science and basic biology	0.82	0.60	0.34
General biology	1.01	1.02	0.88
Chemistry I or physics I	0.55	0.98	0.91
Chemistry I and physics I	0.41	0.60	0.82
Chemistry II, physics II, or advanced biology	0.72	0.80	0.78

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table B-13. Standard errors for figure 18: Mean credits earned in science by high school graduates, by sex: 1982, 1992, and 2004

	Male			Female		
Year	Sample (n)	SE	SD	Sample (n)	SE	SD
1982	5,300	0.03	1.20	5,800	0.03	1.11
1992	6,700	0.03	1.07	6,800	0.03	1.00
2004	5,300	0.03	1.12	5,500	0.02	1.01

NOTE: SE = standard error; SD = standard deviation.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table B-14. Standard errors for figure 19: Percentage of high school graduates who completed different levels of science courses, by sex: 1982, 1992, and 2004

	Male			Female		
Levels of science	1982	1992	2004	1982	1992	2004
No science or low level science	0.81	0.43	0.44	0.86	0.30	0.24
Secondary physical science and basic biology	1.04	1.03	0.41	0.92	0.41	0.38
General biology	1.19	1.49	1.00	1.22	1.15	1.04
Chemistry I or physics I	0.71	1.38	0.98	0.71	1.25	1.13
Chemistry I and physics I	0.63	0.66	0.90	0.42	0.89	0.97
Chemistry II, physics II, or advanced biology	0.87	1.23	0.91	0.87	0.77	0.92

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table B-15. Standard errors for figure 20: Mean credits earned in science by high school graduates, by race/ethnicity: 1982, 1992, and 2004

Year	American Indian			Asian			Black			Hispanic			White		
	Sample (n)	SE	SD	Sample (n)	SE	SD	Sample (n)	SE	SD	Sample (n)	SE	SD	Sample (n)	SE	SD
1982	150	0.09	1.03	310	0.11	1.37	1,500	0.05	0.99	2,200	0.03	0.95	7,000	0.03	1.19
1992	130	0.09	0.88	1,000	0.09	1.19	1,100	0.07	1.01	1,400	0.04	0.84	9,800	0.03	1.04
2004	80	0.19	1.05	1,146	0.06	1.28	1,200	0.04	1.01	1,400	0.04	0.98	6,600	0.02	1.05

NOTE: SE = standard error; SD = standard deviation. Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table B-16. Standard errors for figure 21: Percentage of high school graduates who completed different levels of science courses, by race/ethnicity: 1982, 1992, and 2004

Levels of science	American Indian			Asian			Black			Hispanic			White		
	1982	1992	2004	1982	1992	2004	1982	1992	2004	1982	1992	2004	1982	1992	2004
No science or low level science	3.87	2.89	1.93	1.74	0.55	0.53	1.85	0.75	0.64	1.75	0.71	0.74	0.72	0.33	0.35
Secondary physical science and basic biology	10.53	4.49	3.14	2.21	1.69	0.41	2.10	2.28	0.59	1.66	2.37	1.00	0.84	0.62	0.38
General biology	7.08	4.81	8.90	4.07	3.89	1.49	2.37	3.16	1.86	1.91	2.66	1.87	1.12	1.17	1.08
Chemistry I or physics I	3.83	2.89	6.72	3.01	2.07	1.86	1.42	2.12	2.25	0.96	2.70	1.82	0.65	1.20	1.07
Chemistry I and physics I	1.68	3.86	5.64	2.95	2.62	1.76	0.65	2.18	1.72	0.49	1.20	1.74	0.49	0.65	0.98
Chemistry II, physics II, or advanced biology	3.27	2.69	3.16	3.28	2.29	2.52	1.59	1.64	1.41	0.88	1.13	1.02	0.85	0.99	0.99

NOTE: Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table B-17. Standard errors for figure 22: Mean credits earned in science by high school graduates, by socioeconomic status: 1982, 1992, and 2004

	First quartile (lowest)			Second quartile			Third quartile			Fourth quartile (highest)		
Year	Sample (n)	SE	SD	Sample (n)	SE	SD	Sample (n)	SE	SD	Sample (n)	SE	SD
1982	2,800	0.04	1.04	2,500	0.03	1.08	2,500	0.04	1.15	3,000	0.04	1.20
1992	2,300	0.04	0.95	3,000	0.04	0.95	3,300	0.04	1.03	4,400	0.04	1.02
2004	2,100	0.03	1.04	2,500	0.03	1.03	2,700	0.03	1.04	3,500	0.03	1.05

NOTE: SE = standard error; SD = standard deviation.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), “High School Transcript Study”; National Education Longitudinal Study of 1988 (NELS:88/92), “Second Follow-up, Transcript Survey, 1992”; and Education Longitudinal Study of 2002 (ELS:2002), “First Follow-up, High School Transcript Study, 2004.”

Table B-18. Standard errors for figure 23: Percentage of high school graduates who completed different levels of science courses, by socioeconomic status: 1982, 1992, and 2004

	First quartile (lowest)			Second quartile			Third quartile			Fourth quartile (highest)		
Levels of science	1982	1992	2004	1982	1992	2004	1982	1992	2004	1982	1992	2004
No science or low level science	1.44	0.80	0.60	1.21	0.65	0.42	0.91	0.28	0.38	0.73	0.11	0.29
Secondary physical science and basic biology	1.35	1.05	0.80	1.48	1.30	0.60	1.18	0.72	0.47	1.02	1.25	0.34
General biology	1.61	1.98	1.60	1.60	1.92	1.46	1.55	1.57	1.36	1.56	1.75	0.88
Chemistry I or physics I	0.77	1.82	1.49	0.90	2.00	1.39	0.99	1.53	1.37	1.06	1.97	1.31
Chemistry I and physics I	0.35	0.72	0.91	0.64	0.68	1.08	0.64	1.24	1.15	0.95	1.32	1.34
Chemistry II, physics II, or advanced biology	0.88	0.71	1.01	1.02	0.96	1.03	1.11	0.95	1.10	1.45	2.01	1.39

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table B-19. Standard errors for figure 24: Mean credits earned in science by high school graduates, by educational expectations: 1982, 1992, and 2004

	High school diploma/ GED or less			Some postsecondary education			Baccalaureate degree			Graduate degree		
Year	Sample (n)	SE	SD	Sample (n)	SE	SD	Sample (n)	SE	SD	Sample (n)	SE	SD
1982	1,800	0.03	0.83	3,100	0.03	0.94	2,700	0.03	1.12	2,400	0.05	1.28
1992	520	0.07	0.91	2,800	0.03	0.85	4,300	0.03	0.94	4,500	0.04	1.06
2004	400	0.06	1.02	1,600	0.03	0.88	3,800	0.03	0.98	4,300	0.03	1.08

NOTE: GED = General Educational Development certificate. SE = standard error; SD = standard deviation.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table B-20. Standard errors for figure 25: Percentage of high school graduates who completed different levels of science courses, by educational expectations: 1982, 1992, and 2004

	High school diploma/ GED or less			Some postsecondary education			Baccalaureate degree			Graduate degree		
Levels of science	1982	1992	2004	1982	1992	2004	1982	1992	2004	1982	1992	2004
No science or low level science	1.68	1.30	2.03	1.06	0.71	0.79	0.68	0.24	0.30	0.64	0.35	0.20
Secondary physical science and basic biology	1.52	2.09	2.22	1.26	1.66	0.93	1.09	0.45	0.35	0.86	0.78	0.25
General biology	1.88	4.04	3.00	1.51	1.89	1.72	1.42	1.41	1.16	1.54	1.66	0.79
Chemistry I or physics I	0.60	4.72	2.26	0.76	1.45	1.59	1.20	2.03	1.24	1.35	1.28	1.18
Chemistry I and physics I	0.22	0.52	0.74	0.43	0.37	0.61	0.88	1.26	1.22	1.16	1.14	1.12
Chemistry II, physics II, or advanced biology	0.71	0.63	1.74	0.76	0.73	0.92	1.30	0.95	0.97	1.58	1.87	1.22

NOTE: GED = General Educational Development certificate.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), “High School Transcript Study”; National Education Longitudinal Study of 1988 (NELS:88/92), “Second Follow-up, Transcript Survey, 1992”; and Education Longitudinal Study of 2002 (ELS:2002), “First Follow-up, High School Transcript Study, 2004.”

Table B-21. Standard errors for figure 26: Mean credits earned in science by high school graduates, by school sector: 1982, 1992, and 2004

	Public			Catholic			Other private		
Year	Sample (n)	SE	SD	Sample (n)	SE	SD	Sample (n)	SE	SD
1982	8,400	0.02	1.16	2,100	0.07	1.10	730	0.10	0.94
1992	11,500	0.03	1.05	780	0.08	0.89	1,200	0.14	0.87
2004	8,300	0.02	1.08	1,600	0.06	0.83	1,000	0.06	0.88

NOTE: SE = standard error; SD = standard deviation.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), “High School Transcript Study”; National Education Longitudinal Study of 1988 (NELS:88/92), “Second Follow-up, Transcript Survey, 1992”; and Education Longitudinal Study of 2002 (ELS:2002), “First Follow-up, High School Transcript Study, 2004.”

Table B-22. Standard errors for figure 27: Percentage of high school graduates who completed different levels of science courses, by school sector: 1982, 1992, and 2004

	Public			Catholic			Other private		
Levels of science	1982	1992	2004	1982	1992	2004	1982	1992	2004
No science or low level science	0.76	0.32	0.32	1.14	0.54	0.54	0.77	0.23	†
Secondary physical science and basic biology	0.89	0.64	0.37	2.58	0.72	0.75	2.72	2.61	0.26
General biology	1.04	1.04	0.94	3.82	3.46	2.36	7.11	5.51	2.15
Chemistry I or physics I	0.59	1.00	0.97	1.89	2.99	2.70	2.58	8.34	3.71
Chemistry I and physics I	0.39	0.59	0.86	1.38	4.01	3.02	4.27	3.04	4.69
Chemistry II, physics II, or advanced biology	0.72	0.63	0.83	3.31	2.95	2.11	5.73	10.85	3.92

† Not applicable.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), “High School Transcript Study”; National Education Longitudinal Study of 1988 (NELS:88/92), “Second Follow-up, Transcript Survey, 1992”; and Education Longitudinal Study of 2002 (ELS:2002), “First Follow-up, High School Transcript Study, 2004.”

Table B-23. Standard errors for appendix table A-2: Percentage distribution of selected student characteristics and mean math IRT score for freshened versus unfreshened samples (transcript weight) of NELS:88 and ELS:2002 seniors: 1992 and 2004

	NELS:88: 1992		ELS:2002: 2004	
Characteristic	Seniors who were sophomores two years earlier	Full senior cohort (freshened sample)	Seniors who were sophomores two years earlier	Full senior cohort (freshened sample)
Sex				
Male	0.92	0.87	0.60	0.57
Female	0.92	0.87	0.60	0.57
Race/ethnicity				
Asian/Pacific Islander	0.34	0.33	0.28	0.30
Hispanic	0.84	0.81	0.82	0.85
Black	0.88	0.86	0.68	0.68
White	1.26	1.21	1.04	1.04
American Indian/Alaska Native	0.25	0.25	0.22	0.21
More than one race	—	—	0.26	0.26
SES				
1st (low) quartile	0.78	0.78	0.68	0.67
Middle 2 quartiles	1.04	1.02	0.68	0.67
4th (high) quartile	1.21	1.17	0.79	0.80
School control				
Public	1.02	0.92	0.36	0.35
Catholic	0.54	0.49	0.22	0.21
NAIS private	0.55	0.48	—	—
Other private	0.50	0.46	0.29	0.28
Region				
Northwest	1.20	1.15	0.83	0.82
Midwest	1.01	0.95	0.81	0.79
South	1.09	1.04	0.79	0.77
West	0.87	0.85	0.86	0.83
Math test (mean IRT score)	0.33	0.33	0.29	0.29

— Not available.

NOTE: IRT = item response theory. SES = socioeconomic status. NAIS = National Association of Independent Schools. Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native.

SOURCE:U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, 2004."

Table B-24. Standard errors for appendix table A-3: Percentage of selected student characteristics and mean math score for 1980 senior cohort and 1980 sophomore cohort two years later (in 1982) of HS&B: 1980 and 1982

Characteristic	Senior cohort of 1980	Sophomore cohort of 1980, as seniors in 1982
Sex		
Male	0.51	0.52
Female	0.51	0.52
Race/ethnicity		
Asian/Pacific Islander	0.16	0.16
Hispanic	0.27	0.34
Black	0.69	0.66
White	0.80	0.83
American Indian/Alaska Native	0.11	0.16
Other	0.13	0.04
SES		
1st (low) quartile	0.62	0.60
Middle 2 quartiles	0.53	0.57
4th (high) quartile	0.69	0.74
Region		
New England	0.99	1.04
Mid Atlantic	1.32	1.35
South Atlantic	1.30	1.38
East south central	0.76	0.78
West south central	1.06	1.10
East north central	1.41	1.43
West north central	1.01	0.98
Mountain	0.81	0.80
Pacific	1.17	1.09
Math test (mean number right)	0.06	0.07

NOTE: SES = socioeconomic status. Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82); and High School and Beyond Longitudinal Study of 1980 Seniors (HS&B-Sr:80).

Appendix C
Sample Size Tables for Select Subgroups

This appendix presents approximate sample sizes for select subgroups. The sample sizes are approximate because restricted-use data are used, and in accordance with National Center for Education Statistics (NCES) Statistical Standards (Seastrom 2003), exact sample sizes from restricted-use data files cannot be published unless the data are perturbed in some way. The perturbation approach taken here was to round the exact sample sizes of cells to 10s (for two or three-digit numbers) or 100s (for larger numbers).

Table C-1. Sample sizes for each level of the mathematics pipeline, by student characteristics: 1982, 1992, and 2004

Characteristic	No mathematics or low academic mathematics			Algebra I/plane geometry			Algebra II			Algebra III/ trigonometry/analytic geometry			Precalculus			Calculus		
	1982	1992	2004	1982	1992	2004	1982	1992	2004	1982	1992	2004	1982	1992	2004	1982	1992	2004
Gender																		
Male	1,200	850	240	1,400	1,400	910	960	1,500	1,300	990	1,100	950	340	860	1,000	450	980	910
Female	1,300	700	180	1,900	1,400	830	1,100	1,800	1,400	900	1,200	1,100	300	890	1,200	340	880	920
Race/ethnicity																		
American Indian	50	30	10	50	40	20	20	40	30	20	10	10	#	10	10	10	#	10
Asian	30	50	20	50	120	120	60	170	200	80	160	140	40	180	280	50	320	390
Black	480	220	70	420	290	210	280	300	370	190	140	310	50	80	170	40	80	80
Hispanic	710	200	80	730	470	320	390	380	410	280	150	190	60	130	250	80	90	120
White	1,200	1,000	230	2,000	1,900	980	1,300	2,400	1,500	1,300	1,700	1,300	490	1,300	1,400	600	1,400	1,200
School sector																		
Public	2,300	1,500	410	2,600	2,700	1,600	1,500	2,900	2,100	1,200	1,800	1,400	330	1,300	1,500	430	1,300	1,200
Catholic	140	10	10	590	80	70	480	200	340	490	170	380	190	190	420	170	130	330
Other private	40	10	10	110	50	90	100	150	190	160	250	190	120	280	250	190	470	280
Socioeconomic status																		
First quartile (lowest)	1,100	540	190	940	730	560	430	590	620	290	190	320	50	130	290	60	110	160
Second quartile	650	480	120	810	840	590	470	790	700	360	440	450	90	280	380	90	200	220
Third quartile	440	320	90	780	750	370	550	930	720	450	590	550	150	410	610	150	360	420
Fourth quartile (highest)	240	110	30	660	420	230	590	900	610	760	940	680	330	890	920	450	1,200	1,000
Educational expectations																		
High school diploma/ GED or less	880	220	90	620	170	170	190	90	90	100	20	40	10	10	10	10	10	#
Some postsecondary education	860	700	160	1,200	1,100	580	550	680	540	370	230	210	70	70	120	60	20	20
Baccalaureate degree	250	220	70	690	770	480	680	1,300	1,100	640	900	830	230	650	850	250	470	470
Graduate degree	150	150	40	420	410	300	510	910	730	640	880	810	280	890	1,200	400	1,300	1,300

Rounds to zero.

NOTE: Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native. All race categories exclude Hispanic or Latino origin. GED = General Educational Development certificate.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), “High School Transcript Study”; National Education Longitudinal Study of 1988 (NELS:88/92), “Second Follow-up, Transcript Survey, 1992”; and Education Longitudinal Study of 2002 (ELS:2002), “First Follow-up, High School Transcript Study, 2004.”

Table C-2. Sample sizes for each level of the science pipeline, by student characteristics: 1982, 1992, and 2004

Characteristic	No science or low-level science			Secondary physical science and basic biology			General biology			Chemistry I or physics I			Chemistry I and physics I			Chemistry II, physics II, or advanced biology		
	1982	1992	2004	1982	1992	2004	1982	1992	2004	1982	1992	2004	1982	1992	2004	1982	1992	2004
Gender																		
Male	670	240	130	760	460	160	1,800	2,200	1,300	880	1,700	1,600	450	990	1,100	800	1,100	1,000
Female	730	160	80	880	370	140	2,100	2,400	1,200	1,000	2,000	2,000	280	800	960	840	1,100	1,200
Race/ethnicity																		
American Indian	20	10	#	20	20	#	60	60	30	20	20	20	10	10	10	20	10	10
Asian	20	30	20	30	40	10	70	190	150	80	240	310	40	200	210	80	310	450
Black	200	30	20	210	110	30	570	440	360	250	290	470	80	110	170	150	120	150
Hispanic	340	60	50	420	170	60	850	610	390	310	330	500	100	130	220	210	120	150
White	800	280	110	940	480	170	2,300	3,200	1,400	1,200	2,800	2,100	500	1,300	1,300	1,200	1,700	1,400
School sector																		
Public	1,300	400	210	1,300	800	260	3,000	4,200	2,100	1,300	3,100	2,800	440	1,400	1,300	1,100	1,700	1,600
Catholic	110	#	10	310	30	30	710	180	240	440	240	490	190	150	460	320	180	330
Other private	10	10	#	40	#	10	240	170	120	180	380	310	90	240	290	180	410	280
Socioeconomic status																		
First quartile (lowest)	530	140	90	470	290	100	1,200	1,100	720	340	470	730	90	150	210	260	170	280
Second quartile	370	130	60	410	250	100	940	1,300	730	350	770	840	110	280	360	280	330	370
Third quartile	270	90	50	380	170	60	850	1,200	610	470	1,000	940	170	430	560	390	450	530
Fourth quartile (highest)	170	30	30	330	80	40	830	880	410	690	1,300	1,100	340	890	910	680	1,200	1,100
Educational expectations																		
High school diploma/GED or less	460	50	50	350	90	40	800	300	190	100	60	80	10	10	10	90	20	30
Some postsecondary education	500	190	60	590	330	110	1,300	1,500	710	360	530	540	80	80	90	280	130	120
Baccalaureate degree	170	70	50	330	150	80	820	1,300	810	690	1,500	1,400	230	660	780	510	590	650
Graduate degree	90	40	30	180	100	40	540	830	490	610	1,300	1,300	340	930	1,100	640	1,300	1,300

Rounds to zero.

NOTE: Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or Other Pacific Islander, and American Indian includes Alaska Native. All race categories exclude Hispanic or Latino origin. GED = General Educational Development certificate.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study"; National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992"; and Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Appendix D
Course-Specific Completion Percentages

Appendix D presents the percentage distribution of courses in which graduating seniors earned credits, for each of the three studies included in this report. Tables D-1 and D-2 present data from the High School & Beyond (HS&B) graduating cohort of 1982. Tables D-3 and D-4 present data from the National Education Longitudinal Study of 1988 (NELS:88) graduating cohort of 1992. Tables D-5 and D-6 present data from the Education Longitudinal Study of 2002 (ELS:2002) graduating cohort of 2004. Only credits earned for courses taken during students' 9^{th} through 12^{th} grade are included (even if the course has a 7^{th} or 8^{th} grade label).

It is important to note that course codes as identified within each of the studies may differ over time. Courses were identified on the basis of the Classification Scheme of Secondary School Courses (CSSC) used to code the transcripts collected under NELS:88 (Ingels et al. 1995); this framework was used to classify HS&B and ELS:2002 transcripts as well. However, there may be differences in course classifications across studies because the original coding of the transcripts used certain codes, descriptions, or titles, and not others. In addition, while some CSSC codes did not exist in the previous years, it does not mean that the courses were not available; they would have been included in another existing CSSC value. Directly comparing individual courses across years should be done with caution.

Table D-1. Percentage and standard errors of graduating seniors who received credit in mathematics courses, by pipeline level: 1982

Pipeline level and CSSC[1] course title	CSSC[1] code	Percentage	Standard error
(1) No or low academic math	†		
Mathematics, Other General	270100	1.8	0.31
Mathematics 7[2]	270101	0.1	0.05
Mathematics 7, Accelerated[2]	270102	#	†
Mathematics 8[2]	270103	0.1	0.04
Mathematics 8, Accelerated[2]	270104	0.1	0.04
Mathematics 1, General	270106	25.4	0.90
Mathematics 2, General	270107	10.6	0.66
Science Mathematics	270108	0.2	0.07
Mathematics in the Arts	270109	0.3	0.12
Mathematics, Vocational	270110	1.7	0.25
Technical Mathematics	270111	0.8	0.18
Mathematics Review	270112	1.1	0.22
Mathematics Tutoring	270113	0.2	0.11
Consumer Mathematics	270114	8.3	0.55
Actuarial Sciences, Other	270200	#	0.01
Applied Mathematics, Other	270300	0.1	0.05
Basic Math 1[3]	270601	#	†
Basic Math 2[3]	270602	#	†
Basic Math 3[3]	270603	#	†
Basic Math 4[3]	270604	#	†
Basic Math - old code[3]	270105	7.2	0.52
Vocational Math - old code[3]	320108	0.5	0.14
Pre-Algebra	270401	13.5	0.78
Algebra 1, Part 1	270402	6.2	0.55
Algebra 1, Part 2	270403	4.6	0.48
Geometry, Informal	270409	3.3	0.41
(2) Algebra I/plane geometry	†		
Pure Mathematics, Other	270400	0.5	0.10
Algebra 1	270404	58.6	0.96
Geometry, Plane	270406	6.0	0.63
Geometry, Solid	270407	0.8	0.17
Geometry	270408	41.2	0.99
Mathematics 1, Unified	270421	1.3	0.28
Mathematics 2, Unified	270422	0.8	0.23
Geometry, Part 1[4]	270425	†	†
Geometry, Part 2[4]	270426	†	†
Unified Math 1, Part 1[4]	270427	†	†
Unified Math 1, Part 2[4]	270428	†	†
Pre-IB Geometry[4]	270429	†	†
IB Math Methods 1[4]	270431	†	†
IB Math Studies 1[4]	270432	†	†
Discrete Math 4	270436	†	†
Finite Math 4	270437	†	†
Algebra and Geometry[4]	270441	†	†
Mathematics, Other	279900	0.5	0.11

See notes at end of table.

Table D-1. Percentage and standard errors of graduating seniors who received credit in mathematics courses, by pipeline level: 1982—Continued

Pipeline level and CSSC[1] course title	CSSC[1] code	Percentage	Standard error
(3) Algebra II	†		
Algebra 2	270405	32.6	0.87
Mathematics 3, Unified	270423	1.0	0.26
Pre-IB Algebra 2/Trigonometry[4]	270430	†	†
(4) Algebra III/trigonometry/analytic geometry	†		
Algebra 3	270410	7.6	0.57
Trigonometry	270411	7.8	0.52
Analytic Geometry	270412	2.8	0.35
Trigonometry and Solid Geometry	270413	0.5	0.13
Algebra and Trigonometry	270414	4.7	0.45
Algebra and Analytic Geometry	270415	0.5	0.14
Linear Algebra	270417	0.9	0.19
Mathematics, Independent Study	270424	0.9	0.19
Statistics, Other	270500	#	†
Statistics	270511	0.3	0.09
Probability	270521	#	†
Probability and Statistics	270531	0.8	0.13
AP Statistics[4]	270532	†	†
(5) Precalculus	†		
Analysis, Introductory	270416	6.4	0.46
IB Math Studies 2[4]	270433	†	†
(6) Calculus	†		
Calculus and Analytic Geometry	270418	0.4	0.12
Calculus	270419	4.0	0.37
AP Calculus	270420	1.9	0.27
IB Math Studies/Calculus[4]	270434	†	†
AP Calculus CD[4]	270435	†	†

Rounds to zero.
† Not applicable.
[1] CSSC = Classification Scheme of Secondary School Courses. Each CSSC course code comprises six digits with an associated course title, alternate titles, and a course description. The first two digits identify the main program area (e.g., mathematics), the second set of two digits represents a subcategory of courses within the main program area (e.g., pure math), and the last two digits are associated with the specific courses in each of the main and subcategories (e.g., trigonometry).
[2] Indicates lower grade (7-8) course levels that existed on transcripts. Only a few students have transcript records for grade levels lower than the 9th grade. For this reason, in these figures only those students who took the lower level courses in grade levels 9 through 12 were included in the percentages.
[3] Indicates CSSC definitions that exist in later data collections. These definitions were usually redefined because they were split into many codes.
[4] Indicates CSSC definitions that may have not been used in the transcript collection or codes that did not exist at that time. It should be noted that in these cases it does not mean that no courses were taken in this course area, but that the courses may have been given different CSSC values.
NOTE: Comparing individual courses from different studies across time may result in misleading conclusions. Some course codes have been consolidated, split, dropped, or added over time. Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School & Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study."

Table D-2. Percentage and standard errors of graduating seniors who received credit in science courses, by pipeline level: 1982

Pipeline level and CSSC[1] course title	CSSC[1] code	Percentage	Standard error
(1) No science or low-level science	†		
Science, Unified	300111	26.7	1.26
Physical Science	400121	29.4	1.31
Physical Science, Applied	400141	1.0	0.27
Geological Sciences, Other	400600	0.1	0.07
Earth Science	400611	12.1	1.00
Earth Science, College Prep	400621	0.4	0.10
Misc. Physical Sciences, Other	400700	#	†
(2) Secondary physical science and basic biology	†		
Biology, Basic 1	260121	24.1	1.24
Biology, Basic 2	260122	#	†
Biological and Physical Sciences, Other	300100	0.7	0.24
Science Study, Independent	300121	0.8	0.20
Outdoor Education	300131	0.2	0.06
Futuristics	300611	0.3	0.09
Environmental Science	300621	2.2	0.36
Astronomy, Other	400200	0.1	0.05
Astronomy	400211	1.4	0.26
Astrophysics, Other	400300	#	†
Atmospheric Sciences and Meteorology	400400	#	†
Meteorology	400411	0.6	0.18
Chemistry, Other	400500	0.4	0.14
Chemistry, Introductory	400511	6.7	0.55
Chemistry in the Community[2]	400512	†	†
Organic Biochemistry	400531	0.2	0.08
Physical Chemistry	400541	0.1	0.06
Consumer Chemistry	400551	0.3	0.08
Chemistry, Independent Study	400561	0.1	0.04
AP Environmental Science[3]	400622	†	†
Geology	400631	1.7	0.28
Geology - Field Studies	400632	#	†
Mineralogy	400641	0.1	0.06
Oceanography	400711	1.0	0.25
Physics, Other	400800	0.2	0.07
Physics	400811	3.4	0.35
Electricity and Electronics Science	400841	0.3	0.11
Acoustics	400851	#	†
Planetary Science, Other	400900	#	†
Rocketry and Space Science	400911	0.4	0.18
Aerospace Science	401011	#	†
AP Environmental Science	300622	#	†

See notes at end of table.

Table D-2. Percentage and standard errors of graduating seniors who received credit in science courses, by pipeline level: 1982—Continued

Pipeline level and CSSC[1] course title	CSSC[1] code	Percentage	Standard error
(3) General biology	†		
Biology, Other General	260100	1.0	0.30
Biology, General 1	260131	50.0	1.32
Biology, General 2	260132	#	†
Biology, Honors 1	260141	3.5	0.42
Pre-IB Biology[2]	260143	†	†
Ecology	260611	2.1	0.28
Marine Biology	260621	1.3	0.26
Marine Biology, Advanced	260622	0.1	0.05
Zoology, Other	260700	#	†
Zoology	260711	1.0	0.18
Zoology, Vertebrate	260721	0.1	0.09
Zoology, Invertebrate	260731	#	†
Animal Behavior	260741	0.2	0.06
Physiology, Human	260751	5.2	0.44
Physiology, Advanced	260752	0.1	0.07
Pathology	260761	0.1	0.04
Comparative Embryology	260771	#	†
Life Sciences, Other	269900	#	†
(4/5) Chemistry I and/or physics I	†		
Chemistry 1	400521	25.6	0.81
Pre-IB Chemistry[2]	400523	†	†
Physics 1	400821	11.9	0.56
(6) Chemistry II, physics II, or advanced biology	†		
Chemistry 2	400522	3.7	0.39
IB Chemistry 2[2]	400524	†	†
IB Chemistry 3[2]	400525	†	†
AP Chemistry[2]	400526	†	†
Physics 2	400822	1.5	0.19
IB Physics[2]	400823	†	†
AP Physics B[2]	400824	†	†
AP Physics C: Mechanics[2]	400825	†	†
AP Physics C: Electricity/Magnetism[2]	400826	†	†
Physics 2 without Calculus	400831	#	†
Biology, Advanced	260142	7.9	0.57
Field Biology	260151	0.6	0.20
Genetics	260161	0.7	0.16
Biopsychology	260171	0.1	0.04
Biology, Seminar	260181	0.1	0.05
Biochemistry and Biophysics, Other	260200	#	†
Biochemistry	260211	0.2	0.09
Botany, Other	260300	0.1	0.08
Botany	260311	0.7	0.16

See notes at end of table.

Table D-2. Percentage and standard errors of graduating seniors who received credit in science courses, by pipeline level: 1982—Continued

Pipeline level and CSSC[1] course title	CSSC[1] code	Percentage	Standard error
(6) Chemistry II, physics II, or advanced biology—Continued	†		
Cell and Molecular Biology, Other	260400	#	†
Cell Biology	260411	0.2	0.08
Microbiology, Other	260500	#	†
Microbiology	260511	0.7	0.17
Misc. Specialized Areas; Life Sciences, Other	260600	#	†
Anatomy	260631	0.6	0.14
IB Biology 2[2]	260144	†	†
IB Biology 3[2]	260145	†	†
AP Biology[2]	260146	†	†

Rounds to zero.
† Not applicable.
[1] CSSC = Classification Scheme of Secondary School Courses. Each CSSC course code comprises six digits with an associated course title, alternate titles, and a course description. The first two digits identify the main program area (e.g., life science), the second set of two digits represents a subcategory of courses within the main program area (e.g., biology), and the last two digits are associated with the specific courses in each of the main and subcategories (e.g., advanced).
[2] Indicates CSSC definitions that may have not been used in the transcript collection or codes that did not exist at that time. It should be noted that in these cases it does not mean that no courses were taken in this course area, but that the courses may have been given different CSSC values.
[3] Indicates a CSSC definition that prior to the year 2000 did not exist, but existed as another code (300622). This code also existed in 2000.
NOTE: Comparing individual courses from different studies across time may result in misleading conclusions. Some course codes have been consolidated, split, dropped, or added over time. Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School & Beyond Longitudinal Study of 1980 Sophomores (HS&B-So:80/82), "High School Transcript Study."

Table D-3. Percentage and standard errors of graduating seniors who received credit in mathematics courses, by pipeline level: 1992

Pipeline level and CSSC[1] course title	CSSC[1] code	Percentage	Standard error
(1) No or low academic math	†		
Mathematics, Other General	270100	0.3	0.07
Mathematics 7[2]	270101	#	†
Mathematics 7, Accelerated[2]	270102	#	†
Mathematics 8[2]	270103	0.1	0.03
Mathematics 8, Accelerated[2]	270104	#	†
Mathematics 1, General	270106	13.0	0.76
Mathematics 2, General	270107	5.5	0.43
Science Mathematics	270108	0.1	0.04
Mathematics in the Arts	270109	0.5	0.28
Mathematics, Vocational	270110	2.0	0.26
Technical Mathematics	270111	0.6	0.14
Mathematics Review	270112	1.3	0.26
Mathematics Tutoring	270113	#	†
Consumer Mathematics	270114	9.7	0.59
Actuarial Sciences, Other	270200	#	†
Applied Mathematics, Other	270300	0.3	0.11
Basic Math 1	270601	6.2	0.41
Basic Math 2	270602	2.4	0.31
Basic Math 3	270603	0.6	0.12
Basic Math 4	270604	0.4	0.10
Basic Math - old code[3]	270105	#	†
Vocational Math - old code[3]	320108	#	†
Pre-Algebra	270401	20.2	1.02
Algebra 1, Part 1	270402	4.6	0.47
Algebra 1, Part 2	270403	3.9	0.40
Geometry, Informal	270409	4.8	0.53
(2) Algebra I/plane geometry	†		
Pure Mathematics, Other	270400	0.7	0.47
Algebra 1	270404	67.3	0.96
Geometry, Plane	270406	3.7	0.45
Geometry, Solid[4]	270407	#	†
Geometry	270408	59.4	1.13
Mathematics 1, Unified	270421	5.8	0.61
Mathematics 2, Unified	270422	4.3	0.55
Geometry, Part 1[4]	270425	†	†
Geometry, Part 2[4]	270426	†	†
Unified Math 1, Part 1[4]	270427	†	†
Unified Math 1, Part 2[4]	270428	†	†
Pre-IB Geometry[4]	270429	†	†
IB Math Methods 1[4]	270431	†	†
IB Math Studies 1[4]	270432	†	†
Discrete Math[4]	270436	†	†
Finite Math[4]	270437	†	†
Algebra and Geometry[4]	270441	†	†
Mathematics, Other	279900	0.8	0.22

See notes at end of table.

Table D-3. Percentage and standard errors of graduating seniors who received credit in mathematics courses, by pipeline level: 1992—Continued

Pipeline level and CSSC[1] course title	CSSC[1] code	Percentage	Standard error
(3) Algebra II	†		
Algebra 2	270405	53.0	1.14
Mathematics 3, Unified	270423	3.6	0.44
Pre-IB Algebra 2/Trigonometry[4]	270430	†	†
(4) Algebra III/trigonometry/analytic geometry	†		
Algebra 3	270410	5.6	0.50
Trigonometry	270411	10.9	0.65
Analytic Geometry	270412	2.9	0.27
Trigonometry and Solid Geometry	270413	0.4	0.17
Algebra and Trigonometry	270414	9.8	0.78
Algebra and Analytic Geometry	270415	1.0	0.21
Linear Algebra	270417	0.5	0.15
Mathematics, Independent Study	270424	1.4	0.30
Statistics, Other	270500	#	†
Statistics	270511	0.8	0.18
Probability	270521	0.1	0.06
Probability and Statistics	270531	1.3	0.19
AP Statistics[4]	270532	†	†
(5) Precalculus	†		
Analysis, Introductory	270416	16.5	0.96
IB Math Studies 2[4]	270433	†	†
(6) Calculus	†		
Calculus and Analytic Geometry	270418	0.4	0.13
Calculus	270419	4.7	0.63
AP Calculus	270420	5.9	0.40
IB Math Studies/Calculus[4]	270434	†	†
AP Calculus CD[4]	270435	†	†

Rounds to zero.

† Not applicable.

[1] CSSC = Classification Scheme of Secondary School Courses. Each CSSC course code comprises six digits with an associated course title, alternate titles, and a course description. The first two digits identify the main program area (e.g., mathematics), the second set of two digits represents a subcategory of courses within the main program area (e.g., pure math), and the last two digits are associated with the specific courses in each of the main and subcategories (e.g., trigonometry).

[2] Indicates lower grade (7-8) course levels that existed on transcripts. Only a few students have transcript records for grade levels lower than the 9th grade. For this reason, in these figures only those students who took the lower level courses in grade levels 9 through 12 were included in the percentages.

[3] Indicates CSSC definitions that exist in later data collections. These definitions were usually redefined because they were split into many codes.

[4] Indicates CSSC definitions that may have not been used in the transcript collection or codes that did not exist at that time. It should be noted that in these cases it does not mean that no courses were taken in this course area, but that the courses may have been given different CSSC values.

NOTE: Comparing individual courses from different studies across time may result in misleading conclusions. Some course codes have been consolidated, split, dropped, or added over time. Detail may not sum to totals because of rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992."

Table D-4. Percentage and standard errors of graduating seniors who received credit in science courses, by pipeline level: 1992

Pipeline level and CSSC[1] course title	CSSC[1] code	Percentage	Standard error
(1) No science or low-level science	†		
Science, Unified	300111	15.4	0.94
Physical Science	400121	41.9	1.46
Physical Science, Applied	400141	2.5	0.30
Geological Sciences, Other	400600	#	†
Earth Science	400611	19.2	1.10
Earth Science, College Prep	400621	1.5	0.26
Misc. Physical Sciences, Other	400700	#	†
(2) Secondary physical science and basic biology	†		
Biology, Basic 1	260121	9.8	0.74
Biology, Basic 2	260122	0.2	0.07
Biological and Physical Sciences, Other	300100	0.2	0.08
Science Study, Independent	300121	0.5	0.11
Outdoor Education	300131	0.1	0.06
Futuristics	300611	0.9	0.20
Environmental Science	300621	4.4	0.48
Astronomy, Other	400200	#	†
Astronomy	400211	2.1	0.42
Astrophysics, Other	400300	#	†
Atmospheric Sciences and Meteorology	400400	#	†
Meteorology	400411	0.3	0.10
Chemistry, Other	400500	0.1	0.03
Chemistry, Introductory	400511	9.4	0.90
Chemistry in the Community[2]	400512	†	†
Organic Biochemistry	400531	0.2	0.07
Physical Chemistry	400541	0.2	0.12
Consumer Chemistry	400551	0.7	0.13
Chemistry, Independent Study	400561	#	†
AP Environmental Science[3]	400622	†	†
Geology	400631	1.4	0.22
Geology - Field Studies	400632	#	†
Mineralogy	400641	#	†
Oceanography	400711	0.9	0.18
Physics, Other	400800	#	†
Physics	400811	4.5	0.46
Electricity and Electronics Science	400841	0.1	0.03
Acoustics	400851	#	†
Planetary Science, Other	400900	#	†
Rocketry and Space Science	400911	0.1	0.05
Aerospace Science	401011	0.2	0.06
AP Environmental Science	300622	#	†

See notes at end of table.

Table D-4. Percentage and standard errors of graduating seniors who received credit in science courses, by pipeline level: 1992—Continued

Pipeline level and CSSC[1] course title	CSSC[1] code	Percentage	Standard error
(3) General biology	†		
Biology, Other General	260100	1.0	0.57
Biology, General 1	260131	75.4	1.06
Biology, General 2	260132	6.7	0.71
Biology, Honors 1	260141	8.4	0.57
Pre-IB Biology[2]	260143	†	†
Ecology	260611	1.5	0.21
Marine Biology	260621	2.5	0.35
Marine Biology, Advanced	260622	0.1	0.03
Zoology, Other	260700	#	†
Zoology	260711	1.4	0.49
Zoology, Vertebrate	260721	0.1	0.04
Zoology, Invertebrate	260731	#	†
Animal Behavior	260741	0.2	0.07
Physiology Human	260751	7.7	0.61
Physiology, Advanced	260752	0.2	0.06
Pathology	260761	#	†
Comparative Embryology	260771	#	†
Life Sciences, Other	269900	0.4	0.14
(4/5) Chemistry I and/or physics I	†		
Chemistry 1	400521	46.6	1.17
Pre-IB Chemistry[2]	400523	†	†
Physics 1	400821	20.0	0.96
(6) Chemistry II, physics II, or advanced biology			
Chemistry 2	400522	4.7	0.34
IB Chemistry 2[2]	400524	†	†
IB Chemistry 3[2]	400525	†	†
AP Chemistry[2]	400526	†	†
Physics 2	400822	3.2	0.28
IB Physics[2]	400823	†	†
AP Physics B[2]	400824	†	†
AP Physics C: Mechanics[2]	400825	†	†
AP Physics C: Electricity/Magnetism[2]	400826	†	†
Physics 2 without Calculus	400831	0.1	0.05
Biology, Advanced	260142	6.4	0.66
Field Biology	260151	0.4	0.11
Genetics	260161	0.2	0.06
Biopsychology	260171	#	†
Biology, Seminar	260181	0.3	0.10
Biochemistry and Biophysics, Other	260200	#	†
Biochemistry	260211	#	†
Botany, Other	260300	#	†
Botany	260311	0.5	0.12
Cell and Molecular Biology, Other	260400	#	†
Cell Biology	260411	0.3	0.15

See notes at end of table.

Table D-4. Percentage and standard errors of graduating seniors who received credit in science courses, by pipeline level: 1992—Continued

Pipeline level and CSSC[1] course title	CSSC[1] code	Percentage	Standard error
(6) Chemistry II, physics II, or advanced biology—Continued	†		
Microbiology, Other	260500	#	†
Microbiology	260511	0.3	0.09
Misc. Specialized Areas; Life Sciences, Other	260600	#	†
Anatomy	260631	0.6	0.17
IB Biology 2[2]	260144	†	†
IB Biology 3[2]	260145	†	†
AP Biology[2]	260146	†	†

Rounds to zero.

† Not applicable.

[1] CSSC = Classification Scheme of Secondary School Courses. Each CSSC course code comprises six digits with an associated course title, alternate titles, and a course description. The first two digits identify the main program area (e.g., life science), the second set of two digits represents a subcategory of courses within the main program area (e.g., biology), and the last two digits are associated with the specific courses in each of the main and subcategories (e.g., advanced).

[2] Indicates CSSC definitions that may have not been used in the transcript collection or codes that did not exist at that time. It should be noted that in these cases it does not mean that no courses were taken in this course area, but that the courses may have been given different CSSC values.

[3] Indicates a CSSC definition that prior to the year 2000 did not exist, but existed as another code (300622). This code also existed in 2000.

NOTE: Comparing individual courses from different studies across time may result in misleading conclusions. Some course codes have been consolidated, split, dropped, or added over time. Detail may not sum to totals because of rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88/92), "Second Follow-up, Transcript Survey, 1992."

Table D-5. Percentage and standard errors of graduating seniors who received credit in mathematics courses, by pipeline level: 2004

Pipeline level and CSSC[1] course title	CSSC[1] code	Percentage	Standard error
(1) No or low academic math	†		
Mathematics, Other General	270100	3.8	0.45
Mathematics 7[2]	270101	#	†
Mathematics 7, Accelerated[2]	270102	#	†
Mathematics 8[2]	270103	#	†
Mathematics 8, Accelerated[2]	270104	0.1	0.05
Mathematics 1, General	270106	5.6	0.41
Mathematics 2, General	270107	1.7	0.29
Science Mathematics	270108	#	†
Mathematics in the Arts	270109	0.3	0.09
Mathematics, Vocational	270110	0.6	0.18
Technical Mathematics	270111	2.2	0.28
Mathematics Review	270112	1.7	0.32
Mathematics Tutoring	270113	0.3	0.14
Consumer Mathematics	270114	3.0	0.44
Actuarial Sciences, Other	270200	#	†
Applied Mathematics, Other	270300	1.0	0.18
Basic Math 1	270601	4.3	0.44
Basic Math 2	270602	1.4	0.32
Basic Math 3	270603	0.7	0.19
Basic Math 4	270604	0.7	0.21
Basic Math - old code[3]	270105	#	†
Vocational Math - old code[3]	320108	#	†
Pre-Algebra	270401	8.7	0.61
Algebra 1, Part 1	270402	10.4	0.88
Algebra 1, Part 2	270403	9.9	0.83
Geometry, Informal	270409	5.4	0.64
(2) Algebra I/plane geometry	†		
Pure Mathematics, Other	270400	1.4	0.26
Algebra 1	270404	61.0	1.21
Geometry, Plane	270406	2.1	0.63
Geometry, Solid	270407	#	†
Geometry	270408	68.4	1.24
Mathematics 1, Unified	270421	8.2	0.75
Mathematics 2, Unified	270422	7.0	0.73
Geometry, Part 1	270425	0.6	0.18
Geometry, Part 2	270426	0.5	0.15
Unified Math 1, Part 1	270427	0.6	0.18
Unified Math 1, Part 2	270428	0.4	0.14
Pre-IB Geometry	270429	0.1	0.07
IB Math Methods 1	270431	0.2	0.07
IB Math Studies 1	270432	0.3	0.15
Discrete Math	270436	1.8	0.32
Finite Math	270437	0.2	0.07
Algebra and Geometry	270441	1.1	0.38
Mathematics, Other	279900	#	†

See notes at end of table.

Table D-5. Percentage and standard errors of graduating seniors who received credit in mathematics courses, by pipeline level: 2004—Continued

Pipeline level and CSSC[1] course title	CSSC[1] code	Percentage	Standard error
(3) Algebra II	†		
Algebra 2	270405	60.0	1.17
Mathematics 3, Unified	270423	5.2	0.66
Pre-IB Algebra 2/Trigonometry	270430	0.1	0.07
(4) Algebra III/trigonometry/analytic geometry	†		
Algebra 3	270410	7.2	0.65
Trigonometry	270411	9.8	0.82
Analytic Geometry	270412	3.8	0.49
Trigonometry and Solid Geometry	270413	0.1	0.04
Algebra and Trigonometry	270414	10.0	0.96
Algebra and Analytic Geometry	270415	0.7	0.18
Linear Algebra	270417	0.1	0.03
Mathematics, Independent Study	270424	0.9	0.17
Statistics, Other [4]	270500	†	†
Statistics	270511	2.1	0.33
Probability	270521	0.1	0.06
Probability and Statistics	270531	2.8	0.33
AP Statistics	270532	3.1	0.36
(5) Precalculus	†		
Analysis, Introductory	270416	28.6	0.85
IB Math Studies 2	270433	0.4	0.18
(6) Calculus	†		
Calculus and Analytic Geometry	270418	0.2	0.05
Calculus	270419	4.5	0.35
AP Calculus	270420	8.8	0.43
IB Math Studies/Calculus	270434	0.1	0.07
AP Calculus CD	270435	1.7	0.24

Rounds to zero.
† Not applicable.
[1] CSSC = Classification Scheme of Secondary School Courses. Each CSSC course code comprises six digits with an associated course title, alternate titles, and a course description. The first two digits identify the main program area (e.g., mathematics), the second set of two digits represents a subcategory of courses within the main program area (e.g., pure math), and the last two digits are associated with the specific courses in each of the main and subcategories (e.g., trigonometry).
[2] Indicates lower grade (7-8) course levels that existed on transcripts. Only a few students have transcript records for grade levels lower than the 9th grade. For this reason, in these figures only those students who took the lower level courses in grade levels 9 through 12 were included in the percentages.
[3] Indicates CSSC definitions that existed in earlier data collections. These definitions were usually redefined because they were split into many codes.
[4] Indicates CSSC definitions that may have not been used in the transcript collection or codes that did not exist at that time. It should be noted that in these cases it does not mean that no courses were taken in this course area, but that the courses may have been given different CSSC values.
NOTE: Comparing individual courses from different studies across time may result in misleading conclusions. Some course codes have been consolidated, split, dropped, or added over time. Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."

Table D-6. Percentage and standard errors of graduating seniors who received credit in science courses, by pipeline level: 2004

Pipeline level and CSSC[1] course title	CSSC[1] code	Percentage	Standard error
(1) No science or low-level science	†		
Science, Unified	300111	11.5	1.11
Physical Science	400121	41.5	1.62
Physical Science, Applied	400141	1.1	0.27
Geological Sciences, Other	400600	#	0.01
Earth Science	400611	13.3	1.03
Earth Science, College Prep	400621	9.2	0.94
Misc. Physical Sciences, Other[2]	400700	†	†
(2) Secondary physical science and basic biology	†		
Biology, Basic 1	260121	4.5	0.55
Biology, Basic 2	260122	0.2	0.06
Biological and Physical Sciences, Other	300100	1.0	0.26
Science Study, Independent	300121	0.6	0.12
Outdoor Education	300131	0.3	0.14
Futuristics	300611	0.3	0.13
Environmental Science	300621	9.8	0.77
Astronomy, Other[2]	400200	†	†
Astronomy	400211	3.3	0.43
Astrophysics, Other	400300	#	†
Atmospheric Sciences and Meteorology	400400	#	†
Meteorology	400411	0.4	0.17
Chemistry, Other	400500	#	0.04
Chemistry, Introductory	400511	5.7	0.71
Chemistry in the Community	400512	0.2	0.07
Organic Biochemistry	400531	1.2	0.26
Physical Chemistry	400541	#	0.04
Consumer Chemistry	400551	0.6	0.17
Chemistry, Independent Study	400561	0.1	0.03
AP Environmental Science[3]	400622	1.7	0.25
Geology	400631	0.3	0.16
Geology - Field Studies	400632	0.1	0.04
Mineralogy	400641	#	†
Oceanography	400711	1.4	0.34
Physics, Other	400800	#	0.02
Physics	400811	4.9	0.62
Electricity and Electronics Science	400841	0.1	0.10
Acoustics	400851	0.1	0.08
Planetary Science, Other	400900	#	†
Rocketry and Space Science	400911	0.1	0.07
Aerospace Science	401011	0.1	0.07
AP Environmental Science	300622	#	†

See notes at end of table.

Table D-6. Percentage and standard errors of graduating seniors who received credit in science courses, by pipeline level: 2004—Continued

Pipeline level and CSSC[1] course title	CSSC[1] code	Percentage	Standard error
(3) General biology	†		
Biology, Other General	260100	#	0.01
Biology, General 1	260131	73.6	1.19
Biology, General 2	260132	6.5	0.85
Biology, Honors 1	260141	13.1	0.79
Pre-IB Biology	260143	0.4	0.15
Ecology	260611	3.4	0.51
Marine Biology	260621	3.4	0.38
Marine Biology, Advanced	260622	0.2	0.06
Zoology, Other	260700	0.1	0.01
Zoology	260711	2.4	0.40
Zoology, Vertebrate	260721	0.1	0.05
Zoology, Invertebrate	260731	#	0.01
Animal Behavior	260741	0.3	0.12
Physiology Human	260751	14.2	0.68
Physiology, Advanced	260752	0.4	0.13
Pathology	260761	0.2	0.16
Comparative Embryology	260771	#	†
Life Sciences, Other	269900	#	0.03
(4/5) Chemistry I and/or physics I	†		
Chemistry 1	400521	61.8	1.03
Pre-IB Chemistry	400523	0.3	0.13
Physics 1	400821	26.7	1.04
(6) Chemistry II, physics II, or advanced biology	†		
Chemistry 2	400522	3.5	0.46
IB Chemistry 2	400524	0.2	0.10
IB Chemistry 3	400525	0.1	0.05
AP Chemistry	400526	3.0	0.26
Physics 2	400822	1.9	0.29
IB Physics	400823	0.2	0.08
AP Physics B	400824	2.1	0.23
AP Physics C: Mechanics	400825	0.5	0.13
AP Physics C: Electricity/Magnetism	400826	0.1	0.04
Physics 2 without Calculus	400831	#	0.03
Biology, Advanced	260142	2.4	0.40
Field Biology	260151	0.5	0.12
Genetics	260161	0.8	0.19
Biopsychology[2]	260171	†	†
Biology, Seminar	260181	0.2	0.08
Biochemistry and Biophysics, Other	260200	#	†
Biochemistry	260211	0.7	0.20
Botany, Other	260300	#	†
Botany	260311	1.1	0.26

See notes at end of table.

Table D-6. Percentage and standard errors of graduating seniors who received credit in science courses, by pipeline level: 2004—Continued

Pipeline level and CSSC[1] course title	CSSC[1] code	Percentage	Standard error
(6) Chemistry II, physics II, or advanced biology—Continued	†		
Cell and Molecular Biology, Other	260400	#	0.02
Cell Biology	260411	0.2	0.11
Microbiology, Other	260500	#	†
Microbiology	260511	0.4	0.11
Misc. Specialized Areas; Life Sciences, Other[2]	260600	†	†
Anatomy	260631	0.5	0.13
IB Biology 2	260144	0.3	0.08
IB Biology 3	260145	0.1	0.05
AP Biology	260146	4.6	0.32

Rounds to zero.
† Not applicable.
[1] CSSC = Classification Scheme of Secondary School Courses. Each CSSC course code comprises six digits with an associated course title, alternate titles, and a course description. The first two digits identify the main program area (e.g., life science), the second set of two digits represents a subcategory of courses within the main program area (e.g., biology), and the last two digits are associated with the specific courses in each of the main and subcategories (e.g., advanced).
[2] Indicates CSSC definitions that may have not been used in the transcript collection or codes that did not exist at that time. It should be noted that in these cases it does not mean that no courses were taken in this course area, but that the courses may have been given different CSSC values.
[3] Indicates a CSSC definition that prior to the year 2000 did not exist, but existed as another code (300622). This code also existed in 2000.
NOTE: Comparing individual courses from different studies across time may result in misleading conclusions. Some course codes have been consolidated, split, dropped, or added over time. Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), "First Follow-up, High School Transcript Study, 2004."