NATIONAL CENTER FOR EDUCATION STATISTICS
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Interpreting 12th-Graders' NAEP-Scaled Mathematics Performance Using High School Predictors and Postsecondary Outcomes From the National Education Longitudinal Study of 1988 (NELS:88)

Statistical Analysis Report

NCES 2007-328

U.S. DEPARTMENT OF EDUCATION

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TEACHERS PARENTS SCHOOLS STUDENTS NELS 88

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Executive Summary

The National Assessment of Educational Progress (NAEP)—the Nation's Report Card—is the best known measure of student achievement in the country. Yet interpreting in practical terms what attaining a particular score or achievement level on NAEP means can be difficult, if not controversial. In the book *The Nation's Report Card: Evolution and Perspectives* (Jones and Olkin 2004), which chronicles the history of NAEP, Fredric Mosher writes, "In some ways, the history of NAEP could be written as a struggle to find a way to report the assessment's results so that people could understand them and form some judgment of their significance" (Mosher 2004, p. 330).

Recently, the search for an understandable reporting format has led the National Assessment Governing Board to explore the possibility of measuring and interpreting student performance on the 12th-grade NAEP in terms of readiness for college, the workplace, and the military (National Commission on NAEP 12th Grade Assessment and Reporting 2004; Porter 2004). As Porter writes (2004, p. 4), "National 12th-grade NAEP reports percentages of United States 12th-graders that are advanced or proficient, but advanced and proficient are abstract ideas. Perhaps a more powerful 12th-grade NAEP indicator would be to know the extent to which high school seniors are ready for college." Yet validating a NAEP college or labor market readiness measure requires information about post-high school outcomes that are not available in NAEP and that only a longitudinal study could supply.

Thus, this report attempts to explore the meaning and utility of the NAEP achievement levels in a new way. It interprets 12th-grade NAEP-scaled mathematics performance using data from the National Education Longitudinal Study of 1988 (NELS:88). NELS:88 followed a cohort of spring 1988 8th-graders through high school and thereafter until 2000 (when they were about 26 years old). The 1992 round of data collection included a battery of achievement tests. Results include a NELS:88 12th-grade mathematics score expressed on the NAEP scale. NELS:88 student and parent survey data, as well as data both from high school and postsecondary transcripts, are used to explore what achievement on the NAEP mathematics scale might mean relative to both student, family, and high school factors as well as later education outcomes—in particular, postsecondary access and attainment.

Using the NAEP metric with the NELS:88 data is of interest because it allows NAEP achievement levels and scale scores to be interpreted in an expanded context. Researchers can investigate how a given mastery level relates to later outcomes, such as probability of entry to a selective postsecondary institution. The meaning of NELS:88 NAEP-scaled results can be interpreted further by relating 12th-grade achievement to temporal antecedents or premeasures (such as 8th- and 10th-grade test scores), or to extensive 8th- and 12th-grade background characteristics provided in NELS:88 parent surveys.

This report explores using the 1992 NAEP-scaled mathematics scores in conjunction with this wider spectrum of NELS:88 12th-grade cross-sectional and longitudinal data elements. NELS:88 cross-sectional data include many measures unavailable in NAEP, including information from parents. NAEP contains no longitudinal data points, but NELS:88 longitudinal data include both 8th- and 10th-grade antecedents and post-12th-grade outcomes. The vantage point of these NELS:88 perspectives may allow the interpretation of the NAEP achievement levels and scale scores to be extended and deepened.

On the other hand, viewed apart from their special reference to NAEP metrics, the substantive conclusions of this report confirm past research using the NELS:88 database rather than provide novel or unique findings. Indeed, the NAEP-scaled score does not uncover relationships or conclusions that could not already be observed using the NELS:88 scale scores and the NELS:88 proficiency levels. The primary contribution of the NAEP-scaled score is to help interpret the NAEP achievement levels in their relationship to a wider set of variables, including longitudinal data. The secondary contribution of the NAEP-scaled mathematics score is a benefit to NELS:88, expressing some of its conclusions in a NAEP metric that has become a familiar yardstick for measuring achievement.

Analysis Samples

This report uses two analysis samples from NELS:88, both of which generalize to the population of 1992 12th-graders. The first analysis sample is *cross-sectional* and generalizes to the population of students who were in 12th grade in 1992. This is the analysis sample used in chapter 2, which explores relationships between family and academic factors, and achievement—using NAEP-scaled mathematics scores from NELS:88.

While the analysis sample in chapter 2 is cross-sectional, the analysis sample used in chapter 3 is *longitudinal*. Chapter 3 uses the 1992 NAEP-scaled mathematics score in conjunction with data from the third follow-up of NELS:88 in 1994 and the NELS:88 Postsecondary Education Transcript Study in 2000. This longitudinal sample generalizes to the population of 1992 high school seniors as of 1994 (the third follow-up of NELS:88) and 2000 (the fourth follow-up of NELS:88), 2 and 8 years after senior cohort members were scheduled to graduate from high school. Chapter 3 explores relationships among 1992 seniors' achievement on the NELS:88 NAEP-scaled mathematics assessment and subsequent postsecondary educational outcomes.

Key Findings

While NELS:88 has its own criterion-referenced scale and proficiency levels, analyses involving the NAEP-scaled scores from NELS:88 may enhance the interpretation of what performance at particular levels of achievement on the Nation's Report Card might mean in practical terms. Key findings are presented below.

NELS:88 Mathematics Performance Expressed on the NAEP Achievement Levels

NAEP mathematics scores are reported in two forms. The first is a scale score, reported as a mean. The second is an achievement or proficiency level. The NAEP performance of students in mathematics is reported on a scale of 0 to 500. The "average score is 250 (anchored at Grade 8) with a standard deviation of 50 scale score points" (Loomis and Bourque 2001, p. 7). NAEP achievement levels for different grades are set at specific scale points. At 4th grade, a score of 249 marks the "Proficient" achievement level; at 8th grade, a score of 299 marks Proficient; and at 12th grade, a score of 336. The focus of this report is the NAEP achievement levels, and for the 12th grade only. The first of the achievement levels is the Basic level.

The Basic level indicates partial mastery of the knowledge and skills that are fundamental for proficient 12th-grade work. The Proficient level (the minimal goal for all students) represents solid academic performance. Superior performance is denoted by the Advanced achievement level. Achievement that is less than partial mastery (i.e., Basic) is called “below Basic.” Under the 1990/1992 framework, three primary abilities—conceptual understanding, procedural knowledge, and problem solving—were assessed within five content strands: (1) number sense, properties, and operations; (2) measurement; (3) geometry and spatial sense; (4) data analysis, statistics, and probability; and (5) algebra and functions. While NELS:88 is designed to provide reliable status and growth measurement at the individual level, NAEP’s emphasis is on reliable group-level measurement.

- Using the NELS:88 12th-grade cohort and the NELS:88 12th-grade mathematics assessment placed on the NAEP 1992-2000 mathematics scale, the average score for the NELS:88 1992 senior cohort was 299—within the Basic achievement level for 12th-graders—with a standard deviation of 34.38 and a score range of 178 (lowest score achieved) to 409 (highest score achieved) (table A).
- Overall, 63 percent of 1992 high school seniors performed at the level of Basic or above on the NELS:88 NAEP-scaled mathematics assessment, with slightly more than one-third (37 percent) performing below Basic (table A).
- Across all achievement levels, 2 percent of seniors performed at the Advanced level, 13 percent performed at the Proficient level, 48 percent performed at the Basic level, and 37 percent performed at the less-than-Basic level (table A).

Table A. Mean achievement, standard deviation (SD), and percentage of students scoring at the various levels of proficiency on the NELS:88 NAEP-scaled mathematics assessment, by proficiency levels: 1992

12th-grade NAEP-scaled achievement levels	Mean	SD	Percent
All students	298.7	34.38	100.0
Below basic	263.0	18.96	37.2
Basic	310.6	13.31	48.2
Proficient	347.7	8.42	13.0
Advanced	376.3	8.52	1.6

NOTE: In the five NAEP content strands, Basic level students demonstrate procedural and conceptual knowledge in solving problems; Proficient level students consistently integrate mathematical concepts and procedures to the solutions of more complex problems; Advanced level students consistently demonstrate the integration of procedural and conceptual knowledge and the synthesis of ideas. NAEP = National Assessment of Educational Progress.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), “Second Follow-up Student Survey, 1992.”

Twelfth-grade Student, Family, and High School Cross-Sectional Correlates and NAEP-Scaled NELS:88 Performance

- **Socioeconomic Status (SES)**. SES (a composite measure drawn from parent education and occupation and family income) was positively associated with NELS:88 NAEP-scaled mathematics performance: NELS:88 12th-graders from higher SES families achieved higher levels of proficiency. Thirty percent of high-SES students understood mathematics at the Proficient and Advanced levels by 12th grade. Only 3 percent of low-

SES 12th-graders achieved a Proficient or higher level of understanding. Indeed, only one-tenth of 1 percent of seniors in the lowest SES quarter (as contrasted to 4 percent of seniors in the highest SES quarter) reached the NAEP Advanced level.

- **Educational Expectations**. NELS:88 seniors whose educational expectations were to attain a bachelor's degree or higher had a better understanding of mathematics than seniors with lesser educational expectations. For example, some 59 percent of those whose highest educational expectation was "some college" fell into the NAEP "below Basic" category—as did 25 percent of those who expected to end their education with a bachelor's degree, and 20 percent of those who expected to complete a graduate or professional degree. About half (50 percent) of those expecting a graduate or professional degree achieved the NAEP Basic level in mathematics, and 30 percent were Proficient or Advanced.

Student, Family, and High School Antecedents to NAEP-Scaled NELS:88 Performance

- **Seniors' Prior Achievement in Mathematics**. Some 91 percent of the students scoring in the lowest quarter of the NELS:88 8th-grade achievement distribution had a below-Basic NELS:88 12th-grade NAEP-scaled score in 1992. On the other hand, of those who scored in the top 8th-grade mathematics quarter in 1988, 44 percent were at the Proficient or Advanced levels of NAEP-scaled achievement as seniors.

- **4-Year GPA in Mathematics**. A majority (56 percent) of Proficient and above NELS:88 performers on the 1992 NAEP mathematics scale also maintained an "A" average in mathematics throughout high school. Some 20 percent of "B" students reached the Proficient or Advanced levels, as did 5 percent of "C" students.

- **High School Coursetaking**. Of those who completed no more than non-academic mathematics (below the level of pre-algebra, such as general, basic, or technical mathematics), 95 percent scored below Basic. On the other hand, of those seniors who had completed calculus, 55 percent scored at the Proficient level, and 13 percent at Advanced.

- **Multiple Regression Results**. The results of a multiple regression analysis suggested that high levels of mathematics coursework and performance in mathematics—starting as early as 8th grade—are associated with high NAEP-defined mathematics mastery levels. However, in addition to school factors such as coursework, background factors such as race/ethnicity and SES were still associated with mathematics achievement, even after controlling for coursework and earlier mathematics performance.

12th-Grade NELS:88 NAEP-Scaled Mathematics Performance and Predicted Postsecondary Outcomes

This report also explored the relationship between NELS:88 NAEP-scaled mathematics performance and four postsecondary education outcomes—postsecondary attendance by 1994 (2 years after seniors' scheduled high school graduation), highest degree attained by 2000 (8 years after seniors' scheduled high school graduation), number of remedial mathematics courses taken in postsecondary school, and selectivity[1] of first postsecondary school attended. Concerning postsecondary attendance by 1994, findings were as follows:

- For those with NAEP-scaled performance at less than Basic, some 46 percent had had no postsecondary attendance 2 years later. In contrast, 2 percent of those who scored at Advanced and 5 percent of those at the Proficient level registered no postsecondary enrollment. Some 98 percent of those who scored at Advanced had entered a postsecondary institution; indeed, for the Advanced group, 94 percent had enrolled in a 4-year postsecondary institution within 2 years of senior year (and 4 percent in a 2-year institution). About 84 percent of those at the Proficient level recorded 4-year postsecondary attendance.

With respect to baccalaureate attainment by 2000, the findings were:

- Over 91 percent of NELS:88 seniors at the Advanced level for NAEP-scaled mathematics performance had earned a bachelor's degree or higher, compared to 18 percent of the below-Basic group, 50 percent of those at Basic, and 79 percent of those at the Proficient level.

With respect to selectivity of institution first attended, findings showed:

- Of those examinees who scored at the NAEP Advanced mathematics level in NELS:88 in 1992, 72 percent had enrolled (by 1994) in either highly selective (32 percent) or selective (40 percent) postsecondary institutions. Of those who scored at below Basic or Basic, about 1 percent of each of these two groups enrolled in a highly selective institution, while 9 percent of those at the Proficient level did so.

Readers are reminded that any relationship that exists between the cross-tabulated variables and NAEP-scaled performance on the NELS:88 mathematics test does not provide an adequate basis for inference to an underlying cause, as cross-tabulations do not take into account the possible influence of other variables. Nor do regression analyses provide a basis for causal inference, although they improve on bivariate tables by controlling for numerous covariates.

[1] Postsecondary institutions were classified as highly selective, selective, non-selective, open door, or not ratable/missing. "Open door" includes community colleges; "not ratable" includes foreign institutions and sub-baccalaureate vocational schools.

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Chapter 1
Introduction

The National Assessment of Educational Progress (NAEP)—the Nation's Report Card—is the most recognizable measure of student achievement in the nation. Yet interpreting in practical terms what attainment of a particular score or achievement level on NAEP means can be difficult, if not controversial. In the book *The Nation's Report Card, Evolution and Perspectives* (Jones and Olkin 2004), which chronicles the history of NAEP, Fredric Mosher writes, "In some ways, the history of NAEP could be written as a struggle to find a way to report the assessment's results so that people could understand them and form some judgment of their significance" (Mosher 2004, p. 330). In the search for an understandable reporting format, NAEP has evolved over the years. It initially provided a measure of what the population and relevant subgroups know and can do. Its descriptions of achievement were based on first reporting item-by-item performance, then clusters of items defining particular constructs, and finally, scores on a common scale. More recently, emphasis has shifted to a focus on what students should know as defined by attaining one of three achievement levels: Basic, Proficient, and Advanced (Mosher 2004).

The search for the most transparently understandable reporting format continues today. Recently, the National Assessment Governing Board (NAGB) explored the possibility of measuring and interpreting students' performance on 12th-grade NAEP in terms of readiness for college, the work place, and the military (National Commission on NAEP 12th-Grade Assessment and Reporting 2004; Porter 2004). As Porter writes (2004, p. 4), "National 12th-grade NAEP reports percentages of United States 12th-graders that are advanced or proficient, but advanced and proficient are abstract ideas. Perhaps a more powerful 12th-grade NAEP indicator would be to know the extent to which high school seniors are ready for college." Yet validating a NAEP college or labor market readiness measure, Porter notes, requires information about post-high school outcomes, as could be supplied by a longitudinal study that follows individuals across the transition point from high school to postsecondary education or the work force.

This report takes up the suggestion (Pellegrino, Jones, and Mitchell 1999) that the complementary strengths of studies such as NAEP and the National Education Longitudinal Study of 1988 (NELS:88) should be exploited. More specifically, this report attempts to explore the meaning and utility of the NAEP achievement levels in a new way, interpreting 12th-grade NAEP-scaled mathematics performance using data from NELS:88. NELS:88 includes a 12th-grade mathematics score expressed on the NAEP scale. NELS:88 student, parent, and other data sources offer many items of information that are not available from NAEP. Through NELS:88 analysis using the NAEP-scaled score, this information can be related to the various NAEP achievement levels and scale scores, thus deepening their interpretation.

With the fall 2003 release of the Postsecondary Education Transcript Study (PETS) data, NELS:88 now contains extensive information about the postsecondary educational trajectories of the high school senior class of 1992, including data on dates of attendance, type of institution attended, college major, undergraduate grades, remedial courses, number of postsecondary credits, and attainment by the end of 2000. This report draws on the PETS data to explore what NAEP achievement levels might mean in future terms, relative to such outcomes as postsecondary enrollment and attainment.

1.1 Background

In its external evaluation of NAEP, the Committee on the Evaluation of National and State Assessments of the National Research Council discussed five ways of enhancing the current design and usefulness of NAEP (Pellegrino, Jones, and Mitchell 1999). The Committee's first recommended enhancement was to embed NAEP within a "coordinated system of indicators for assessing educational progress" (p. 34). For a comprehensive picture of the nation's progress, the Committee suggested, NAEP should be one of several complementary and coordinated methods for collecting information about student achievement. This recommendation arose in part from the ever-increasing need for more information on educational achievement and its correlates, which NAEP alone cannot supply.

Given the current design of NAEP—both its cross-sectional nature and the limited contextual information it collects (e.g., teachers and school administrators are surveyed, but not parents)—there is a lack of background information on student, school, teacher, family, and community factors related to student achievement. The Committee therefore suggested that NAEP's sponsor, the National Center for Education Statistics (NCES), "capitalize on potentially powerful synergies among discrete data collection efforts in ways that enhance the usefulness of NAEP results and contribute to the knowledge base about American educational progress" (p. 49). The Committee proceeded to name specific data collections, including NELS:88, that it envisioned might be linked to one another so that information collected in one study could supplement information collected in another.

Such a link was included on the 1992 NELS:88 second follow-up student data file. The 1992 NELS:88 NAEP-scaled mathematics assessment scores place the results of the 1992 NELS:88 mathematics assessment on the more recognizable NAEP scale, connecting the rich longitudinal and multilevel contextual data of NELS:88 to achievement on NAEP.

As a longitudinal study, NELS:88 collected data from three distinct grade cohorts (8, 10, and 12) beginning in 1988 and lasting until 2000, and collected postsecondary transcript records through 2000. The NELS:88 NAEP-scaled mathematics scores are used here to explore relationships among some of the contextual (student, parent, and school) factors unavailable in NAEP but present in NELS:88 and students' performance on the 1992 NAEP-scaled mathematics assessment. This report also explores the relationships among achievement on the 1992 NAEP-scaled mathematics assessment and a number of postsecondary school outcomes. These postsecondary outcomes include postsecondary attendance, remedial mathematics coursetaking, selectivity of postsecondary institution attended, and completion or attainment.

On the other hand, viewed apart from their special reference to NAEP metrics, the substantive conclusions of this report confirm past research using the NELS:88 database rather than uncover unique new findings. Indeed, the NAEP-scaled score does not reveal relationships or suggest conclusions that could not already be obtained using the NELS:88 scale scores and the NELS:88 proficiency levels. The primary contribution of the NAEP-scaled score is to examine further interpretive implications of the NAEP achievement levels in their relationship to a wider set of variables, including longitudinal data. While NELS:88 has its own criterion-referenced scale and proficiency levels, analyses involving the NAEP-scaled scores from NELS:88 may enhance the interpretation of what performance at particular levels of achievement on the Nation's Report Card might mean in practical terms.

1.2 Organization of Report

This report is divided into three chapters. Chapter 1 introduces and discusses the research designs of NAEP and NELS:88 and their similarities and differences. Chapter 2 focuses on some of the middle school and high school parent and student correlates of the NAEP-scaled score using contextual data available in NELS:88 but not in NAEP, including composite student socioeconomic status (SES), prior mathematics achievement, at-risk status, and SAT and ACT (American College Test) scores. Chapter 3 examines the bivariate relationships between achievement expressed in the NAEP metric and a number of later postsecondary outcomes. These bivariate relationships are contrasted to other frequently used high school predictors of postsecondary school outcomes, including average high school mathematics and reading grades, highest level of mathematics courses taken, and seniors' future educational expectations.

The remaining sections of chapter 1 provide a concise account of the design and conduct of NAEP and NELS:88, including key similarities and differences. A detailed discussion of the method used for equating the NELS:88 and NAEP mathematics assessments is presented in appendix A.

1.3 Overview of NAEP and NELS:88

The National Assessment of Educational Progress—The Nation's Report Card—has been conducted since 1969. The purpose of NAEP is to report to the public on the status of academic achievement in the United States. There is both a "main" (or "national") NAEP, and a "long-term trend" NAEP that separately tracks changes over time. Since 1990, NAEP has also been conducted at the state level. NAEP's aim is to provide a comprehensive measure of learning at critical junctures in students' school experience—specifically (for the national NAEP) at grades 4, 8, and 12. NAEP reports information at the national and group level (sub-national and group-level estimates include results for different regions of the country; for males and females; and for different race/ethnicity groups, for example). Periodic assessments have been conducted in reading, mathematics, science, writing, U.S. history, civics, geography, and the arts. These assessments follow frameworks developed by NAGB.

A good introduction to the background and purposes of NAEP that also includes information on assessment development, scoring and reporting, using NAEP data, and NAEP's sampling and data collection methodology, is provided by *The NAEP Guide* (Horkay 1999). A detailed history of NAEP is supplied by Jones and Olkin (2004). For further information about the specific version of NAEP to which NELS:88 has been linked (the national NAEP 1992 mathematics assessment), see Johnson and Carlson (1994) and Loomis and Bourque (2001).

NELS:88 is one of a series of high school longitudinal studies conducted by NCES extending back over 30 years. Starting with the National Longitudinal Study of the High School Class of 1972 (NLS-72), and continuing to the most recent study, the Education Longitudinal Study of 2002 (ELS:2002), NCES provides longitudinal data to education policymakers and researchers that link secondary school educational experiences with important future outcomes such as labor market experiences and postsecondary education enrollment and attainment.

Initiated in 1988 as the third in NCES's series of secondary school longitudinal studies, NELS:88 began with the eighth-grade class of 1988. Along with the student survey, NELS:88 included surveys of parents, teachers, and school administrators. The study also administered assessments in reading, mathematics, science, and social studies (history/geography/civics) to the sample members. High school transcripts for the sample members were collected in 1992; postsecondary education transcripts were collected in the autumn of 2000 and early 2001. NELS:88 followed this eighth-grade cohort over time, but also "freshened" the sample at each of the first two follow-up studies. Thus, nationally representative 10th- and 12th-grade cohorts were generated in NELS:88, in the first follow-up (1990) and second follow-up (1992) surveys. While the NELS:88 sample contains three cohorts—8th, 10th, and 12th grade—the analysis population for this report was the senior (12th-grade) cohort only.

Analyses in this report are based on the transformation of NELS:88 second follow-up mathematics scores to the NAEP scale. The second follow-up took place in the spring term of the 1991–1992 school year, when most sample members were in their senior year. (Analyses in this report are based on the subset of cases that are nationally representative of the nation's spring term 1992 high school seniors; section 1.5 elaborates on the analysis sample.) The second follow-up provided a capstone measurement of learning in the course of secondary school, and also collected information to facilitate investigating the transition into the labor force and postsecondary education after high school. For a comprehensive account of the NELS:88 second follow-up, see Ingels et al. (1994); for details on the NELS:88 test battery, see Rock and Pollack (1995a). Data for this report also draw on the NELS:88 high school transcript component (Ingels et al. 1995) and the NELS:88 postsecondary education transcript study (Curtin et al. 2004).

NELS:88 continued for two more rounds, which gathered considerable postsecondary outcome data. The third follow-up took place in 1994, when most sample members had been out of high school for 2 years. Major content areas for the 1994 interview were education histories, work experience histories, work-related training, family formation, income, opinions, and other experiences. A fourth and final follow-up took place in 2000, the year in which most sample members turned 26 years of age and typically were 8 years removed from high school enrollment. The interview in 2000 focused on the educational and labor market processes and transitions experienced by young adults. Interview topics included experiences with postsecondary education, labor market participation, job-related training, community integration, and marriage and family formation. The study also included a student transcript data collection from the postsecondary institutions that NELS:88 respondents reported attending after high school. Transcript data collection began in September 2000 and ended in March 2001.

1.4 Similarities and Differences

NAEP and NELS:88 have important similarities and differences. As briefly discussed above, both collected achievement data across a variety of subjects, including mathematics, and both administered such tests to nationally representative samples of high school seniors in the spring term of the 1991-1992 school year. Both also collect contextual data from students, teachers, and principals; NELS:88 collects data from parents as well.

NAEP is designed to measure achievement for various subjects at the aggregate level using samples of 4th-, 8th-, or 12th-graders (for Main NAEP), and samples of 9-, 13-, and 17-year-olds (for Long-term Trend NAEP). NAEP is a cross-sectional study that provides time series data from 1969 to the present (this is true of both Main and Trend NAEP). NAEP has breadth and depth of curricular content coverage: it spirals[1] a large pool of items from each content area in order to produce its *group* or *aggregate level* estimates of achievement. In reporting its scores, NAEP provides both scale scores and achievement[2] levels (thus making mastery or proficiency information available about test performance). The scale scores mark the distribution of achievement, while the hierarchical achievement levels represent judgments about what students should be able to do.

On the other hand, NELS:88 is a longitudinal study designed to measure achievement for various subjects at the *individual student level*, and specifically to measure achievement *gain* and its correlates *over time*. To this end, the NELS:88 testing program reports longitudinal or gain scores, as well as cross-sectional normative and criterion-referenced scores. Achievement test scores for the NELS:88 sample can be related to *later outcomes* such as postsecondary education access and choice, persistence, subject area concentration, and degree attainment, as well as initial position in the labor market, including both occupation and income.

At the same time, the NELS:88 achievement battery does not sample the curriculum as richly in that, because of its longitudinal design and focus on individual results, it differs from NAEP in not spiraling a large pool of items. While NELS:88 did not spiral items, not all students in 1992 completed precisely the same mathematics items. In NELS:88, students had different points of entry and exit from the mathematics test, based on their prior round ability estimate (*theta*).

The two mathematics assessments are alike in two important senses: their mathematics frameworks and their target populations are highly similar. Both

- represent a national sample of high school seniors in the spring of 1992;
- include all seniors who can validly be assessed in English (with exclusions for students with some disabilities or language barrier);
- are vertically equated (common scale for grades 8-12);[3]

[1] In spiraling, test forms are assigned randomly through multiple matrix sampling and different samples of respondents take different samples of items. The specific form of matrix sampling used in NAEP is focused BIB (Balanced Incomplete Block) spiraling. For further details, see Horkay 1999 (pp. 59-61).
[2] In this report, the terms NAEP *achievement levels*, *mastery levels*, and *proficiency levels* are used interchangeably.
[3] Both NELS:88 and NAEP link grades 8 and 12 by putting them on a common scale; the NELS:88 scale includes 10th grade as well, and the NAEP scale includes 4th grade. Note that while the NAEP scale historically has been vertically equated and was indeed linked across the three NAEP assessment grades in 1992, the most recent mathematics assessment, the 2005 NAEP, is only vertically equated between grades 4 and 8. In 2005, NAEP grade 12 mathematics is on its own 0-300 scale.

- measure mathematics content achievement across arithmetic (number sense), algebra, geometry, data interpretation/probability/advanced topics; and
- include items that measure procedural skills knowledge (NAEP at 30 percent of items, NELS:88 at 28 percent), conceptual understanding (NAEP at 40 percent, NELS:88 at 42 percent), and problem solving (NAEP at 30 percent, NELS:88 at 31 percent).

Both also use similar assessment methods—paper and pencil group administrations—although item formats are different in one important respect. While the NAEP test has a balanced mixture of multiple choice and constructed response items, the NELS:88 test comprises multiple choice items only. In fact, by 1992 about 40 percent of the items (Loomis and Bourque 2001) and half of testing time in NAEP mathematics was devoted to constructed response or extended constructed response, and, unlike NELS:88, protractors and scientific calculators were made available to examinees (Mullis 2004). However, experiments were conducted in NELS:88 to measure the impact of these two different formats for the mathematics (and science) tests.[4] Pollack and Rock (1997) found that correlations of the constructed response tests with multiple choice tests and with total scores in mathematics were quite high. However, the constructed response formats were slightly advantageous for some subgroups. Also, while constructed response items had lower reliability, combining the two formats resulted in a slight increase in reliability over that for multiple choice items alone. Principal differences between the two mathematics assessments in 1992 are detailed in figure 1.

[4] While no constructed response items were used in the regular NELS:88 1992 mathematics assessment, constructed response items were included in the field test, and an experimental supplementary evaluation of such items was conducted in the NELS:88 High School Effectiveness Study.

Figure 1. Differences between the NAEP and the NELS:88 (1992) mathematics assessments: 1992

NAEP	NELS:88
Cross-sectional only	Longitudinal and cross-sectional
Optimizes group-level measurement	Optimizes individual-level measurement
Measures overall and group trends over time	Measures individual achievement over time
Spiraled—different examinees get different test forms based on random assignment	One test but with multiple overlapping forms; difficulty tailored to prior round ability estimate
Employs conditioning and plausible values	Does not employ conditioning and plausible values
Test form assigned at random	Test form assigned based on ability estimate
Constructed response and multiple choice items	Multiple choice items only
Breadth and depth in sampling of curriculum topics	Broad (but not deep) sampling of curriculum topics

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), "Base Year to Second Follow-up Survey, 1992," and National Assessment of Educational Progress (NAEP) 1992 Mathematics Assessment.

While NAEP and NELS:88 serve somewhat different purposes, clearly the data they provide are complementary. It is therefore of the utmost interest to exploit the complementarity of these studies. The 1992 linkage, in which NAEP scales are implemented in NELS:88, is one such effort.

1.5 Methodology of Report: NELS:88 Analysis Samples

This report uses two NELS:88 analysis samples, both of which generalize to the population of 1992 12th-graders. The first analysis sample is cross-sectional, generalizing only to the population of spring term 1992 high school senior test takers. This is the analysis sample used in chapter 2, which examines relationships among high school parent, student, and school factors and achievement on the 1992 NAEP-scaled mathematics assessment. The analysis uses data from the NELS:88 base year through second follow-up data file.

The analyses conducted in chapter 3 are longitudinal, and use data from the NELS:88 PETS. This analysis sample generalizes to the population of 1992 seniors, with a NAEP-scaled mathematics score, as of 1994 and 2000, 2 and 8 years after they were scheduled to graduate from high school. The chapter examines the relationship between seniors' NELS:88-measured achievement as defined in the NAEP mathematics reporting metric, and future postsecondary educational outcomes.

Comparisons drawn in the text of this report have been tested for statistical significance at the .05 level using the *t* statistic to ensure differences are larger than those that might be expected due to sampling variation. Logistic regression analyses in chapter 2 present results in odds ratios, a readily interpretable magnitude-of-effect measure. Additional information about NELS:88 and NAEP sample designs, weighting, unit and item response rates, and variable definitions is provided in appendix A. Appendix B documents the standard errors for the estimates presented in text tables.

1.6 A Note on Test Linking

1.6.1 Can the NAEP and NELS:88 Tests Be Linked, and, if so, How?

Angoff (1982, p. 56) defines equating as "the process of developing a conversion from the system of units of one form of a test to the system of units of another form so that scores derived from the two forms after conversion will be equivalent and interchangeable." Equating is the strongest form of test linkage. It ensures that the scores that are linked are truly equivalent, that is, statistically and conceptually interchangeable. Test equating is a critical step in test development. Equating has a number of contexts of application. Vertical equating of forms for use with successive age groups or grades is critical to both NAEP (with its samples at grades 4, 8, and 12, and trend samples at ages 9, 13, and 17) and NELS:88 (with its longitudinal testing program at grades 8, 10, and 12). Both studies have a single vertical (or "developmental") scale that spans different grades (or ages) at which assessment takes place. Equating also ensures the equivalence of alternate forms of a test so that scale scores have the same meaning across test administrations. The multiple test forms of the SAT, for example, or of the ACT, are equated to ensure sameness of meaning of scale scores regardless of which form is administered at any given point in time (Dorans 1999). On the other hand, cross-walks between ACT and SAT results are usually called *concordances* (Dorans 2004; Marco and Abdel-Fattah 1991) in recognition of the fact that the linked scores are equivalent only in the sense of marking the same percentile ranks for some common or equivalent group of test takers; that is, the linkage is based on distributional similarities.

Indeed, although equating is among the most common procedures in test construction, it is not always appropriate, nor always successfully implemented (Feuer et al. 1999). Moreover, invalid linkages can seriously misrepresent student performance. The benefits and, for some situations, the limitations of equating must be taken seriously. The National Research Council was asked to study the feasibility of developing a scale to link scores of existing commercial and state tests both to each other and to NAEP. Its conclusion was that because of differences between the tests, such linkage was not feasible (Feuer et al. 1999).

A variety of special conditions must be met for successful equating. Lord (1980) provided the classical statement of these conditions: (1) Tests to be equated must measure the same construct; (2) the conditional distributions of scores given true score on each test after equating must be equal (this is termed the requirement of equity, and Lord draws out its implication, stating that it must be a matter of indifference to each examinee whether he or she is administered test X or test Y[5]); (3) the equating transformation should be invariant across populations; (4) the equating transformation should be symmetric (the function equating X to Y should be the inverse of the function equating Y to X). A fifth condition is often added—the tests should be equally reliable.[6]

Since there is no group of students who took both tests, the success of linking cannot be measured and evaluated by examining correlations between the two assessments. The persuasiveness of the link depends on the degree to which the five conditions of equating can be demonstrated to have been met. To the degree that some of the conditions are less than fully met, the conditions for some weaker form of linkage may conceivably be achieved.

A fundamental requirement is that the tests be essentially alike in content. Equating can only be implemented when two different tests are congeneric; that is, they measure the same underlying factor(s). In terms of test content, the NELS:88 12th-grade mathematics test fits comfortably within the NAEP mathematics content framework and the item specifications are quite similar, with a like proportion of items allocated to various content and skill or process areas (illustrated by tables A-3 and A-4 in appendix A). Both are low-stakes tests that appear in similar paper-and-pencil formats intended for group administration in school settings through similar methods.

Another condition of equating is that the tests measure the same populations. Both studies tested large, nationally representative samples of high school seniors in the spring term of the 1991-1992 school year, and the samples were defined with similar eligibility and exclusion criteria (Ingels 1996). Further, the effective sample sizes in both cases support national reporting with similar standard errors for key subgroups (race/ethnicity, school sector, region, etc.). The condition of sample equivalence therefore may be thought to apply. (A comparison of the samples is provided in appendix A [table A-5], as well as a bias analysis for unit nonresponse on the NELS:88 mathematics test in 1992.)

A further condition of equating is that the tests being linked should have similar reliabilities. Putting the scores of an unreliable test on the scale of a more reliable test will result in scores that are still unreliable, though they may misleadingly take on the aura or reputation of the more reliable test.[7] Both the NAEP and NELS:88 mathematics assessments are highly reliable, although they achieve this end through different means (the NELS:88 tests assigned different forms to candidates of different ability; NAEP, on the other hand, includes auxiliary

[5] The *NCES Statistical Standards* (Seastrom 2003, p. 132) extends the interpretation of this requirement: not only should examinees (of every ability level and population subgroup) "have the same expected mean score on each test, but they should also have the same errors of measurement."

[6] Differences in the scoring and scaling methods between tests may also affect the ability to link two assessments (see the accounts of PISA-ELS:2002 scoring differences in Ingels et al. 2004 [reading] and Ingels et al. 2005 [mathematics]).

[7] The fact that NAEP (unlike NELS:88) was not designed to maximize the reliability of individual-level measurement does not raise difficulties for an exercise in applying the NAEP metric to NELS:88 results. However, if the NAEP-NELS:88 equating were in the opposite direction, and results from NAEP were being put on the NELS:88 scale, then the carryover to the NELS:88 metric of the relative unreliability of individual-level measurements in NAEP would be a concern. NAEP results are necessarily less precise and reliable at the individual level (Beaton and Gonzalez 1995).

information in calculating the posterior estimates of ability).[8] Nonetheless, the NAEP design is driven by the need to maximize reliability for group-level measurement, while NELS:88 strives to maximize reliability for individual-level measurement. This is an important difference. The condition of equity (that examinees should be indifferent as to which test they take) is difficult to meet given the difference between an adaptive test in NELS:88 and a test based on a matrix sample of items in NAEP. Moreover, it is at least problematic, given the differences between the two tests, that the condition of symmetry can be fully met.

Any linkage that could be effected between NAEP and NELS:88, then, would appear to fall short of Lord's conditions of equating. While the samples and target populations are extremely close, and content specifications of the two mathematics frameworks are highly similar, many of the statistical specifications for the tests differ in important ways. For tests that are non-equable for statistical or content reasons "when equipercentile methods are used to compute the linkage function, the linkage is called a concordance" (Hanson et al. 2001, p. 2).

The claim that is made for the NELS:88 NAEP-scaled score, then, is that the scores are *comparable*, not that they are *equivalent*. The related claim made for the NELS:88 NAEP-scaled score is that NAEP and NELS:88 have not been equated, but rather a comparatively weak linkage, a scale concordance, has been achieved.[9] Linking scales to yield concordant scores relies on minimal assumptions about the comparability of the tests involved. Neither means, standard deviations, reliabilities, nor standard errors of measurement are assumed to be the same. The tests need only be roughly congeneric in that they measure essentially the same underlying factor. However, a concordance is stronger if the populations are systematic samples from the same population, as is the case for the NELS:88-NAEP link. The question of the "goodness" of the concordant score is typically investigated by how it affects the positioning of subgroups: does relative standing change depending on which of the scores is used?

1.6.2 Linking Procedures

Tests may be equated or linked through a variety of methods. Two of the most common (both are used in NELS:88) are IRT[10] common item equating, and equipercentile equating or transformation. Common item equating makes use of items shared by both tests to link the scales (this method has been used to equate NELS:88 with other studies in the same series, such as HS&B and ELS:2002). Equipercentile equating aligns the frequency distributions of scores on the two tests to establish the equating transformation. Angoff (1982, p. 56) defines the equipercentile method as follows:

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[8] On internal consistency reliability for *theta* in the NELS:88 assessments, see appendix A of this report and Rock and Pollack 1995a (especially p. 67 and appendix G).

[9] On concordances, see Dorans 2004, Hanson et al. 2001, Kolen 2004, Marco and Abdel-Fattah 1991, Pommerich et al. 2000, and Pommerich and Dorans 2004. For typologies of other kinds of linkage, see Johnson 1998, Johnson et al. 2005, Kolen and Brennan 2004, Linn 1993, and Mislevy 1992.

[10] IRT stands for Item Response Theory. IRT is a test analysis procedure that applies mathematical models to the probability that any given examinee will provide a correct test response. IRT uses patterns of correct, incorrect, and omitted answers to obtain ability estimates that are comparable across different test forms within a domain. In estimating a student's ability, IRT also accounts for each test question's difficulty, discriminating ability, and a guessing factor. For more information on IRT, see Embretson and Reise (2000), Hambleton (1989), and Hambleton, Swaminathan, and Rogers (1991).

> Equipercentile equating is based on the following definition: Two scores, one on Form x and one on Form y—where x and y are equally reliable and parallel measures…may be considered equivalent if their respective percentile ranks in any given group are equal. Thus equipercentile equating of Form x to Form y operates to match all moments (i.e., all characteristics of the shape, in addition to the mean and standard deviation) of the distribution of Form x scores to the respective moments of the distribution of Form y scores.

In an equipercentile transformation (whether a true equating, or a weaker link such as a concordance), it is also essential that test content be essentially similar, that is, that the same constructs be measured. For a true equating by this method, the samples of examinees who took the two tests should be equivalent—that is, represent the same population. For IRT equating, samples may be different so long as there are sufficient items common to both forms (Kolen and Brennan 2004).

The transformation of NELS:88 scores to the NAEP scale used an equipercentile method. The equipercentile approach was based on the premise that if two examinations measuring a like construct are given to two samples from the same population, the score corresponding to a certain percentile on one exam may be considered to be comparable to the score on the other exam that represents the same percentile of the population. For example, the mathematics score that represents the 45th percentile in NAEP is assumed to be concordant with the mathematics score that is the 45th percentile in NELS:88. The score was calibrated on weighted samples of NELS:88 high school seniors and NAEP high school seniors. The resulting mathematics score is the NAEP-scaled equivalent of the NELS:88 IRT-Estimated Number Right Score.

A critical test (perhaps *the* critical test for a concordance) is whether the linkage holds up for subgroups (e.g., the NAEP-scaled score that is at the 25th percentile for NELS:88 Black 12th graders should be about the same as the 25th percentile for NAEP Black 12th-graders, and so on). After the linking exercise was carried out, it was determined that mean scores indeed were extremely close for key subgroups (sex, race/ethnicity, school type [see table A-3 of this report]) (virtually all checks were within one standard error; see Rock and Pollack 1995a, p. 65). Further discussion of linking may be found in appendix A of this report.

1.7 Potential Limitations of the Research

This report examines correlates of high school senior-year mathematics achievement and mathematics achievement relative to future outcomes such as postsecondary educational enrollment and baccalaureate attainment. However, it examines only a single (albeit critically important) subject area: mathematics. Other domains that may be relevant to predicting future outcomes, including both other aspects of tested achievement (e.g., reading and writing skills, science knowledge) and non-academic competencies (e.g., teamwork skills, self-concept, and work habits), are excluded in light of the narrow focus on mathematics.

Another limitation is that the NELS:88 NAEP-scaled mathematics score has not been linked to the NAEP score in a way that ensures an equivalence in which, both statistically and conceptually, the scores are interchangeable. The weaker linkage that has been achieved, a concordance, carries with it only assurances about the distributional similarities of the scores.

Two potential (and interrelated) limitations to the current study of which readers should be aware are a lower than desired response rate on the NELS:88 1992 mathematics assessment, and the possibility of low student motivation on the NELS:88 12th-grade test (low student motivation has also been a concern for 12th-grade NAEP [Brophy and Ames 2005]).

In NELS:88 a "participant or respondent" is a sample member who completed a student or dropout background questionnaire. Under this definition, test data are treated as contextual data similar in nature to background questionnaire items, such as the background questionnaire item on students' educational expectations, and non-response is treated as item non-response (a test score is missing) and calculated as a coverage rate. While 91 percent (weighted) of sample members who were students in 1992 completed a student questionnaire, test data were collected from 77 percent (weighted) of students completing a student questionnaire. This coverage rate is slightly higher for the subsample of students who were in 12th grade in the spring of 1992. For sample members who were seniors in the spring of 1992, the completion rate for the NELS:88 NAEP-scaled mathematics assessment was 79 percent (weighted).[11] Weights were adjusted for unit non-response, but not item non-response. Therefore, a bias analysis was undertaken to determine whether the NELS:88 NAEP-scaled score analysis sample generalized to the target population of 1992 12th-graders, and, if not, the extent to which differences in the two samples might bias the results reported—that is, result in misleading conclusions regarding relationships among high school predictors, postsecondary school outcomes, and NELS:88 performance registered on the NAEP mathematics scale.

A comparison of 12th-graders with a NELS:88 NAEP-scaled mathematics assessment score to those without revealed that the analysis sample (i.e., NELS:88 12th-graders with a NAEP-scale mathematics score) over-represents males, students who attended rural schools for high school, students whose fathers' highest level of education is a high school diploma or GED, and students who were the highest performers on the NELS:88 8th- and 10th-grade mathematics tests. The sample under-represents females, students who attended urban schools for high school, students who attended high schools in the west, and the poorest performers on the NELS:88 8th-grade (but not 10th-grade) mathematics test. A complete discussion of the bias analysis performed for this report is presented in appendix A. The results of this analysis are similar to more extensive analyses of NELS:88 cognitive test non-response reported in Ingels, Scott, and Taylor (1998) and Rock and Pollack (1995a).

Nonresponse, both questionnaire and test, is a problem for all studies, perhaps especially for assessments and surveys of high school seniors (Ingels, Scott, and Taylor 1998; National Commission on NAEP 12th Grade Assessment and Reporting 2004; Rock and Pollack 1995a). By spring term, seniors may be beginning to disengage from high school in a phenomenon

[11] Some NELS:88 sample members were not in 12th grade in the spring of 1992. Some graduated early, some dropped out, and yet others were held back a grade or more. This response rate applies only to members of the senior cohort (i.e., 12th-grade students in the spring of 1992) (see Ingels et al. 1994 for more details). Test non-response of questionnaire completers in NELS:88 in 1992 primarily reflects not a student choice (to not be tested) but rather data collection constraints for a highly dispersed longitudinal sample. It was uneconomical to test students who were not clustered, although unclustered students can cost-efficiently complete paper-and-pencil self-administered interviews or telephone interviews.

sometimes called "senior slump" or "senioritis." National data suggest that they are often less likely to participate in general than students in 4th, 8th, and 10th grade. Even seniors who do choose to participate may not expend much effort or take seriously answering questionnaire or test items. Motivation may also be a problem because the assessments are not "high stakes" for the test takers. In their analysis of the NELS:88 test data across the three grades (8, 10, and 12), Rock and Pollack (1995a) found no evidence of motivational problems for test takers, who overwhelmingly completed most or all items within a coherent pattern of response regardless of the grade at which tested. However, a possible difference of motivational context, between NAEP and NELS:88, is that the NELS:88 test was adaptive. Students were, in the main, exposed only to those items that were neither too difficult nor too easy for them. Since the blocks of NAEP items were randomly assigned, examinees would be more likely to encounter items that could be too difficult for them, which might affect their test-taking motivation.

Readers familiar with the history of the NAEP mathematics assessment may wonder about the extent to which findings based on the 1992 NAEP mathematics assessment may generalize to its later administrations. The current findings generalize to the mathematics trend line begun in 1990 and maintained in the 1992, 1996, and 2000 NAEP 12th-grade mathematics assessments. However, the NAEP mathematics assessment developed for the 2005 12th-grade administration (but not 4th or 8th grades) begins a new trend line with revised content framework and achievement level descriptions (NAGB 2004).

To the question, then, of the applicability of the historical results here reported to the present, one must wait for further research that will update information from NELS:88. Currently, the NELS:88 postsecondary transcript study (conducted in 2000) provides the most recent data available for looking at the relationship between high school mathematics achievement and a broad array of postsecondary outcomes. However, additional relevant data will be available in the future. The 2005 NAEP mathematics assessment has been linked to NELS:88's successor study, ELS:2002; a concordant NAEP-scaled score has been produced for the senior-year round of ELS:2002 (2004). ELS:2002 data collected in the spring of 2006 will provide a postsecondary outcome—prompt entry into a 2- or 4-year postsecondary institution[12]—with which the ELS:2002 NAEP-scaled score can be tested as a predictor. Examining the new ELS:2002 NAEP:2005-scaled score in relation to baccalaureate attainment must await future data collections.

Readers are reminded that relationships between cross-tabulated variables and performance on the NAEP mathematics assessment do not provide a basis for inference to an underlying cause. Cross-tabulations do not take into account the possible influence of other variables. Nor do regression analyses provide a basis for causal inference, although they improve on bivariate tables by controlling for various observed covariates.

The next chapter examines data bearing on the student, family, and school correlates of mathematics achievement. In particular, it draws on contextual data available in NELS:88 but

[12] The ELS:2002 second follow-up (2006) data will also include measures of postsecondary institutional selectivity.

not in NAEP, such as students' home background as measured by a socioeconomic status variable that takes account of parental income and occupation as well as educational attainment. Prior mathematics achievement is also considered, as well as high school seniors' school characteristics such as sector and region.

Chapter 2
Student, Family, and High School Predictors of 12th-Graders' NELS:88 NAEP-Scaled Performance

This chapter explores the 1992 cross-sectional data available in the National Education Longitudinal Study of 1988 (NELS:88) in relation to high school seniors' 1992 National Assessment of Educational Progress (NAEP)-scaled mathematics results. It also employs some antecedent data such as 8th- and 10th-grade test scores. Three classes of predictor variables are examined: student, family, and high school. This chapter exploits some of the background and schooling variables available in NELS:88 but not in NAEP (e.g., seniors' educational expectations, family income, parental occupation, prior achievement) or variables that are arguably more reliable in NELS:88 (e.g., parent report of parental education rather than student report).

Chapter 2 comprises four sections. The first section describes the NAEP achievement or proficiency levels and reports (in table 1) overall mean scores for the levels and percentages of 1992 NELS:88 seniors performing at each level. The second section discusses bivariate relationships between student, family, and high school background characteristics, such as sex, race/ethnicity, and high school sector of attendance, and NAEP-scaled mathematics performance (table 2). The third section reports on bivariate associations between NAEP-scaled mathematics performance and other measures of students' academic engagement, performance, and risk assessed concurrently and in earlier grades (i.e., 8th and 10th) (table 3). The fourth section re-examines the bivariate relationships discussed in the second and third sections using multiple logistic regression analysis to add additional information to the earlier bivariate findings after holding other factors constant (table 4).

2.1 NAEP Mathematics Proficiency (Achievement) Levels

NAEP mathematics scores are reported in two forms. The first is a scale score, computed for each student and reported as aggregate group means. The second is an achievement or proficiency level. More specifically, in 1990 the National Assessment Governing Board adopted achievement levels for grades 4, 8, and 12 in mathematics (and other NAEP subjects). While, in both NAEP and NELS:88, different grades are on the same vertical scale, the 1992-2000 NAEP achievement levels are set at a different scale point, depending on grade (see Loomis and Bourque 2001). The NAEP scale of 0-500 is anchored at 250 in grade 8, with a standard deviation of 50 scale score points. At 4th grade, a score of 249 marks the "Proficient" achievement level; at 8th grade, a score of 299 marks Proficient; and at 12th grade, a score of 336. The focus of this report will be the NAEP achievement levels only at the 12th-grade level. The first of these levels is the Basic level.

The Basic level indicates partial mastery of the knowledge and skills that are fundamental for proficient 12th-grade work. The Proficient level (the minimal goal for all students) represents solid academic performance. Superior performance is denoted by the "Advanced" achievement level. Achievement that is less than partial mastery (i.e., Basic) is called "below Basic." Figure 2 presents descriptions of the NAEP proficiency levels and cutscores for 12th-grade mathematics in 1992. Proficiency level cutscores were set in 1992 by a panel of experts and apply to the 1990, 1992, 1996, and 2000 NAEP mathematics assessments (Loomis and Bourque 2001).

Figure 2. Definitions and cutscores for the three achievement levels of the 1992 NAEP mathematics assessment: 2001

Achievement level for G12	Definition
Basic (288)	*12th-grade students performing at the Basic level should demonstrate procedural and conceptual knowledge in solving problems in the five NAEP content strands.*
	12th-graders performing at the Basic level should be able to use estimation to verify solutions and determine the reasonableness of results as applied to real-world problems. They are expected to use algebraic and geometric reasoning strategies to solve problems. 12th-graders performing at the Basic level should recognize relationships presented in verbal, algebraic, tabular, and graphical forms; and demonstrate knowledge of geometric relationships and corresponding measurement skills. They should be able to apply statistical reasoning in the organization and display of data and in reading tables and graphs. They also should be able to generalize from patterns and examples in the strands of algebra, geometry, and statistics. At this level, they should use correct mathematical language and symbols to communicate mathematical relationships and reasoning processes; and use calculators appropriately to solve problems.
Proficient (336)	*12-grade students performing at the Proficient level should consistently integrate mathematical concepts and procedures to the solutions of more complex problems in the five NAEP content strands.*
	12th-graders performing at the Proficient level should demonstrate an understanding of algebraic, statistical, and geometric and spatial reasoning. They should be able to perform algebraic operations involving polynomials, justify geometric relationships, and judge and defend the reasonableness of answers as applied to real-world situations. These students should be able to analyze and interpret data in tabular and graphical form; understand and use elements of the function concept in symbolic, graphical, and tabular form; and make conjectures, defend ideas, and give supporting examples.
Advanced (367)	*12th-grade students performing at the Advanced level should consistently demonstrate the integration of procedural and conceptual knowledge and the synthesis of ideas in the five NAEP content strands.*
	12th-grade students performing at the Advanced level should understand the function concept and be able to compare and apply the numeric, algebraic, and graphical properties of functions. They should apply their knowledge of algebra, geometry, and statistics to solve problems in more advanced areas of continuous and discrete mathematics. They should be able to formulate generalizations and create models through probing examples and counterexamples. They should be able to communicate their mathematical reasoning through the clear, concise, and correct use of mathematical symbolism and logical thinking.

NOTE: NAEP = National Assessment of Educational Progress.

SOURCE: Adapted from Loomis, S.C., and Bourque, M.L. (Eds.) (2001, p. 9). *National Assessment of Educational Progress Achievement Levels, 1992-1998 for Mathematics*. Washington, DC: National Assessment Governing Board.

The NAEP achievement levels were implemented with the intent that they would provide a basis for comparing actual achievement with what students *should* know (Horkay 1999). The achievement levels for what students should know to display a basic, proficient, or advanced performance in mathematics have cut points that are set on the basis of the collective judgment of expert panels. Mathematics achievement levels set in 1992 were based on the mathematics framework developed for the 1990 administration. Under the 1990/1992 framework, three primary abilities—conceptual understanding, procedural knowledge, and problem solving—within five content strands were assessed: (1) number sense,[13] properties, and operations; (2) measurement; (3) geometry and spatial sense; (4) data analysis, statistics, and probability; and (5) algebra and functions.

Historically, NAEP achievement levels have been employed on a "developmental" basis, with the caveat that they should be interpreted and used with caution. The No Child Left Behind Act of 2001 (NCLB) continues this policy by requiring that the trial status of the achievement levels be stated clearly in all NAEP reports. There are many controversial issues of reasonableness, validity, and usefulness that surround any effort at standards-setting within large-scale assessments. The methodological challenges of setting achievement standards within NAEP have been documented and their implications debated within a number of publications (see, in particular, Bourque and Byrd 2000; Burstein et al. 1993, 1995/1996; Linn 2004; Pellegrino, Jones, and Mitchell 1999; Shepard, Glaser, and Linn 1993).[14] Use of the NAEP mathematics achievement levels within the NELS:88 dataset may provide further information that can contribute to discussions of NAEP standard-setting.

The performance of students on the NAEP mathematics assessment is reported on a scale of 0 to 500 (Loomis and Bourque 2001). Using the NELS:88 12th-grade cross-sectional sample and the NELS:88 12th-grade mathematics assessment placed on the NAEP 1992 mathematics assessment scale, table 1 reports the mean scale scores for the three achievement levels of NAEP along with the percentages of students performing at each level.

Note that the data reported throughout this report are from NELS:88, not NAEP. The NAEP scores reported are NELS:88 seniors' 1992 mathematics scores placed on the NAEP 1992 mathematics assessment scale.

[13] The mathematics content domain called "number sense" (or "numerical operations") in NAEP is called "arithmetic" in the NELS:88 mathematics framework.
[14] Burstein et al. 1993 and 1995/1996 specifically analyze and discuss the 1992 NAEP mathematics achievement levels.

Table 1. Mean achievement, standard deviation (SD), and percentage of high school seniors scoring at the various levels of proficiency on the 1992 NAEP-scaled mathematics assessment, by proficiency levels: 1992

12th-grade NAEP-scaled proficiency level	Mean	SD	Percent
All students	298.7	34.38	100.0
Below basic	263.0	18.96	37.2
Basic	310.6	13.31	48.2
Proficient	347.7	8.42	13.0
Advanced	376.3	8.52	1.6

NOTE: In the five NAEP content strands, Basic-level students demonstrate procedural and conceptual knowledge in solving problems; Proficient-level students consistently integrate mathematical concepts and procedures to the solutions of more complex problems; Advanced-level students consistently demonstrate the integration of procedural and conceptual knowledge and the synthesis of ideas.

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

Table 1 indicates that the average score for the NELS:88 1992 12th-grade cohort was 299—within the Basic achievement level for 12th-graders—with a standard deviation of 34.38. The score range was 178 (lowest) to 409 (highest). Overall, more than half of 1992 12th-graders (63 percent) performed at the level of Basic or above on the 1992 NAEP-scaled mathematics assessment, with slightly more than one-third (37 percent) performing below Basic.[15]

Students who attain a score between 288 and 335 are performing at the Basic level (see figure 2). Forty-eight percent of 1992 12th-graders performed at this level and their average score was 311—12 points above the overall average for 12th-graders. These students can use "algebraic and geometric reasoning strategies to solve problems and recognize relationships presented in verbal, algebraic, tabular and graphical forms" (Loomis and Bourque 2001, p. 9).

Performance at the Proficient level is denoted by a score falling between 336 and 366. Thirteen percent of 1992 12th-graders performed at this level and their average score was 348—49 points above the overall mean. Students at this level are able to "perform algebraic operations involving polynomials, justify geometric relationships and judge and defend the reasonableness of answers as applied to real-world solutions; they can make conjectures, defend ideas, and give supporting examples" (Loomis and Bourque 2001, p. 9).

Students who attain a score between 367 and 500 are performing at the Advanced level. As shown in table 1, 2 percent of 12th-graders performed at this level and their average score was 376—77 points above the overall mean for 1992 12th-graders. Students performing at this level "understand the function concept and can compare and apply numeric, algebraic, and graphical properties of functions; they can apply their knowledge of algebra, geometry, and

[15] These results obtained with the 1992 NELS:88 senior cohort replicate the results obtained with the 1992 NAEP seniors. The overall mean for 1992 seniors participating in NAEP was 299 with a standard deviation of 34. Forty-nine percent of the NAEP senior cohort performed at the Basic level, 13 percent performed at the Proficient level, 2 percent performed at the Advanced level, and 36 percent performed at the below-Basic level (U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress [NAEP] 1992 Mathematics Assessment, NAEP Data Tool).

statistics to solve problems in more advanced areas of continuous and discrete mathematics" (Loomis and Bourque 2001, p. 9).

Thirty-seven percent of 1992 12th-graders performed below the Basic level; these are students who achieved a score between 178 (the lowest score attained) and 287. The average score for this proficiency level was 263, which is 36 points below the overall mean for 1992 12th-graders (299). Students performing at this level were unable to use "algebraic and geometric reasoning strategies to solve problems, and recognize relationships presented in verbal, algebraic, tabular, and graphical forms" (Loomis and Bourque 2001, p. 9).

Nevertheless, the proficiency level descriptions together with the percentages of 12th-graders who have mastered certain achievement levels allow for interpreting student performance on the NAEP mathematics assessment only so far. What high school experiences might be related to attainment of a Basic, Proficient, or Advanced understanding of mathematics? How do family background factors, and individual factors such as student expectations for future educational attainment, relate to performance? The longitudinal design of NELS:88 (with its individual-level measurement and multiple time points) permits better insight into such relationships. This is the focus of the remaining sections of this chapter.

2.2 Student, Family, and High School Characteristics and NELS:88 NAEP-Scaled Performance

Table 2 displays characteristics of the 1992 12th-grade NELS:88 cohort as they relate to performance in the 1992 NAEP mathematics assessment metric.[16] (Readers wishing to see the number of students in each of the cells will find the unweighted sample sizes in appendix B.) With the exception of one student/family background characteristic—student socioeconomic status (SES)—and one school background characteristic—enrollment in a high school that is a member of the National Association of Independent Schools (NAIS)—all of the characteristics presented in table 2 are also available in NAEP and are used as the major groups for reporting performance on NAEP.

Table 2 shows that results observed with NELS:88 replicate the results observed with the 1992 NAEP 12th-grade sample (Loomis and Bourque 2001; Mullis et al. 1993). In other words, table 2 demonstrates that the 1992 NELS:88 12th-grade sample is essentially similar to the 1992 NAEP 12th-grade sample and other nationally representative samples of 12th graders (Berends et al. 2005; Hedges and Nowell 1995, 1999; Nowell and Hedges 1998).

[16] The student, family, and school characteristics displayed in table 2 are the standard classification variables used throughout the education literature and by federal statistical agencies to report on the status of education in the nation and internationally. Core NAEP reporting categories required by law (NCLB) include race/ethnicity, parental education, sex, disability, and limited English proficiency status. The importance of these variables has been underlined by past NELS:88 research (Green et al. 1995).

Table 2. Percentage of students scoring at the various levels of proficiency on the NAEP-scaled mathematics assessment, by selected student characteristics: 1992

	NAEP-scaled proficiency levels[1]			
Student characteristic	Below basic	Basic	Proficient	Advanced
All students	37.2	48.2	13.0	1.6
Sex				
Male	36.5	47.3	14.0	2.2
Female	38.1	49.0	11.9	1.0
Race/ethnicity[2]				
White	30.7	52.1	15.3	1.8
Black	64.1	32.9	3.0	#
Hispanic	56.6	37.8	5.2	0.4
Asian	27.5	47.7	19.6	5.2
American Indian	60.9	37.5	1.6	#
Socioeconomic status				
Lowest quarter	62.5	34.3	3.0	0.1
Middle-low quarter	46.0	46.2	7.3	0.5
Middle-high quarter	32.4	55.2	11.6	0.8
Highest quarter	17.0	53.0	25.8	4.2
12th-grade school type				
Public	39.3	47.5	11.8	1.4
Catholic	17.8	61.5	19.0	1.7
NAIS	4.5	30.4	52.3	12.8
Other private	26.5	50.5	20.6	2.4
12th-grade school location				
Urban	38.1	45.8	14.4	1.8
Suburban	34.5	49.7	13.9	2.0
Rural	39.9	48.3	10.8	1.1
12th-grade school region				
Northeast	27.5	53.1	16.9	2.5
Midwest	32.9	51.3	14.0	1.8
South	44.4	44.4	10.0	1.2
West	40.5	45.4	12.8	1.2

Rounds to zero.

[1] In the five NAEP content strands, Basic-level students demonstrate procedural and conceptual knowledge in solving problems; Proficient-level students consistently integrate mathematical concepts and procedures to the solutions of more complex problems; Advanced-level students consistently demonstrate the integration of procedural and conceptual knowledge and the synthesis of ideas.

[2] Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or other Pacific Islander, and American Indian includes Alaska Native. Race categories exclude Hispanic origin unless specified.

NOTE: NAEP = National Assessment of Educational Progress. NAIS = National Association of Independent Schools.

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

The variables respondent sex, race/ethnicity, socioeconomic status, school sector, and region are explored below.

Sex. Based on this report's statistical significance criterion for presenting findings, no discernable differences in performance—as measured by percentages achieving particular levels of proficiency in the 1992 NAEP mathematics metric—were observed between males and females. More than half of both males (64 percent) and females (62 percent) scored at the Basic or above Basic levels, while slightly more than one-third of males (37 percent) and females (38 percent) performed below the Basic level (table 2). The largest percentages of males and females performed at the Basic level (47 percent for males and 49 percent for females). These results mirror those for the population of 12th-graders as a whole (see table 1) and those documented in NAEP reports (see Mullis et al. 1993).

Other student or family characteristics, however, reveal differences among student subgroups.

Race/Ethnicity. Less than half of Black (36 percent), Hispanic (43 percent), and American Indian (39 percent) seniors performed at or above the Basic level in 1992. In contrast, 73 percent of Asian and 69 percent of White seniors performed in NELS:88 at or above the NAEP Basic level in 1992.

Socioeconomic Status (SES). One NELS:88 variable not included in NAEP[17] is respondent-level socioeconomic status. SES is a composite construct comprising five equally weighted elements: father's occupation and highest level of education, mother's occupation and highest level of education, and parent-reported family income. The SES variable employed in this report divided continuous SES into four equally weighted categories or quarters.

Table 2, consistent with the research literature on socioeconomically disadvantaged students (Braswell et al. 2001; Grigg et al. 2003; Persky, Daane, and Jin 2003), shows that students' SES is positively associated with NAEP-scaled mathematics results. Some 63 percent of low-SES quarter seniors performed at the below-Basic level (63 percent). The majority of all higher SES quarter groups performed at the level of Basic or above (54 percent of middle-low SES students, 68 percent of middle-high SES students, and 83 percent of high-SES students). The most notable subgroup difference is the 30 percent of students from high-SES families who attained either a Proficient (26 percent) or an Advanced (4 percent) understanding of mathematics by 12th grade. Three percent of low-SES students attained such levels of understanding (3 percent performed at the Proficient level and 0.1 percent performed at the Advanced level).

[17] NAEP does collect reports of parental educational attainment from students. In NELS:88, SES information (including family income and parental occupation as well as parental education) was collected from parents whenever possible, since parents are the preferred source on data quality grounds. However, NAEP has no parent survey. The implications for assessment of these differences in social background variables across the two studies are explored in Berends and Koretz (1995/1996).

Table 2 also reports school characteristics that are available both in NELS:88 and NAEP, with the exception of the alternative presentation of high school sector of attendance that includes a separate category for students enrolled in high schools belonging to NAIS.[18]

Subgroup differences that met the report's statistical criteria are observed for two of the three school characteristics (table 2), 12th-grade school sector and 12th-grade school region. No measurable differences were observed among 12th-graders attending urban, suburban, and rural high schools.

High School Sector of Attendance. Some 61 percent of public school 12th-graders performed at Basic or above. About 39 percent performed at the below-Basic level. The largest percentages of public school 12th-graders (48 percent) performed at the Basic level.

Eighty-two percent of Catholic high school seniors, 96 percent of NAIS seniors, and 74 percent of other private school seniors performed at the level of Basic or above in the NELS:88 1992 NAEP-scaled mathematics metric. In NAIS schools, 65 percent of students demonstrated a Proficient (52 percent) or an Advanced (13 percent) understanding of mathematics in the 12th grade. Students in the NAIS schools were more likely than those in any other sector to achieve the Advanced level (13 percent for NAIS, versus 2 percent for Catholic and other private, and 1 percent for public school students).

Region. Differences among 12th-graders attending high schools in different regions of the country were also found, also consistent with the NAEP literature (Mullis et al. 1993). In all regions, more than half of 12th-graders performed at the level of Basic or above—73 percent from the Northeast, 67 percent from the Midwest, 56 percent from the South, and 59 percent from the West. Students in the South and West scored at the Below-basic level more often than students in the Northeast (44 percent of high school seniors in the South were Below basic, as were 41 percent of seniors in the West; in comparison, 28 percent of seniors in the Northeast scored at Below basic).

2.3 Additional Student and High School Predictors and Correlates of NAEP-Scaled Performance

Additional relationships among student and high school contextual factors and NAEP-scaled test performance are explored in this section. Two classes of factors are examined. The first is student predictors of high school mathematics achievement that temporally precede the assessment of 12th-graders' understanding of mathematics. These variables, such as prior mathematics achievement and at-risk (for school failure) status, exemplify student-level variables available in NELS:88 but not in NAEP.

[18] NAIS schools are independent, private schools with a distinct mission. They are primarily supported by tuition payments, charitable contributions, and endowment revenue. They include day, boarding, and day/boarding elementary and secondary schools, and their members agree in spirit to support the Association's Principles of Good Practice.

The second class of factors comprises standard correlates of high school and postsecondary school performance that occur (for the most part) concurrently with the assessment of students' understanding of mathematics in 12th grade. These correlates were drawn from the NELS:88 second follow-up high school transcripts file (Ingels et al. 1995).

2.3.1 Student Predictors and Correlates

Table 3 presents NELS:88 NAEP-scaled achievement levels in relation to a number of student attributes at 12th grade. Three of the student characteristics temporally precede the administration of the 1992 mathematics assessment—seniors' prior mathematics achievement as measured in 8th and 10th grades, and "at risk of school failure" status. Other factors relate to seniors' cumulative experience over four years of high school: coursetaking (highest mathematics course taken) and average grade in mathematics[19] (some 66 percent of NELS:88 seniors were enrolled in mathematics in the 1991-1992 school year [Hoffer and Moore 1995]). A further student characteristic—12th-graders' educational expectations—occurs currently with the administration of the NELS:88 1992 mathematics assessment. SAT and ACT mathematics scores (when available) are also included as a table 3 row variable.

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[19] On the correlations and differences between grades and test scores in NELS:88, and the complementary strengths of each measure, see Lewis, Pollack, and Willingham 2002. Also see Kao and Thompson 2003.

Table 3. Percentage of high school seniors scoring at the various levels of proficiency on the 1992 NAEP-scaled mathematics assessment, by student background characteristics or high school performance measures: 1992

Student characteristic or high school performance measure	NAEP-scaled proficiency levels[1]			
	Below basic	Basic	Proficient	Advanced
All students	37.2	48.2	13.0	1.6
12th-graders' educational expectations				
High school or less	69.3	29.1	1.6	#
Some vocational/trade/business	67.6	31.1	1.2	#
Trade school certificate/degree	62.1	36.9	1.0	#
Some college	58.9	39.3	1.9	#
Bachelor's degree	25.4	60.3	13.5	0.8
Graduate/professional degree	20.2	49.9	25.5	4.4
8th-grade mathematics achievement				
Lowest quarter	90.9	9.0	0.1	#
Middle 1 quarter	58.3	41.3	0.4	#
Middle 2 quarter	21.0	75.5	3.5	#
Highest quarter	1.9	53.9	39.1	5.1
10th-grade mathematics achievement				
Lowest quarter	97.5	2.5	#	#
Middle 1 quarter	63.1	36.9	#	#
Middle 2 quarter	11.0	87.7	1.3	#
Highest quarter	0.3	51.4	42.9	5.3
At-risk status				
0 risk factors	27.1	53.5	17.2	2.2
1 risk factor	44.5	45.8	9.0	0.7
2 risk factors	57.2	37.3	4.7	0.7
3 risk factors	69.4	28.2	2.1	0.3
4 or more risk factors	70.9	28.6	0.5	#
SAT mathematics score				
200 to 300	92.1	7.9	#	#
310 to 400	42.0	57.9	0.1	#
410 to 500	5.8	91.4	2.7	0.1
510 to 600	0.7	61.2	37.7	0.4
610 to 700	0.7	15.4	73.5	10.5
710 to 800	#	2.9	37.9	59.2
ACT mathematics score				
6 to 10	100.0	#	#	#
11 to 15	75.0	25.0	#	#
16 to 20	27.8	70.3	1.8	#
21 to 25	1.8	76.8	21.3	0.1
26 to 30	0.2	25.0	67.3	7.4
31 to 36	#	3.1	51.3	45.6

See notes at end of table.

Table 3. Percentage of high school seniors scoring at the various levels of proficiency on the 1992 NAEP-scaled mathematics assessment, by student background characteristics or high school performance measures: 1992—Continued

Student characteristic or high school performance measure	NAEP-scaled proficiency levels[1]			
	Below basic	Basic	Proficient	Advanced
Completion of new basics[2]				
Failed threshold	49.6	42.7	6.9	0.7
Met threshold	13.0	59.7	24.0	3.4
Average grade in mathematics				
D or below	68.1	31.3	0.5	#
C	44.6	50.7	4.6	0.1
B	19.9	60.5	18.3	1.3
A	4.1	40.1	45.5	10.3
Highest mathematics course taken[3]				
No mathematics	66.5	27.5	6.0	#
Non-academic	95.3	4.6	#	#
Low academic	87.7	12.3	#	#
Mid-academic I	61.3	37.9	0.7	#
Mid-academic II	30.8	66.4	2.8	0.1
Advanced mathematics I	12.9	72.9	13.8	0.4
Advanced mathematics II (pre-calculus)	3.4	60.6	34.3	1.7
Advanced mathematics III (calculus)	1.5	30.2	55.2	13.1

Rounds to zero.

[1] In the five NAEP content strands, Basic-level students demonstrate procedural and conceptual knowledge in solving problems; Proficient-level students consistently integrate mathematical concepts and procedures to the solution of more complex problems; Advanced-level students consistently demonstrate the integration of procedural and conceptual knowledge and the synthesis of ideas.

[2] Met threshold of new basics indicates that students earned at least four Carnegie units in English, three units in each of social studies, science, and mathematics, and two units in foreign language. 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 one year.

[3] Nonacademic mathematics courses are such courses as general mathematics I, general mathematics II, basic mathematics I, and technical mathematics. Low academic mathematics courses are such courses as pre-algebra, algebra I-part 1, algebra I-part 2, and informal geometry. Middle academic mathematics courses are such courses as algebra I, plane geometry, unified mathematics I, algebra II, and unified mathematics III. Advanced mathematics courses are such courses as algebra II, college algebra, probability and statistics, introductory analysis, calculus, and AP mathematics.

NOTE: NAEP = National Assessment of Educational Progress. Details 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), "Base Year Student Survey, 1988"; "First Follow-up Student Survey, 1990"; and "Second Follow-up Student Survey, 1992."

Student Educational Expectations as of 12th Grade. In NELS:88, educational expectations questions were posed at grades 8, 10, and 12. The analysis in this report draws on only the 12th-grade report.[20] As of the spring of 1992, 95 percent of the 1992 senior cohort expected to continue their education after high school, with 69 percent reporting they expected to attain a bachelor's or higher degree. High school seniors in 1992 with expectations of receiving a bachelor's or higher degree were more likely to have higher NAEP-scaled mathematics scores than were seniors with lesser expectations.

[20] Adelman (1999, 2006) has created composite indicators of educational "anticipations" using expectations and plans variables from HS&B and NELS:88. For a discussion of the degree to which educational expectations are intentions generated from rational calculations of costs and benefits, subject to revision in response to new information, see Morgan 1998. For a discussion of problematic aspects of educational expectation and aspiration variables see, Kao and Thompson 2003.

NELS:88 seniors whose educational expectations were to attain a bachelor's degree or higher had a better understanding of mathematics than seniors with lesser educational expectations. Some 75 percent of students expecting to attain a bachelor's degree and 80 percent of students expecting to attain a graduate or first professional degree performed at the Basic or above level in the 1992 NAEP mathematics metric. Some 59 percent of those whose highest educational expectation was "some college" fell into the NAEP "below Basic" category—as did 25 percent of those who expected to end their education with a bachelor's degree, and 20 percent of those who expected to complete a graduate or professional degree. Based on their NELS:88 mathematics results, about half (50 percent) of those expecting a graduate or professional degree achieved NAEP Basic level in mathematics; 30 percent achieved Proficient or Advanced levels.

Seniors' Earlier Achievement. NELS:88 has its starting point in 8th grade. This design provides two premeasures of students' senior year achievement in mathematics: one measure prior to students' entry into high school (the 8th-grade assessment) and a second midway through their high school careers (10th grade). Table 3 presents percentages of students performing at the three proficiency levels of NAEP for students in different percentage quarters on the NELS:88 8th- and 10th-grade mathematics assessments.

8th-Grade Mathematics Achievement. Some 91 percent of the students scoring in the lowest quarter of the NELS:88 8th-grade achievement distribution had a below-Basic NELS:88 12th-grade NAEP-scaled score in 1992. On the other hand, of those who scored in the top 8th-grade mathematics quarter in 1988, 44 percent were at the Proficient or Advanced levels of NAEP-scaled achievement as seniors.

Students' scores on the 1988 NELS:88 8th-grade mathematics assessment correlated 0.82 with their NELS:88 12th-grade mathematics scores, as expressed on the NAEP scale.

10th-Grade Mathematics Achievement. About 98 percent of seniors who had scored in the bottom quarter of the NELS:88 10th-grade mathematics test were below Basic at 12th grade in terms of their 1992 NELS:88 NAEP-scaled scores. However, of sophomores who had scored in the top quarter on the NELS:88 assessment in 1990, 48 percent were at the NAEP-scaled Proficient or Advanced achievement level as seniors in 1992.

Students' At-Risk Status. Another NELS:88 student-level composite variable is students' risk of school failure (including risk of dropping out). Because this derived factor draws on family information collected from students' parents, it is unavailable in NAEP.

As first reported in Hafner et al. (1990), students were defined in NELS:88 as at risk of school failure based on the research of Pallas, Natriello, and McDill (1989), who described an "educationally disadvantaged" child as one who has been exposed to certain background factors or experiences in formal schooling, family, or community. These factors, which are not wholly independent, have been associated with poor performance in school. The six NELS:88 indicators of at-risk status include living in a single-parent family, low parental education or income, limited English proficiency, having a brother or sister who dropped out of high school, and being at home alone as an 8th-grader without an adult for a period typically greater than 3 hours a day.

Twelfth-graders' NAEP-scaled performance was negatively associated with the number of risk factors—up to three such factors (table 3). No measurable differences were observed between students with three risk factors and students with four or more risk factors. More than half of students with one (56 percent) or no (73 percent) risk factors performed at the Basic or above levels. Forty-three percent of students with two risk factors, 31 percent of students with three risk factors, and 29 percent of students with four or more risk factors attained a Basic or above understanding of mathematics by the end of 12th grade.

2.3.2 Predictors and Correlates Derived From High School Transcripts

NELS:88 also included a high school transcript component. Transcripts were collected for a subsample of NELS:88 seniors in the fall of 1992, after most had graduated from high school. Data abstracted from high school transcripts included number of days absent, reason for leaving school (e.g., graduated with a regular diploma, aged out, dropped out, transferred), courses taken, credits received, and students' college entrance exam scores, among other information. Twelfth-grade NAEP periodically includes a transcript component as well (though there was no NAEP transcript study in 1992). In this section of the chapter, some of these transcript-based indicators of high school performance and predictors of postsecondary educational success are examined relative to seniors' NELS:88 performance as expressed in the 1992 NAEP mathematics metric.

Average Grades in Mathematics. High school seniors' mathematics GPA at the end of 1992 was positively related to their 1992 NELS:88 NAEP-scaled mathematics achievement.[21] The correlation between seniors' average GPA in mathematics and performance on the 1992 NELS:88 NAEP-scaled mathematics assessment was 0.59.

A majority (56 percent) of Proficient and above performers on the 1992 NAEP-scaled mathematics assessment maintained an "A" average in mathematics throughout high school. Some 20 percent of "B" students and 5 percent of "C" students reached the proficient or advanced levels.

High School Coursetaking. In the 1983 landmark publication *A Nation at Risk*,[22] the National Commission on Excellence in Education (NCEE) (1983) recommended a renewed emphasis on basic courses taught in high school. Specifically, the Commission recommended that:

> …at minimum, all students seeking a diploma be required to lay the foundations in the Five New Basics by taking the following curriculum during their four years of high school: (a) 4 years of English; (b) 3 years of mathematics; (c) 3 years of science; (d) 3 years of social studies; and (e) one-half year of computer science.

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[21] The NELS:88 1992 mathematics GPA transcript variable is positively related to performance on the 1992 NAEP-scaled mathematics assessment when the NELS:88 1992 GPA transcript variable is reverse-scored. See appendix A for details on the construction of variables used in this report.
[22] For a summary of school reform initiatives in place just prior to and at the time that the NELS:88 cohorts were tested and surveyed, see Rasinski et al. 1993. On state increases in graduation requirements, see Medrich et al. 1992.

> For the college-bound, 2 years of foreign language in high school are strongly recommended in addition to those taken earlier (Recommendation A).

Several categorical variables were developed from NELS:88 indicating whether students met or failed to meet New Basics thresholds. For the current report, the following threshold variable was used: at least four Carnegie units in English, three units in each of social studies, science, and mathematics, and two credits in foreign language in high school. This transcript-derived variable has two categories: (1) failed the threshold, and (2) met the threshold.

Looking at the percentages of students who met the threshold, 87 percent had a Basic or above understanding of mathematics by the end of 12th grade. More than half (60 percent) of students who met the threshold had a Basic understanding of mathematics, 24 percent understood mathematics at the Proficient level, and 3 percent understood it at the Advanced level. However, 13 percent of students meeting this New Basics threshold ended 12th grade with a below-Basic understanding of mathematics.

For students who did not meet this New Basic threshold, 50 percent ended 12th grade with a below-Basic understanding of mathematics, 43 percent understood mathematics at the Basic level, 7 percent at the Proficient level, and less than 1 percent (0.7 percent) at the Advanced level.

Highest Mathematics Courses Taken. While credit measures provide useful information about the *amount* of coursework that a student completed in high school, they offer little information about the *level* of the coursework that a student completed in high school. If two students took the same amount of coursework, yet one concentrated on low-level courses and another took courses at a higher level, the consequences for their learning could be quite different. Additionally, in terms of the present analysis, the relationship between coursetaking and achievement could be diluted. It is therefore useful to distinguish the coursetaking history of one student from another.

Using the NELS:88 data, Burkam and Lee (2003; Burkam 2003) developed a series of coursetaking measures—called "pipeline" measures—to capture coursetaking behaviors in terms of course content. The pipeline measures are built on the assumption that the student who completes more advanced-level coursework masters more difficult content and in turn has a greater understanding of the subject area. In this way, the pipeline measures are hypothesized to be better able to predict student achievement than course or Carnegie unit[23] counts alone.

Table 3 shows the percentages of NELS:88 students performing at the various levels of achievement on the NAEP scale by highest mathematics course taken. These percentages show a positive association between coursetaking and achievement. With few exceptions,[24] the higher the mathematics course students took the higher were students' NAEP-scaled mathematics

[23] 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 one year.
[24] No measurable differences were found between the mean scores of students who took "no math" and "low-academic math" or "middle-academic math I."

scores. The correlation between highest mathematics course taken and students' scores on the 1992 NAEP-scaled mathematics test was 0.74.

Of those who completed no more than non-academic mathematics (below the level of pre-algebra, such as general, basic, or technical mathematics), 95 percent scored below Basic, when their NELS:88 mathematics performance was expressed in NAEP-scaled terms and related to the NAEP achievement levels. On the other hand, of those seniors who had completed calculus, 55 percent scored at the Proficient level, and 13 percent at Advanced.

College Entrance Exams. Caveats must be entered concerning this measure. A selective and self-selected population takes college entrance exams. The test takers are not representative of a grade population, such as all 11th-graders or 12th-graders, although they may constitute a good sample of the college-bound. Second, not all NELS:88 transcript study schools recorded students' SAT or ACT scores. An SAT-M score was available for 82 percent of the 12th-grade cohort that reported taking the SAT-M, and an ACT Mathematics score was available for 81 percent of the 12th-grade cohort that reported taking the ACT Mathematics.

SAT-M. The correlation between the SAT-M and the 1992 NAEP-scaled mathematics score was 0.87. About 92 percent of NELS:88 seniors scoring between 200 and 300 on the 200-800 SAT-M scale fell below Basic in the NAEP achievement level metric. Fifty-eight percent of those scoring between 310 and 400 on the SAT-M were at the NAEP Basic level or above. Of those scoring at the highest SAT-M level—710 to 800—38 percent were Proficient and 59 percent Advanced.

ACT Mathematics. A similar pattern of performance is observed for the ACT Mathematics college entrance exam. The correlation between ACT Mathematics and the 1992 NAEP-scaled mathematics assessment was 0.83.

The majority of students who scored between 6 and 15 on the ACT Mathematics—the two lowest categories[25]—exhibited a level of NELS:88 performance below Basic on the 1992 NAEP mathematics scale. All students (100 percent) scoring between 6 and 10 on the ACT Mathematics and 75 percent of students scoring between 11 and 15 on the ACT Mathematics performed below Basic in the 1992 NAEP-scaled mathematics metric. Students' mean scores reflect the distribution of percentages performing at the various levels on the NAEP scale.

The majority of students scoring between 26 and 36—the highest category on the ACT Mathematics test—performed at the Proficient or the Advanced levels. Three-fourths (75 percent) of NELS:88 examinees scoring between 26 and 30 on the ACT Mathematics and 97 percent of NELS:88 examinees scoring between 31 and 36 on the ACT Mathematics performed at the Proficient or above levels on the 1992 NAEP mathematics scale. Among students who scored between 31 and 36 on the ACT Mathematics, 51 percent ended 12th grade with a NAEP-

[25] The lowest scoring category for the ACT Mathematics assessment is 1 to 5, and no NELS:88 senior with a NAEP-scaled mathematics score was at this level.

scaled Proficient understanding of mathematics and 46 percent ended 12th grade with a NAEP-scaled Advanced understanding of mathematics.

2.4 Logistic Regression Analysis

The results of the bivariate analyses reported in the previous sections found all 1992 senior cohort student, background, and academic characteristics examined related to NAEP-scaled assessment results, with two exceptions: students' sex and "urbanicity" (whether urban, suburban, or rural) of their high school. This section of the chapter reports results of a series of logistic regression analyses. These analyses examine whether each of these student, family, and high school characteristics continues to be related to performance in the 1992 NAEP-scaled mathematics metric, after controlling for selected background and academic characteristics.

Three separate logistic regressions were conducted on three dichotomous outcomes to identify the factors that differentiate adjacent levels of performance on the NAEP mathematics assessment:[26] (1) Basic level performance from below Basic level performance, (2) Proficient level from Basic level, and (3) Advanced level from Proficient level. The results of the three separate analyses are reported in table 4. The student, family, and high school factors examined are: sex, race/ethnicity, socioeconomic status, students' educational expectations, risk of school failure, prior achievement in mathematics, type of high school attended (e.g., public, private), urbanicity of high school, high school mathematics GPA, completion of the New Basics curriculum, and highest mathematics courses taken. All factors were entered simultaneously for these analyses. The results of all logistic regressions are presented in terms of odds ratios, because outcomes examined with logistic regression are binary or dichotomous. More specifically, the odds ratio is the ratio of the odds that X *will occur* versus *not occur* given a unit change in the independent variable. For the analysis examining the dichotomous outcome variable of performance at the Basic level on the NELS:88 NAEP-scaled mathematics assessment versus performance at the below-Basic level, the odds ratio is the ratio of the odds of a particular subgroup performing at the Basic level (versus performing at the below-Basic level) to the odds of a reference group performing at the Basic level (versus performing at the below-Basic level). An odds ratio of greater than 1 indicates an increase in the odds of a particular subgroup performing at the Basic level relative to odds of a reference subgroup performing at the Basic level; an odds ratio of less than 1 indicates a decrease in the odds of one subgroup relative to the odds of a reference subgroup of performing at the Basic level on the NELS:88 NAEP-scaled mathematics assessment.

For example in table 4, for the outcome comparing the odds associated with performing at the Basic versus the below-Basic level, after taking all other factors into account, the odds ratio of 1.27 for students attending Catholic high schools indicates that the odds of performing at

[26] The use of *j* – 1 adjacent pairwise logistic regressions to explain a dependent variable with *j* categories is sometimes termed "adjacent category logit." For more information on this model, see Powers and Xie (2000) and Agresti (2002).

the Basic level for Catholic high school students are 1.27 as large as the odds of performing at the Basic level for public high school students (the reference group in the model). Another way to interpret odds ratios is as follows: holding all other factors constant (e.g., SES, future educational expectations), the odds of performing at the Basic level for Catholic high school students is 27 percent higher than the odds of performing at the Basic level for public high school students [computed: (odds ratio – 1) * 100].

Table 4. Coefficients, standard errors, and odds ratios from logistic regression analysis of 1992 12th-grade NAEP-scaled mathematics proficiency levels, by selected student and school characteristics and high school performance: 1992

	Basic vs. below basic			Proficient vs. basic			Advanced vs. proficient		
Characteristic	Co-efficient	SE	Odds ratio	Co-efficient	SE	Odds ratio	Co-efficient	SE	Odds ratio
Constant	-7.82	0.44	†	-13.27	0.66	†	-20.98	2.43	†
Female	-0.41*	0.10	0.66	-0.71*	0.11	0.49	-0.90*	0.19	0.41
Race/ethnicity									
Black	-0.23	0.18	0.79	-0.42	0.29	0.66	-2.15	1.14	0.12
Hispanic	-0.39*	0.16	0.68	0.14	0.27	1.15	-0.25	0.55	0.78
Asian	-0.12	0.20	0.89	0.37*	0.18	1.45	0.55*	0.25	1.73
Socioeconomic status	-0.01	0.12	.99	0.17*	0.09	1.19	0.35	0.19	1.42
Students' educational expectations[1]	0.14*	0.04	1.15	0.20*	0.08	1.22	0.81*	0.23	2.25
Risk of school failure[2]	-0.45	0.31	0.64	0.02	0.09	1.02	0.05	0.19	1.05
8th-grade NELS:88 mathematics test score	0.18*	0.01	1.20	0.17*	0.01	1.19	0.16*	0.02	1.17
School type in 12th grade									
Catholic high school	0.24	0.20	1.27	0.27	0.23	1.31	0.38	0.52	1.46
NAIS high school	-0.07	0.47	0.93	0.56	0.40	1.75	-0.10	0.41	0.90
Other private high school	-0.66	0.47	0.52	0.45	0.45	1.57	0.25	0.63	1.28
Urbanicity									
Suburban high school in 12th grade	0.14	0.14	1.15	-0.08	0.16	0.92	0.51	0.40	1.67
Rural high school in 12th grade	0.30*	0.15	1.35	0.04	0.18	1.04	0.39	0.42	1.48
High school GPA in mathematics	-0.14*	0.02	0.87	-0.24*	0.03	0.79	-0.41*	0.07	0.66
New basics course counts	0.56*	0.14	1.75	0.07	0.13	1.07	0.04	0.24	1.04
Highest mathematics courses taken in high school	0.64*	0.05	1.90	0.74*	0.06	2.10	0.85*	0.20	2.34

† Not applicable.

* $p < .05$.

[1] Students' educational expectations as of 12th grade in 1992.

[2] Risk of school failure as identified in 8th grade, 1988.

NOTE: Male is the omitted category for sex. White is the omitted category for race/ethnicity. Results for American Indians have been suppressed because of their low sample size. Public school is the omitted category for 1992 high school type. Urban school is the omitted category for high school location. Failed to take 4 years of English; 3 years each of mathematics, science, and social studies; and 2 years of a foreign language is the omitted category for the New Basics course counts. An odds ratio greater than 1 indicates a greater likelihood of an occurrence or outcome, and a ratio of less than 1 indicates a lesser likelihood of an occurrence or outcome; 1.0 would represent equal likelihood of the occurrence or outcome for both groups being compared. Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or other Pacific Islander, and American Indian includes Alaska Native. Race categories exclude Hispanic origin unless specified. NAIS = National Association of Independent Schools.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), "Base Year Student Survey, 1988;" and "Second Follow-up Student Survey, 1992."

Table 4 shows that six predictors consistently differentiated student performance at the various levels of proficiency; that is, between students performing at the Basic level versus the below-Basic level, between students performing at the Proficient level compared to the Basic level, and between students performing at the Advanced level compared to the Proficient level. For all three logistic regressions, the following factors differentiated higher performing students from lower performing students:

- sex,
- race/ethnicity,
- future educational expectations,
- 8th-grade mathematics achievement,
- high school GPA in mathematics, and
- highest mathematics course taken in high school.

Across all regressions (i.e., comparisons), female seniors' odds of performing at higher NAEP achievement levels were lower than male seniors' odds. The odds of performing at the Basic versus the below-Basic level for females were 34 percent lower than the odds of performing at the Basic versus the below-Basic level for males (the reference subgroup in the model). Similarly, the odds of performing at the Proficient versus the Basic level and the Advanced versus the Proficient level for females were 51 percent and 59 percent lower, respectively, than the odds of performing at the Proficient versus the Basic level and the Advanced versus the Proficient level for males.

After controlling for all other variables in the equation, the odds of performing at the Basic level versus the below-Basic level for Hispanic seniors were 32 percent lower than the odds of performing at the Basic level versus the below-Basic level for White seniors (the reference subgroup in the model). Compared to White 12th-graders, the odds of performing at the Proficient level versus the Basic level for Asian 12th-graders were 45 percent higher. Also compared to White high school seniors, the odds of performing at the Advanced level versus the Proficient level were 73 percent higher for Asian seniors.

High school seniors' future educational expectations were related positively and consistently to NAEP achievement level performance on the NELS:88 mathematics assessment. With each unit increase in seniors' future educational expectations (a unit increase is moving from expecting a high school diploma or less education to some trade/vocational/business school, to a professional/trade school certificate/degree, to some college, to a bachelor's degree, and finally, a graduate degree), the odds associated with performing at the higher level of proficiency increased. The odds of performing at the Basic versus the below-Basic level increased 15 percent with each unit change in seniors' future educational expectations, 22 percent for the odds associated with performing at the Proficient versus the Basic level, and 125 percent for the odds associated with performing at the Advanced versus the Proficient level.

Similarly, with each unit increase in seniors' 8th-grade mathematics achievement (a unit increase here is an additional item correct on the NELS:88 8th-grade mathematics assessment), the odds of performing at the Basic level versus the below-Basic level increased 20 percent; 19

percent for the odds associated with performing at the Proficient versus the Basic level; and 17 percent for the odds associated with performing at the Advanced versus Proficient level.

Three high school coursework factors were consistently related to performance at the various levels of proficiency. The three factors were (1) seniors' high school GPA in mathematics; (2) highest level of mathematics courses taken in high school; and (3) completion of a New Basics curriculum. With each unit increase in mathematics GPA—moving from an "A+" (coded in the dataset as 1.00) to an "F" (coded in the dataset as a 13.00)—the odds of performing at the Basic versus below-Basic level decreased 13 percent, the odds of performing at the Proficient versus the Basic level decreased 21 percent, and the odds of performing at the Advanced versus the Proficient level decreased 34 percent.[27]

Mathematics coursetaking is associated with achievement.[28] With each unit increase in level of mathematics courses taken (moving from no mathematics to non-academic to low to the two levels of middle mathematics and the three levels of advanced mathematics):

- the odds of performing at the Basic versus the below-Basic level of proficiency increased 90 percent,
- the odds of performing at the Proficient versus the Basic level increased 110 percent, and
- the odds of performing at the Advanced versus the Proficient level on the NELS:88 NAEP-scaled 12th-grade mathematics assessment increased 134 percent.

Completion of a New Basics curriculum is also associated with achievement. The odds of attaining a Basic level of understanding mathematics versus a below-Basic understanding for seniors who completed the New Basics curriculum—4 years of English; 3 years each of mathematics, science, and social studies; and 2 years of a foreign language—were 75 percent higher than the odds of attaining a Basic level of understanding of mathematics for seniors who did not complete this curriculum (the reference subgroup).

Two additional factors differentiated lower performing students from higher performing students, but not consistently. The factors were SES and urbanicity (suburban, urban, rural) of students' high school.

With each unit increase in SES (a unit is a point on the SES scale, which runs from -3.24 to 2.75, with a mean of 0 and a standard deviation of 1 for the 12th-grade cohort), the odds of performing at the Proficient versus the Basic achievement level on the NELS:88 NAEP-scaled 12th-grade mathematics assessment increased 19 percent. In the current regression, students'

[27] The continuous GPA variable is reversed coded on the NELS:88 data files. A numerical value of 1.00 is equal to an "A+," and the numerical value of 13.00 is equal to an "F." Hence, the results are reported in the negative or in the reversed direction.
[28] For other discussions of the associations between mathematics coursetaking and achievement, see Bozick and Ingels 2007; Chaney, Burgdorf, and Atash 1997; Hoffer, Rasinski, and Moore 1995; Leow et al. 2004; Ma 2001; and Rock and Pollack 1995b.

SES was not associated with any other levels of performance on the 12th-grade mathematics assessment.

The results also show that the odds of performing at the Basic versus the below-Basic level for seniors attending rural schools were 35 percent higher than the odds of performing at the Basic versus the below-Basic level for seniors attending urban schools (the reference subgroup).

2.5 Conclusion

Multiple regression analyses found six factors examined in the bivariate cross-tabulations consistently differentiated higher proficiency performers from lower-proficiency performers. The six factors were students' sex, race/ethnicity, future educational expectations, 8th-grade mathematics achievement, high school GPA in mathematics, and highest level of mathematics courses taken.

The results suggest that high levels of mathematics coursework are associated with higher levels of achievement in the NAEP metric.[29] In addition to potentially alterable factors such as course completion, background characteristics such as race/ethnicity and SES were also associated with achievement level. Indeed, seniors' race/ethnicity differentiated Basic performers from below-Basic performers, Proficient performers from Basic performers, and Advanced performers from Proficient performers. Students' SES differentiated Proficient performers from Basic performers only.

In the next chapter the relationship between performance on the 1992 NELS:88 NAEP-scaled mathematics assessment and postsecondary educational outcomes is explored.

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[29] Once more, readers are reminded that the data presented here do not provide an adequate basis for inference to an underlying cause. The association demonstrated between mathematics coursework and achievement, for example, leaves completely open the question of the degree to which coursetaking may foster achievement as opposed to being an artifact of self-selection (through which students who have higher aptitude in mathematics [and hence higher test scores] might be likely to take more, or harder, mathematics courses).

Chapter 3
Student NAEP-Scaled Mathematics Performance and Postsecondary Outcomes

This chapter provides a descriptive profile of the postsecondary educational outcomes of 1992 high school seniors 2 and 8 years after graduation. It includes information on both their NAEP-scaled 1992 mathematics scores and eight additional characteristics: highest mathematics course taken in high school, average mathematics grade in high school, average grade in English, 8th-grade mathematics score, educational expectations, socioeconomic status, race/ethnicity, and sex. These eight characteristics are examined in relation to postsecondary enrollment by 1994 and three outcomes in 2000: educational attainment, college remedial mathematics enrollment, and academic selectivity of the first postsecondary institution attended. The tables in this section describe simple bivariate relationships with no controls for covarying factors.

3.1 Two Years After High School

Table 5 contrasts those 1992 seniors who had gone on to postsecondary education in the 2-year period after high school graduation with those who had not. For those who had gone on, information is provided (based on institution of first attendance) about whether they attended a 4-year, a 2-year, or a sub-associate or other 2-year school.

Postsecondary education enrollment status by 1994 is examined in light of NELS:88 1992 NAEP-scaled mathematics results as well as the additional eight factors listed above. Overall, some 28 percent of the senior cohort had not gone on to postsecondary education. Some 72 percent had enrolled in a postsecondary institution, or more specifically, 43 percent of the cohort had attended a 4-year school, 25 percent a 2-year school, and 4 percent a sub-associate/ other 2-year school.

Table 5 shows an association between NELS:88 NAEP-scaled 1992 grade 12 mathematics results and various postsecondary education enrollment statuses in 1994. For those with NAEP-scaled performance at less than Basic, some 46 percent had had no postsecondary attendance 2 years later. In contrast, 2 percent of those who scored at Advanced and 5 percent of those at the Proficient level registered no postsecondary enrollment. Some 98 percent of those who scored at Advanced had entered a postsecondary institution; indeed, for the Advanced group, 94 percent had enrolled in a 4-year postsecondary institution within 2 years of senior year, and 4 percent a 2-year school. About 84 percent of those at the Proficient level recorded 4-year postsecondary attendance.

Table 5. Percentage of 1992 high school seniors attending postsecondary school, by selected student characteristics: 1994

	First postsecondary school of attendance			
Student characteristic	No postsecondary education	4-year school	2-year school	Sub-associate/ other 2-year school
All students	27.9	42.7	25.1	4.3
12th-grade NAEP-scaled proficiency score				
Below basic	46.4	16.5	30.5	6.6
Basic[1]	17.6	52.7	26.4	3.3
Proficient[1]	5.3	83.9	9.5	1.3
Advanced[1]	2.4	93.7	2.2	1.7
Highest mathematics course taken in high school[2]				
No mathematics	80.4	8.5	7.2	3.9
Non-academic	68.0	4.2	22.8	4.9
Low-academic	56.3	6.7	29.2	7.7
Middle-academic I	42.3	15.6	35.4	6.7
Middle-academic II	21.4	43.1	31.1	4.3
Advanced-mathematics I	11.2	63.5	22.6	2.7
Advanced-mathematics II (pre-calculus)	4.7	79.7	14.1	1.6
Advanced-mathematics III (calculus)	3.9	87.9	7.4	0.8
Average grade in mathematics				
D or below	46.4	17.5	30.0	6.2
C	30.7	33.9	30.5	5.0
B	17.1	57.9	21.9	3.0
A	6.7	80.3	11.3	1.7
Average grade in English				
D or below	64.7	9.2	21.0	5.1
C	36.2	25.9	32.2	5.6
B	15.5	55.3	25.5	3.7
A	4.7	80.3	13.3	1.6
8th-grade mathematics achievement				
Lowest quarter	50.2	15.9	26.4	7.6
Middle-low quarter	35.2	28.0	31.7	5.2
Middle-high quarter	24.0	46.4	26.0	3.6
Highest quarter	9.4	71.7	16.8	2.1
12th-grade educational expectations				
High school or less	89.0	1.4	8.0	1.6
Some vocational/trade/business school	68.8	2.4	20.2	8.5
Trade school certificate/degree	53.3	5.2	27.1	14.3
Some college	41.9	12.0	37.2	8.9
Bachelor's degree	14.5	54.1	28.8	2.6
Graduate/professional degree	10.1	68.6	19.6	1.7

See notes at end of table.

Table 5. Percentage of 1992 high school seniors attending postsecondary school, by selected student characteristics: 1994—Continued

	First postsecondary school of attendance			
Student characteristic	No postsecondary education	4-year school	2-year school	Sub-associate/ other 2-year school
Socioeconomic status				
Lowest quarter	51.5	19.2	24.0	5.3
Middle-low quarter	36.4	28.6	30.0	4.9
Middle-high quarter	23.2	45.2	27.4	4.2
Highest quarter	8.3	68.9	19.7	3.1
Race/ethnicity[3]				
White	26.1	45.3	24.5	4.1
Black	35.4	38.0	21.2	5.4
Hispanic	35.3	27.9	31.8	4.9
Asian	15.2	51.6	29.5	3.7
American Indian	46.1	22.6	29.0	2.4
Sex				
Male	31.5	40.1	24.8	3.6
Female	24.3	45.3	25.4	5.0

[1] Basic-level students demonstrate procedural and conceptual knowledge in solving problems; Proficient-level students consistently integrate mathematical concepts and procedures to the solutions of more complex problems; Advanced-level students consistently demonstrate the integration of procedural and conceptual knowledge and the synthesis of ideas.

[2] Non-academic mathematics courses are such courses as general mathematics I, general mathematics II, basic mathematics I, and technical mathematics. Low academic mathematics courses are such courses as pre-algebra, algebra I-part 1, algebra II-part 2, and informal geometry. Middle academic mathematics courses are such courses as algebra I, plane geometry, unified mathematics I, algebra II, and unified mathematics III. Advanced mathematics courses are such courses as algebra II, college algebra, probability and statistics, introductory analysis, calculus, and AP mathematics.

[3] Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or other Pacific Islander, and American Indian includes Alaska Native. Race categories exclude Hispanic origin unless specified.

NOTE: Details 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), “Base Year Student Survey, 1988”; “Second Follow-up Student Survey, 1992”; “Third Follow-up Student Survey, 1994.”

3.2 Eight Years After High School

Tables 6 through 8 examine status in 2000, about 8 years after the cohort’s high school graduation. The statuses examined include: highest level of educational attainment (table 6), enrollment in postsecondary remedial mathematics (table 7) and selectivity of first institution attended (table 8). Tables 6 through 8 pertain only to those students who had enrolled in a postsecondary institution by 2000 (79 percent of the total senior cohort had some enrollment by 2000, and about 35 percent of the total cohort had obtained a bachelor’s degree).

Table 6 relates 1992 senior cohort characteristics to the educational qualification attained by 2000 (for those members of the cohort who went on to postsecondary school). Overall, 45 percent of the ever-enrolled cohort members held a bachelor’s degree in 2000, 42 percent of the ever-enrolled had achieved no degree or certificate of any kind, 5 percent held a certificate, and 8 percent had an associate’s degree. Over 91 percent of NELS:88 seniors at the Advanced level for NAEP-scaled mathematics performance had earned a bachelor’s degree or higher, compared to 18 percent of the below-Basic group, 50 percent of those at Basic, and 79 percent of those at the Proficient level.

Table 6. Percentage of 1992 high school seniors who attended postsecondary school, by highest degree attained and selected student characteristics: 2000

Student characteristic	Highest degree attained: No degree	Certificate	Associate's degree	Bachelor's degree or higher
All students	42.1	4.9	8.1	44.9
12th-grade NAEP-scaled proficiency score				
Below basic	61.6	9.9	10.5	18.0
Basic[1]	37.7	3.8	9.0	49.5
Proficient[1]	18.1	0.4	2.5	79.0
Advanced[1]	7.5	0.2	1.3	91.1
Highest mathematics course taken in high school[2]				
No mathematics	71.0	9.2	13.1	6.7
Non-academic	75.7	13.6	7.0	3.7
Low academic	75.4	11.6	5.7	7.3
Middle academic I	61.9	9.7	12.4	16.0
Middle academic II	47.7	6.1	11.7	34.6
Advanced academic I	27.5	2.3	6.8	63.4
Advanced academic II (pre-calculus)	19.5	1.0	5.2	74.3
Advanced academic III (calculus)	16.2	0.4	2.3	81.1
Average grade in mathematics				
D or below	69.6	7.3	8.1	15.0
C	50.7	7.3	9.9	32.1
B	29.5	3.3	8.7	58.4
A	12.8	1.0	3.8	82.3
Average grade in English				
D or below	79.1	8.9	6.2	5.8
C	59.3	8.6	9.2	23.0
B	32.2	3.7	10.1	53.9
A	15.2	0.9	3.9	80.0
8th-grade mathematics achievement level				
Lowest quarter	67.0	8.4	8.5	16.1
Middle-low quarter	52.0	7.4	10.9	29.7
Middle-high quarter	42.1	4.5	9.8	43.6
Highest quarter	26.3	1.7	5.0	67.0
12th-grader's educational expectations				
High school or less	68.3	12.8	8.7	10.3
Some vocational/trade/business school	62.0	17.8	15.9	4.2
Trade school certificate/degree	56.5	20.4	20.5	2.6
Some college	62.0	8.6	16.0	13.3
Bachelor's degree	42.1	3.3	7.1	47.5
Graduate/professional degree	29.2	2.2	4.9	63.7

See notes at end of table.

Table 6. Percentage of 1992 high school seniors who attended postsecondary school, by highest degree attained and selected student characteristics: 2000—Continued

	Highest degree attained			
Student characteristic	No degree	Certificate	Associate's degree	Bachelor's degree or higher
Socioeconomic status				
Lowest quarter	59.1	11.4	11.6	17.9
Middle-low quarter	51.8	6.2	12.9	29.0
Middle-high quarter	45.5	4.1	8.1	42.4
Highest quarter	26.3	2.1	4.1	67.4
Race/ethnicity[3]				
White	37.3	4.9	8.5	49.2
Black	59.2	5.4	5.0	30.4
Hispanic	62.9	5.0	8.3	23.8
Asian	37.2	4.6	7.9	50.3
American Indian	74.3	1.4	7.0	17.4
Sex				
Male	47.6	3.8	7.4	41.2
Female	37.2	5.9	8.7	48.2

[1] Basic-level students demonstrate procedural and conceptual knowledge in solving problems; Proficient-level students consistently integrate mathematical concepts and procedures to the solutions of more complex problems; Advanced-level students consistently demonstrate the integration of procedural and conceptual knowledge and the synthesis of ideas.

[2] Non-academic mathematics courses are such courses as general mathematics I, general mathematics II, basic mathematics I, and technical mathematics. Low academic mathematics courses are such courses as pre-algebra, algebra I-part 1, algebra II-part 2, and informal geometry. Middle academic mathematics courses are such courses as algebra I, plane geometry, unified mathematics I, algebra II, and unified mathematics III. Advanced mathematics courses are such courses as algebra II, college algebra, probability and statistics, introductory analysis, calculus, and AP mathematics.

[3] Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or other Pacific Islander, and American Indian includes Alaska Native. Race categories exclude Hispanic origin unless specified.

NOTE: Details 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:88/2000), "Postsecondary Education Transcript Study (PETS), 2000."

Table 7 looks at the number of remedial mathematics courses taken—whether 0, 1, 2, or 3 or more. While over 99 percent of those who reached the NAEP Advanced proficiency level took no remedial courses, 45 percent of those at less than Basic took no remedial courses.

Table 7. Percentage of 1992 high school seniors who attended postsecondary school, by number of remedial mathematics courses taken and selected student characteristics: 2000

Student characteristic	Number of remedial mathematics courses taken			
	0	1	2	3 or more
All students	72.7	15.8	6.8	4.7
12th-grade NAEP-scaled proficiency score				
Below basic	45.0	24.8	16.2	14.0
Basic[1]	79.1	14.7	4.3	1.9
Proficient[1]	97.8	2.0	0.2	#
Advanced[1]	99.4	0.6	#	#
Highest mathematics course taken in high school[2]				
No mathematics	72.1	4.9	#	23.0
Non-academic	38.3	23.5	18.6	19.6
Low academic	50.7	22.4	10.7	16.1
Middle academic I	46.2	27.3	14.8	11.7
Middle academic II	66.6	22.2	6.8	4.4
Advanced academic I	84.6	10.8	3.0	1.6
Advanced academic II (pre-calculus)	91.7	5.9	2.3	0.2
Advanced academic III (calculus)	99.0	0.9	#	#
Average grade in mathematics				
D or below	45.8	26.5	13.7	14.0
C	62.5	22.6	9.1	5.7
B	85.4	9.5	3.0	2.2
A	95.8	3.2	0.7	0.2
Average grade in English				
D or below	52.2	23.0	13.1	11.7
C	56.2	25.2	9.2	9.4
B	78.5	13.1	5.8	2.6
A	94.1	4.2	1.2	0.4
8th-grade mathematics achievement level				
Lowest quarter	42.6	24.6	18.0	14.8
Middle-low quarter	57.0	23.0	11.4	8.5
Middle-high quarter	73.1	17.9	6.1	2.9
Highest quarter	92.5	6.2	1.0	0.3
12th-grader's educational expectations				
High school or less	54.7	37.9	6.1	1.4
Some vocational/trade/business school	59.3	25.7	10.6	4.4
Trade school certificate/degree	64.7	21.6	10.2	3.6
Some college	54.4	22.0	16.0	7.6
Bachelor's degree	72.7	16.4	6.0	4.9
Graduate/professional degree	82.9	10.3	3.5	3.4

See notes at end of table.

Table 7. Percentage of 1992 high school seniors who attended postsecondary school, by number of remedial mathematics courses taken and selected student characteristics: 2000—Continued

Student characteristic	Number of remedial mathematics courses taken			
	0	1	2	3 or more
Socioeconomic status				
Lowest quarter	56.4	22.3	13.9	7.5
Middle-low quarter	66.1	21.0	7.5	5.5
Middle-high quarter	72.0	15.7	6.6	5.6
Highest quarter	83.3	10.2	4.0	2.5
Race/ethnicity[3]				
White	77.2	14.4	5.2	3.2
Black	56.7	21.9	10.7	10.7
Hispanic	51.8	21.8	15.1	11.3
Asian	78.0	10.6	7.9	3.4
American Indian	60.0	14.7	10.6	14.7
Sex				
Male	72.7	16.1	6.5	4.7
Female	72.8	15.5	7.1	4.7

Rounds to zero.

[1] Basic-level students demonstrate procedural and conceptual knowledge in solving problems; Proficient-level students consistently integrate mathematical concepts and procedures to the solutions of more complex problems; Advanced-level students consistently demonstrate the integration of procedural and conceptual knowledge and the synthesis of ideas.

[2] Non-academic mathematics courses are such courses as general mathematics I, general mathematics II, basic mathematics I, and technical mathematics. Low academic mathematics courses are such courses as pre-algebra, algebra I-part 1, algebra II-part 2, and informal geometry. Middle academic mathematics courses are such courses as algebra I, plane geometry, unified mathematics I, algebra II, and unified mathematics III. Advanced mathematics courses are such courses as algebra II, college algebra, probability and statistics, introductory analysis, calculus, and AP mathematics.

[3] Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or other Pacific Islander, and American Indian includes Alaska Native. Race categories exclude Hispanic origin unless specified.

NOTE: Details 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:88/2000), "Postsecondary Education Transcript Study (PETS), 2000."

Table 8 examines selectivity of postsecondary institution first attended. Three percent of postsecondary attendees in the senior cohort enrolled at highly selective institutions and 13 percent at selective institutions. Non-selective institutions were attended by 42 percent, and 42 percent were enrolled at open-door institutions.

Of those NELS:88 seniors who scored at the NAEP Advanced mathematics level, 72 percent enrolled in either highly selective (32 percent) or selective (40 percent) postsecondary institutions. Of those who scored at less-than-Basic or Basic, about 1 percent of each of these two groups had enrolled in highly selective institutions, while 9 percent of those at the Proficient level did so.

Table 8. Percentage of 1992 high school seniors who attended postsecondary school, by selectivity of first postsecondary school attended and selected student characteristics: 2000

Student characteristic	Selectivity of first postsecondary school attended			
	Highly selective	Selective	Non-selective	Open-door
All students	3.4	12.7	41.6	42.3
12th-grade NAEP-scaled proficiency score				
Below basic	1.2	2.5	27.9	68.4
Basic[1]	0.7	11.4	49.3	38.6
Proficient[1]	9.1	31.2	48.9	10.9
Advanced[1]	32.2	40.1	25.0	2.7
Highest mathematics course taken in high school[2]				
No mathematics	#	#	38.1	61.9
Non-academic	0.6	#	10.8	88.6
Low academic	#	#	16.1	83.9
Middle academic I	0.7	1.7	22.9	74.7
Middle academic II	1.3	6.5	44.8	47.4
Advanced academic I	1.5	15.3	53.7	29.5
Advanced academic II (pre-calculus)	2.9	22.5	58.2	16.4
Advanced academic III (calculus)	14.0	35.2	43.3	7.5
Average grade in mathematics				
D or below	1.2	1.3	27.8	69.7
C	0.5	5.7	39.8	53.9
B	2.9	18.7	48.6	29.8
A	11.5	28.8	46.3	13.4
Average grade in English				
D or below	#	0.5	23.7	75.8
C	0.9	3.1	34.1	61.8
B	1.9	16.1	47.1	34.9
A	10.0	25.7	49.5	14.8
8th-grade mathematics achievement level				
Lowest quarter	#	1.7	29.0	69.3
Middle-low quarter	0.1	3.4	38.2	58.3
Middle-high quarter	1.1	9.2	49.5	40.3
Highest quarter	7.1	23.7	48.1	21.1
12th-grader's educational expectations				
High school or less	#	1.0	9.8	89.3
Some vocational/trade/business school	#	0.9	19.2	79.9
Trade school certificate/degree	#	0.8	12.7	86.6
Some college	#	1.6	19.9	78.5
Bachelor's degree	1.3	9.7	49.9	39.1
Graduate/professional degree	7.0	22.4	46.4	24.2
Socioeconomic status				
Lowest quarter	1.1	4.2	33.3	61.5
Middle-low quarter	0.6	5.7	36.2	57.6
Middle-high quarter	2.2	8.7	43.7	45.5
Highest quarter	6.5	23.4	46.6	23.5

See notes at end of table.

Table 8. Percentage of 1992 high school seniors who attended postsecondary school, by selectivity of first postsecondary school attended and selected student characteristics: 2000—Continued

Student characteristic	Selectivity of first postsecondary school attended			
	Highly selective	Selective	Non-selective	Open-door
Race/ethnicity[3]				
White	2.6	13.7	43.8	39.9
Black	4.3	8.0	42.9	44.8
Hispanic	2.9	8.3	30.3	58.5
Asian	11.6	16.5	32.1	39.8
American Indian	#	7.2	31.6	61.2
Sex				
Male	3.8	12.7	39.2	44.3
Female	3.1	12.8	43.8	40.4

Rounds to zero.

[1] Basic-level students demonstrate procedural and conceptual knowledge in solving problems; Proficient-level students consistently integrate mathematical concepts and procedures to the solutions of more complex problems; Advanced-level students consistently demonstrate the integration of procedural and conceptual knowledge and the synthesis of ideas.

[2] Non-academic mathematics courses are such courses as general mathematics I, general mathematics II, basic mathematics I, and technical mathematics. Low academic mathematics courses are such courses as pre-algebra, algebra I-part 1, algebra II-part 2, and informal geometry. Middle academic mathematics courses are such courses as algebra I, plane geometry, unified mathematics I, algebra II, and unified mathematics III. Advanced mathematics courses are such courses as algebra II, college algebra, probability and statistics, introductory analysis, calculus, and AP mathematics.

[3] Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or other Pacific Islander, and American Indian includes Alaska Native. Race categories exclude Hispanic origin unless specified.

NOTE: Details 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:88/2000), “Postsecondary Education Transcript Study (PETS), 2000.”

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Appendix A
Technical Notes and Glossary

A.1 Overview: NAEP and NELS:88

The National Assessment of Educational Progress (NAEP), also known as the Nation's Report Card, has been conducted since 1969. Sponsored by the National Center for Education Statistics (NCES), it includes both a main (or national) NAEP and a long-term trend NAEP that separately tracks changes over time. Since 1990, NAEP has also been conducted at the state level. NAEP's aim is to provide a comprehensive measure of learning at critical junctures in students' school experience—specifically (for the main NAEP) at grades 4, 8, and 12. NAEP reports information at the national and group level (sub-national and group-level estimates include, for example, results for different regions of the country, for males and females, and for race/ethnicity groups). Periodic assessments have been conducted in reading, mathematics, science, writing, U.S. history, civics, geography, and the arts. These assessments follow frameworks developed by the National Assessment Governing Board.

An introduction to the background and purposes of NAEP is provided by *The NAEP Guide* (Horkay 1999). This guide also includes information on assessment development, scoring and reporting, using NAEP data, and NAEP's sampling and data collection methodology. Detailed history of NAEP is supplied by Jones and Olkin (2004). For further information about the specific NAEP assessment (the national NAEP 1992 mathematics assessment) to which NELS:88 has been linked, see Johnson and Carlson (1994) and Loomis and Bourque (2001).

The National Education Longitudinal Study of 1988 (NELS:88) is one of a series of high school longitudinal studies conducted, like NAEP, by NCES. NCES has collected longitudinal data for over 30 years. Starting in 1972 with the National Longitudinal Study of 1972 (NLS-72), and continuing to the most recent study, the Education Longitudinal Study of 2002 (ELS:2002), NCES collects and provides longitudinal data to education policymakers and researchers that link secondary school educational experiences with important future outcomes such as labor market experiences and postsecondary education enrollment and attainment.

Initiated in 1988 as the third in NCES's series of decade-long secondary school longitudinal studies, NELS:88 began with the eighth-grade class of 1988 (base year). Along with the student survey, NELS:88 included surveys of parents, teachers, and school administrators. The study also administered assessments in reading, mathematics, science, and social studies (history/geography/civics) to the sample members. High school transcripts for the sample members were collected in 1992; postsecondary education transcripts were collected in the autumn of 2000 and early 2001. NELS:88 followed this eighth-grade cohort over time, but also "freshened" the sample at each of the first two follow-up studies.[1] Thus, 10th- and 12th-grade cohorts were represented in NELS:88, respectively, in the first follow-up (1990) and second follow-up (1992) surveys. While the NELS:88 sample contains three cohorts—8th-, 10th-, and 12th-grade—the analysis population for this report was the senior (12th-grade) cohort only.

[1] The process referred to here as "freshening" added 1990 sophomores and 1992 seniors who were not in the base-year sampling frame, either because they were not in the country or because they were not in eighth grade in the spring term of 1988. The 1990 freshening process provided a representative sample of students enrolled in 10th grade in the spring of 1990 comparable to the High School and Beyond (HS&B) 1980 sophomore cohort. The 1992 freshening process (see Ingels et al. 1994 for method and details) provided a similar sample of 12th-grade students in the spring of 1992 that is comparable to the National Longitudinal Study of the High School Class of 1972 (NLS-72) seniors and to the 1980 HS&B senior cohort, as well as 1992 12th-grade NAEP.

Analyses in this report are based on implementing the NAEP scale within the NELS:88 second follow-up so that NELS:88 mathematics test scores could be expressed in the NAEP score metric. The second follow-up took place in the spring term of the 1991–1992 school year, when most sample members were in their senior year. Analyses in this report are based on the subset of cases that are nationally representative of the nation's spring term 1992 high school seniors. The second follow-up provided a capstone measurement of learning in the course of secondary school, and also collected information to help investigate students' transition into the labor force and postsecondary education. In addition to surveying the students who were in school during the first follow-up, the NELS:88 second follow-up re-surveyed students who were identified as dropouts in 1990, and identified and surveyed those additional students who dropped out after the first follow-up. For a comprehensive account of the NELS:88 second follow-up, see Ingels et al. (1994); for details on the NELS:88 test battery, see Rock and Pollack (1995). Data for this report also draw on the NELS:88 high school transcript component (Ingels et al. 1995) and the NELS:88 postsecondary education transcript study (Curtin et al. 2004).

NELS:88 continued for two more rounds, during which considerable future outcome data were gathered. The third follow-up took place in 1994, when most sample members had been out of high school for 2 years. Major content areas for the 1994 interview were education histories, work experience histories, work-related training, family formation, income, opinions, and other experiences. A fourth and final follow-up took place in 2000, the year in which most sample members turned 26 years of age and typically were 8 years removed from high school enrollment. The interview in 2000 focused on the educational and labor market transitions experienced by young adults. Interview topics included experiences with postsecondary education, labor market participation, job-related training, community integration, and marriage and family formation. The study also included a student transcript data collection from the postsecondary institutions that NELS:88 respondents reported attending after high school. Transcript data collection began in September 2000 and ended in March 2001. High school and postsecondary transcript data files are restricted use and require a licensing agreement. Other NELS:88 data files have been subjected to non-disclosure analysis and editing to protect respondent confidentiality and are available in public use as well as restricted versions.

A.2 NAEP and NELS:88 Mathematics Assessments: Transforming NELS:88 Scores to the NAEP Scale

A.2.1 The NELS:88 NAEP-Scaled Score: Nature of the Linkage

Many kinds of test linkage are possible. Moreover, the purpose of the linkage must always be taken into account (Feuer et al. 1999). It is necessary to ask: How will the link be used? What inferences will be drawn? Hanson et al. (2001, p. 2) offer the following typology of test linkages:

> The established terminology used to describe the linking of closely equable and weakly equable scores are equating and calibration, respectively… The terminology used to refer to linking nonequable scores depends on the method used to compute the linking function. When regression is used to compute the linkage function the resulting linkage has been termed prediction. When equipercentile methods are used to compute the linkage function the linkage is

termed a concordance. … When the linkage function is computed using methods involving moderator variables the linkage is termed statistical moderation…

Equating is the strongest form of test linkage. Angoff (1982, p. 56) defines equating as "the process of developing a conversion from the system of units of one form of a test to the system of units of another form so that scores derived from the two forms after conversion will be equivalent and interchangeable." Note that Angoff's statement indicates that equated scores should be truly equivalent, not just comparable. A variety of special conditions must be met for successful equating. Lord (1980) provided the classical statement of these conditions: (1) Tests to be equated must measure the same construct; (2) the conditional distributions of scores given true score on each test after equating must be equal (this is termed the requirement of equity, and Lord draws out its implication as entailing that it must be a matter of indifference to examinees whether they are administered test X or test Y[2]); (3) the equating transformation should be invariant across populations; (4) the equating transformation should be symmetric (the function equating X to Y should be the inverse of the function equating Y to X). A fifth condition is often added—the tests should be equally reliable. Collectively, these are stringent conditions, and normally could be met only if the tests were specifically constructed with equating goals in mind (see Mislevy 1992). While the NELS:88-NAEP link meets some of the stated conditions of equating (the studies have highly similar mathematics frameworks for content, and both measure the math achievement of the same target population), other conditions fall short of being fully met because of the many differences between NAEP and NELS:88. Those differences are often based on the difference in objectives—NAEP tries to maximize group-level estimation, while NELS:88 tries to maximize individual-level measurement. Thus, for example, while both tests are highly reliable, the NAEP tests were not designed to maximize their reliability at the individual level (Beaton and Gonzalez 1995).[3] This leads to an asymmetry that violates the conditions of true equating: The fact that (unlike NELS:88) NAEP was not designed for reliable individual-level scoring does not raise difficulties for an exercise in applying the NAEP metric to NELS:88 results. However, if the NAEP-NELS:88 equating were in the opposite direction, and results from NAEP were being put on the NELS:88 scale, then the carryover to the NELS:88 metric of the unreliability of individual-level measurements in NAEP would be a concern.

Also, there are other differences between the studies that could undermine the prospects for the kind of conceptual and statistical equivalence of scores that equating implies. NAEP employs content subscales that form the basis for a weighted composite, but in NELS:88, the end product is a single IRT score. The NELS:88 tests are grade-level adaptive but also mildly adaptive at the individual level; NAEP is grade-level adaptive but not individually adaptive. The NELS:88 forms are assigned by ability level, but in NAEP via random matrix sampling. NAEP uses conditioning and plausible values but NELS:88 does not. There are some differences (as

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[2] The *NCES Statistical Standards* (Seastrom 2003, p. 132) extends the interpretation of this requirement: not only should examinees (of every ability level and population subgroup) "have the same expected mean score on each test, but they should also have the same errors of measurement."

[3] NAEP assessments are spiraled and while the set of items that an individual takes can generally be considered a reasonably representative subsample of the content being measured by the total item pool, no attempt is made to ensure that the spiraled sets of items are strictly parallel from individual to individual. Beaton and Gonzalez (1995, p. 22) note that "the proficiency for some students can be well estimated while the estimates for others are less accurate." This is not a concern if the data are consistent with the IRT model and one is reporting only at the group level. It is a concern if one is implementing NELS:88 scales in NAEP; that is, using NAEP data on the NELS:88 scale for purposes of individual-level ability estimation.

well as similarities) in scoring and scaling methods, and in item type: constructed response took up over 50 percent of NAEP math testing time in 1992 (Mullis 2004), but NELS:88 had only multiple choice questions. Given these differences, it is best to regard the NELS:88-NAEP link not as an equating, but rather, a concordance.

The claim that is made for the NELS:88 NAEP-scaled score, then, is that the scores of the two studies can be regarded as *comparable*, not that they are *equivalent*. The heart of this claim is that the NAEP-scaled score represents the score level achieved by students of the same percentile rank in two populations that were closely matched, and only that. The related claim made for the NELS:88 NAEP-scaled score is that NAEP and NELS:88 have not been equated, but rather, a comparatively weak linkage, a scale concordance, has been achieved. A concordance asserts a score linkage based on the distributional similarity of a set of scores, while the linkage attainable in equating is that of conceptual and statistical interchangeability (Dorans 2004).

Indeed, linking scales to yield concordant scores relies on minimal assumptions about the comparability of the tests involved. Neither means, standard deviations, reliabilities, nor standard errors of measurement are assumed to be the same. The tests need only be roughly congeneric in that they measure essentially the same underlying factor. However, a concordance is stronger if the populations are systematic samples from the same population, as is the case for the NELS:88-NAEP link. The question of the “goodness” of the concordant score is typically investigated by how it affects the positioning of subgroups: Does relative standing change depending on which of the scores is used? Tables A-1 and A-2 directly address the issue of a subgroup test of the goodness of the concordant score. Further evidence of the success of the linking, as well as the alignment of content and populations for the two studies, is provided in section A.2.2 below.

Although this report argues for the strength and viability of the NAEP-NELS:88 linkage, it should be acknowledged that test linkages across national assessments are often problematic. NAEP-Trends in International Mathematics and Science Study (TIMSS[4]) linkage (see Johnson 1998 and Johnson et al. 2005 on linking results, and Nohara 2001 on differences in content frameworks)—and ELS:2002-PISA linking in reading (Ingels et al. 2004) and in math (Ingels et al. 2005)—provide specific examples of the problematic aspects of test linkage in national datasets.

A.2.2 Implementing the Linkage: Transforming NELS:88 Scores to the NAEP Scale

The 1992 NELS:88 data include a mathematics score on the NAEP scale for every NELS:88 sample member (including dropouts and non-seniors) who had a mathematics score (n = 14,200). However, although available for all sample members, the score was calibrated on 1992 high school seniors only, and then the transformation was applied to all students who had a math score.

The equating samples were composed of the main NAEP (1992) national sample of 12th-graders, and NELS:88 1992 12th-grade cohort members. The transformation of NELS:88 scores to NAEP employed the NAEP composite scale scores (as opposed to various NAEP subscores). The NELS:88 NAEP-scaled mathematics score is a conversion or transformation of the NELS:88

[4] TIMSS was formerly known as the Third International Mathematics and Science Study.

IRT-Estimated Number Right score. The linking was achieved through an equipercentile procedure in which a parameter is estimated for each score level (see Ingels et al. 1994, p. H-36). (Note that the equating exercise was conducted in 1993, and therefore could not take advantage of the many developments [see, for example, Kolen and Brennan 2004, and von Davier, Holland, and Thayer 2004] that have taken place in equating methodology in recent years.) Angoff (1982, p. 56) defines the equipercentile method as follows:

> Equipercentile equating is based on the following definition: Two scores, one on Form x and one on Form y—where x and y are equally reliable and parallel measures…may be considered equivalent if their respective percentile ranks in any given group are equal. Thus equipercentile equating of Form x to Form y operates to match all moments (i.e., all characteristics of the shape, in addition to the mean and standard deviation) of the distribution of Form x scores to the respective moments of the distribution of Form y scores.

The NAEP-scaled math score assigned to a person scoring at the 90th percentile of the weighted distribution of NELS:88 scores would be the score that represented the 90th percentile of the NAEP distribution of scaled scores. Empirical checks on the validity of the equating procedure included comparison of subgroup differences (subgroups were sex, race/ethnicity, and school type) on the linked score with differences found on the original NAEP scale (Rock and Pollack 1995, p. 65). Table A-1 compares the means of the two scores (NAEP and NELS:88 NAEP-scaled) overall, and with subgroup comparisons, at the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentile. Table A-2 again compares the two scores, showing the percentage of students at or above each of five anchor points[5] on the 0-500 NAEP scale: 150, 200, 250, 300, 350.

[5] Scale anchoring (Beaton and Allen 1992) is a reporting device that was employed in the 1992 NAEP Mathematics Assessment (Mullis et al. 1993) and earlier assessments (but not since). A certain anchor point on the scale is identified, along with typical knowledge and skills associated with that portion of the scale. For example, at level 200 on the scale, the associated skill is addition and subtraction and simple problem solving with whole numbers. In table A-2, the anchor points are used as another way to examine the match-up, in percentage of seniors at or above a given anchor point, of populations, for the NAEP and NELS:88 NAEP-scaled scores.

Table A-1. Twelfth-grade mathematics score comparison of NAEP percentiles with NELS:88 NAEP-scaled percentiles, with weighted mean, standard deviation, and NAEP standard error

Characteristic	Mean	SE	Std. dev.	SE	5th	SE	10th	SE	25th	SE	50th	SE	75th	SE	90th	SE	95th	SE
Total																		
NAEP	298.7	0.9	34.4	0.4	240.3	1.9	252.9	1.2	275.0	1.4	299.9	1.2	323.2	1.3	342.6	1.0	353.6	1.3
NELS:88 NAEP-Scaled	298.7		34.4		240.5		252.7		275.0		299.9		323.2		342.5		353.5	
Sex																		
Male																		
NAEP	300.6	1.1	35.2	0.6	240.7	2.5	253.2	1.5	276.5	2.0	301.5	1.7	326.0	1.5	345.5	1.1	356.7	2.0
NELS:88 NAEP-Scaled	300.1		35.4		241.3		253.2		274.7		301.2		325.2		345.0		356.4	
Female																		
NAEP	297.0	1.0	33.5	0.5	239.9	2.9	252.4	1.3	273.7	1.0	298.3	1.0	320.4	1.5	339.7	1.3	350.6	1.1
NELS:88 NAEP-Scaled	297.4		33.3		239.9		252.3		275.3		298.6		321.0		340.5		350.4	
Race/ethnicity																		
White																		
NAEP	305.0	0.9	32.3	0.5	249.9	1.7	262.0	0.7	283.4	1.5	306.7	1.3	328.0	1.4	345.6	1.1	356.0	1.0
NELS:88 NAEP-Scaled	304.0		32.8		248.5		260.2		281.9		305.8		327.3		345.2		355.1	
Black																		
NAEP	274.8	1.7	30.4	0.8	226.6	1.8	235.0	2.7	252.6	2.0	273.7	2.4	296.5	2.6	314.9	1.8	326.1	2.2
NELS:88 NAEP-Scaled	275.5		31.0		227.4		234.6		252.4		274.9		298.1		314.9		329.7	
Hispanic																		
NAEP	282.9	1.8	32.9	1.3	229.1	18.1	240.5	4.0	260.6	3.3	282.8	1.8	304.5	1.7	324.8	3.0	339.6	1.6
NELS:88 NAEP-Scaled	284.5		31.9		233.7		243.8		263.8		283.0		306.4		327.1		339.2	
Type of school																		
Public																		
NAEP	296.6	1.0	34.3	0.5	238.8	1.6	251.1	1.0	272.5	1.1	297.4	0.9	320.8	1.3	340.7	1.6	351.6	1.4
NELS:88 NAEP-Scaled	297.1		34.3		239.1		251.7		273.2		298.1		321.4		341.4		352.5	
Private																		
NAEP	319.2	4.3	32.8	1.6	259.9	8.1	274.9	6.3	298.1	4.0	322.3	6.2	343.2	3.7	359.1	4.2	367.5	1.6
NELS:88 NAEP-Scaled	316.2		34.8		246.8		276.2		294.7		318.0		338.9		356.9		370.0	
Catholic																		
NAEP	310.4	2.5	30.0	1.0	257.5	2.4	270.6	5.6	291.0	1.5	311.8	2.1	331.4	2.6	348.1	1.6	357.1	1.4
NELS:88 NAEP-Scaled	311.7		28.9		257.1		273.0		293.9		312.2		332.4		347.2		355.9	

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), “Second follow-up, 1992”; and National Assessment of Educational Progress (NAEP), 1992 Mathematics Assessment.

Table A-2. Comparison of NAEP and NELS:88 NAEP-scaled mathematics scores for seniors at or above NAEP anchor points

Characteristic	Weighted percent	SE	150	SE	200	SE	250	SE	300	SE	350	SE
Total	100.0	#	100.0	#	99.9	0.1	91.4	0.5	49.9	1.2	6.4	0.5
NAEP	100.0		100.0		99.9		91.5		49.9		6.4	
NELS:88 NAEP-Scaled												
Sex												
Male												
NAEP	48.8	0.8	100.0	#	99.8	0.1	91.6	0.7	51.6	1.5	7.7	0.6
NELS:88 NAEP-Scaled	50.9		100.0		99.8		91.7		51.3		7.6	
Female												
NAEP	51.2	0.8	100.0	#	99.9	0.1	91.3	0.7	48.2	1.3	5.2	0.7
NELS:88 NAEP-Scaled	49.1		100.0		99.9		91.2		48.4		5.1	
Race/ethnicity												
White												
NAEP	71.1	0.6	100.0	#	99.9	0.1	95.0	0.4	57.6	1.1	7.7	0.6
NELS:88 NAEP-Scaled	73.3		100.0		99.9		94.6		56.3		7.3	
Black												
NAEP	14.7	0.4	100.0	#	99.8	0.2	78.0	2.1	21.5	2.3	0.6	0.3
NELS:88 NAEP-Scaled	11.4		100.0		99.8		77.2		22.5		0.5	
Hispanic												
NAEP	9.5	0.5	100.0	#	99.5	0.5	83.9	2.3	29.7	2.6	2.5	0.8
NELS:88 NAEP-Scaled	9.8		100.0		99.9		85.5		32.0		2.6	
Type of school												
Public												
NAEP	87.1	1.2	100.0	#	99.8	0.1	90.6	0.6	47.2	1.3	5.6	0.5
NELS:88 NAEP-Scaled	90.1		100.0		99.9		91.0		47.9		5.9	
Private												
NAEP	4.5	1.0	100.0	#	100.0	#	96.9	1.1	73.2	5.0	18.6	3.0
NELS:88 NAEP-Scaled	3.9		100.0		100.0		94.8		67.3		15.6	
Catholic												
NAEP	8.4	1.3	100.0	#	100.0	#	96.9	1.0	65.2	3.8	8.5	1.5
NELS:88 NAEP-Scaled	5.9		100.0		100.0		96.6		68.9		7.8	

Rounds to zero.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), "Second follow-up, 1992"; and National Assessment of Educational Progress (NAEP), 1992 Mathematics Assessment.

Tables A-3 through A-5 provide information on the content of the NELS:88 and NAEP 1992 mathematics test. The NELS:88 mathematics test reliability estimates were 0.89 for the base year, 0.93 for the first follow-up, and 0.94 for the second follow-up.[6]

[6] These estimates measure the reliability of the IRT theta (theta is the ability estimate for mathematics). For further information, see Rock and Pollack 1995, p. 67. See also the plot of the test information function for the theta estimate in appendix G of Rock and Pollack (1995). The increased reliabilities of the ability estimates in the follow-up waves reflect the impact of the adaptive multiple-form approach in 1990 and 1992. In more recent studies, such as ELS:2002, reliabilities are reported as a function of the variance of repeated estimates of the IRT ability parameter.

Table A-3. Number of items per content area, by cognitive process, base year through second follow-up: 1995

Cognitive process	Arithmetic	Algebra	Geometry/ measurement	Data analysis/ probability	Advanced topics
Skill/knowledge					
8th grade	10	5	1	1	†
10th-grade low	12	4	2	†	†
10th-grade medium	9	3	†	1	1
10th-grade high	6	3	†	2	2
12th-grade low	10	4	2	†	†
12th-grade medium	7	2	†	1	1
12th-grade high	1	2	†	1	2
Understanding/comprehension					
8th grade	6	7	3	3	†
10th-grade low	7	6	3	2	†
10th-grade medium	6	6	3	2	†
10th-grade high	3	7	2	3	2
12th-grade low	6	5	3	3	†
12th-grade medium	4	6	4	2	†
12th-grade high	1	5	7	1	3
Problem solving					
8th grade	3	†	†	†	1
10th-grade low	3	†	†	†	1
10th-grade medium	3	2	2	†	2
10th-grade high	2	2	3	†	2
12th-grade low	4	†	2	†	1
12th-grade medium	4	3	5	†	1
12th-grade high	2	4	9	1	1

(Content area spans Arithmetic through Advanced topics.)

† Not applicable.

NOTE: Advanced topics includes precalculus and analytic geometry.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88); Rock and Pollack (1995), *Psychometric Report for the NELS:88 Base Year to Second Follow-Up*.

Table A-4. Percentage distribution of test items, by content area and mathematics test form: 1995

Mathematics test form	Arithmetic	Algebra	Geometry/ measurement	Data analysis/ probability	Advanced topics
NELS:88					
NELS:88 8th grade	47	28	10	10	5
10th-grade low form	54	28	10	5	3
10th-grade medium	45	29	13	8	5
10th-grade high	30	30	15	13	12
12th-grade low	50	23	18	8	3
12th-grade medium	38	28	23	8	5
12th-grade high	10	28	40	8	15
NAEP 1992					
NAEP 12th grade	25	25	35	15	†

(Content area spans Arithmetic through Advanced topics.)

† Not applicable.

NOTE: Advanced topics includes precalculus and analytic geometry. Detail may not sum to totals because of rounding. Advanced topics for the NAEP 12th-grade math assessment are distributed throughout the other content areas, and do not constitute a separate content area.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88); Rock and Pollack (1995), *Psychometric Report for the NELS:88 Base Year to Second Follow-Up*; and National Assessment of Educational Progress, Johnson and Carlson, *NAEP 1992 Technical Report* (1994).

Table A-5. Percentage distribution of test items, by process/skill specifications and mathematics test form: 1995

Mathematics test form	Process/skill specifications: Procedural skills/knowledge	Conceptual understanding	Problem solving
NELS:88			
NELS:88 8th grade	42	48	10
10th-grade low form	47	43	10
10th-grade medium	35	45	20
10th-grade high	33	45	22
12th-grade low	40	43	18
12th-grade medium	28	40	33
12th-grade high	15	43	43
NAEP 1992			
NAEP 12th grade	30	40	30

NOTE: 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); Rock and Pollack (1995), *Psychometric Report for the NELS:88 Base Year to Second Follow-Up*; and National Assessment of Educational Progress, Johnson and Carlson, *NAEP 1992 Technical Report* (1994).

A.3 Sample Design, Weighting, Response Rates, and Data Quality

A.3.1 Sampling

The NELS:88 second follow-up sample was ultimately derived (either directly or through a linked freshening) from the students brought in through the base year schools. The NELS:88 base year sample design began with a nationally representative, two-stage stratified probability sample of 1,100 eighth-grade schools and 26,400 sampled students in the schools, of whom 24,600 students participated.[7] The base year sample was reduced in size by subsampling in the first and the third follow-ups, and twice in the fourth follow-up, to reach a final participating sample size of 12,100. While the sample was reduced by subsampling, the NELS:88 sample also was augmented by two activities. First, sample freshening, which ensured three fully representative national grade cohorts (1988 eighth-graders, 1990 sophomores, 1992 seniors), added new students to the sample. Also, a subsample of base year ineligible students was followed. Those whose eligibility status changed in 1990 or 1992 were added to the overall NELS:88 sample. (For example, if a student with limited English proficiency could not be validly assessed or surveyed in 1988, but became proficient in English over the subsequent years, that student became eligible for the study at that later time.)

The NAEP 1992 mathematics assessment sample assumed the same target population as the NELS:88 freshened senior cohort sample (full details of the relevant NAEP sampling procedures can be found in Johnson and Carlson [1994]). However, the NAEP 1992 sample is nationally representative at the school level as well as the student level (high school seniors). The NELS:88 1992 cross-sectional sample is only representative at the student level (high school seniors). Basic characteristics of the realized samples, weighted to population estimates, are compared in table A-6 below.

[7] Some of the base year-eligible eighth-graders who did not participate in 1988 were retained in follow-up samples and participated in one or more of the later rounds.

Table A-6. Twelfth-grade population estimation comparison, by selected student and school characteristics: 1995

Characteristic	NAEP 1992	NELS:88	NELS:88 test-takers
Total	2,522,000	2,537,000	1,980,000
Sex			
Male	48.8	50.4	50.9
Female	51.2	49.6	49.1
Race/ethnicity[1]			
White	71.1	72.3	73.3
Black	14.7	11.9	11.4
Hispanic	9.5	10.0	9.8
Control			
Public	87.1	89.9	90.1
Private	4.5	4.3	3.9
Catholic	8.4	5.8	5.9

[1] Black includes African American, and Hispanic includes Latino. Race categories exclude Hispanic origin unless specified.
NOTE: Estimates are weighted. Detail may not sum to totals because of rounding.
SOURCE: National Assessment of Educational Progress (NAEP), and the National Education Longitudinal Study of 1988 (NELS:88); Rock and Pollack (1995), *Psychometric Report for the NELS:88 Base Year to Second Follow-Up*.

A.3.2 Weighting

For this report, the 1992 12th-grade (second follow-up) cross-sectional estimates (the analyses conducted in chapter 2) were produced using the second follow-up questionnaire weight, F2QWT. The sample was selected based on G12COHRT=1 (member of the 12th-grade cohort) and F2QWT>0. The data were taken from the NELS:88 base year through second follow-up restricted-use electronic codebook (N2R ECB).

The 1992 12th-grade (second follow-up) to 1994 (fourth follow-up) longitudinal estimates (table 5, p. 36 and table 9, p. 47) were produced using the third follow-up panel weight, F2F3PNWT. The analysis sample was selected using G12COHRT=1 (member of the 12th-grade cohort) and F3F2PNWT>0. The data were taken from the NELS:88 base year through third follow-up restricted-use electronic codebook (N4R ECB).

The 1992 12th-grade (second follow-up) to 2000 (fourth follow-up) longitudinal estimates were produced using several different weights from the NELS:88 postsecondary education transcript study (PETS) electronic codebook (ECB) (the ECB name is “N0T”), depending on the dependent variable investigated. (The PETS data are available only as restricted-use.) Tables 6 (highest postsecondary degree attained as of 2000, p. 38) and 7 (number of remedial mathematics courses taken, p. 40) used the second follow-up to fourth follow-up “complete or nearly complete” (defined below) transcript panel weight, F4F2P3WT. This analysis sample was selected using G12COHRT=1 and F4F2P3WT>0. Table 8 (selectivity of first institution of attendance, p. 42) used the second follow-up to fourth follow-up “credible claim to postsecondary school” (defined below) transcript panel weight, F4F2P1WT. This analysis sample was selected using G12COHRT=1 AND F4F2P1WT>0.

The general purpose of weighting survey data is to compensate for unequal probabilities of selection and to adjust for the effects of nonresponse. A basic four-step process was defined for the calculation of the nine second follow-up weights produced. The first step, defining a classification scheme, was performed at the beginning of the weighting process for all sample members. The values remained static and were used throughout the process for all weights. The second and fourth steps were followed for all weights, but the results of each were tailored according to the characteristics of each weight's specific populations (e.g., 1988 8th-grader as of 1992 [base year through second follow-up panel sample], 1992 12th-grader as of 1992 [second follow-up cross-sectional sample]). Steps two through four were to establish second follow-up design weights (step two), adjust for second follow-up nonresponse (step three), and perform multidimensional raking (step four).

Weights for the NELS:88 fourth follow-up study were also developed in several steps. In the first step, unadjusted weights were calculated as the inverse of the probabilities of selection, taking into account all stages of the sample selection process. In the second step, a general exponential model was employed to compensate for unit nonresponse. To maintain consistency in weights across the multiple data collection waves of NELS:88 (i.e., to ensure that weighting totals reflected the population totals of the original group of interest), multidimensional raking was also applied to these nonresponse adjusted weights. The raking was performed with respect to base year through third follow-up study response status, dropout status, race/ethnicity, sex, and school status.

The procedures used to develop the longitudinal (or panel) weights for the NELS:88 postsecondary education transcript study involved three sequential steps. These steps adjusted the base weights for nonresponse, calibrated the weight totals, and developed three weights for each panel (the panels being base year through fourth follow-up, first follow-up through fourth follow-up, and second follow-up through fourth follow-up) defined by the type of transcript response: postsecondary participation based on a credible claim of postsecondary participation—whether or not a transcript was actually returned; postsecondary participation based on a returned or imputed transcript (e.g., from financial aid data); and postsecondary participation based on a returned complete or nearly complete transcript record.

Detailed information on the creation of weights for all five rounds of NELS:88 base year through fourth follow-up is included *NELS:88/2000 Base Year through Fourth Follow-up Data File User's Manual* (Curtin et al. 2002). Information on the creation of weights for the postsecondary education transcript study is available in the technical appendix to Adelman, Daniel, and Berkovits (2003).[8]

Both NAEP and NELS:88 excluded some students. Not all spring-term 1988 8th-graders were eligible for NELS:88. Just over 5 percent of the potential sample was excluded because of factors such as severe disability or greatly limited proficiency in English that would have made test and questionnaire administration difficult or invalid. Thus while the sample contains 8th-graders with disabilities and of limited English proficiency, the included students in these categories generally had mild disabilities or less severe limitations in their English language proficiency. (For more information about the NELS:88 sample design, see Spencer et al. 1990. For a discussion of issues of eligibility, inclusion, the effect of exclusion on national estimates, and comparison of NAEP and NELS:88 exclusion procedures, see Ingels 1996.)

[8] More detail about the weights and their statistical properties is provided in the postsecondary transcript documentation that is available only to licensed users of the data set (Curtin et al. 2004).

A.4 Response Rates and Bias Analysis

A.4.1 Response Rates

Survey Response Rates. The NELS:88 base year sample was drawn in two stages: first schools, and then students. Data from students at 1,100 schools appear on the NELS:88 base year data files. These schools are 69.7 percent of originally selected schools. A bias analysis was conducted comparing schools that participated to those that declined to participate; minimal bias was found. (A detailed discussion of this analysis can be found in Spencer et al. 1990.) Student-level completion rates across rounds are provided in table A-7 below. Participation in NELS:88 was defined by questionnaire completion; some questionnaire completers did not complete the tests. Therefore separate information is also provided in this appendix about test completion rates in 1992, and the extent of bias from missing assessment information.

Table A-7. Summary of NELS:88 student completion rates: 1988-2000

Round of data collection	Participants	Weighted percent	Unweighted percent
Base year (1988)	24,599	93.4	93.1
First follow-up (1990)	18,221	91.1	94.1
Second follow-up (1992)	16,842	91.0	92.5
Third follow-up (1994)	14,915	90.9	94.0
Fourth follow-up (2000)	12,144	82.7	77.6

Note: The sample denominator decreases over time owing to subsampling, mortality, and other factors.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88) base year through fourth follow-up.

This report also draws on archival or records sources, such as secondary and postsecondary transcripts. For high school transcripts, overall coverage rates were 87.8 percent weighted and 89.5 percent unweighted. Ninety-eight percent of the postsecondary education transcripts requested were received or otherwise accounted for by the institution (i.e., postsecondary institution no longer in operation, institution had no record of student ever attending, or institution could not find a transcript for student, although he or she did attend).

Item Response Rates. Weighted item response weights were calculated for all variables used in this report by dividing the weighted number of valid responses by the weighted population for which the item was applicable. Table A-8 presents item response rates for the variables used in this report. Most items had a high response rate (i.e., 85 percent or above). For these variables with high response rates, it is unlikely that reported differences are biased because of missing data. However, the NAEP-scaled score item had a response rate below 85 percent. This variable is the focus of this report and, as such, its low response rate is a salient issue. To determine the implications of this low response rate, a bias analysis was conducted. The results of this bias analysis are presented in the next section.

Table A-8. Item response rates for 12th-grade students and 12th-grade students with a NAEP-scaled score, by variable, selected student, and school characteristics: 1992

		Weighted response rate	
Variable name	Description	All students	Students with NAEP-scaled score
F22XNAEP	NAEP Scaled Score	76.5[1]	†
F2SEX	Sex	100.0	100.0
F2RACE1	Race/ethnicity	99.7	99.9
G12CTRL2	School sector 12th-grade school	99.6	99.8
G12URBAN3	Urbanicity of 12th-grade school	99.6	100.0
G12REGON	Region of 12th-grade school	99.5	100.0
F2S43	12th-grader's own educational expectations	90.8	91.7
BY2XMQ	8th-grade mathematics achievement score quartile	86.2	88.8
F12XMQ	10th grade mathematics achievement score quartile	87.4	91.3
BYRISK	At-risk status	89.2	91.6
F2RHMAG2	Average grade in mathematics	86.3	91.9
MATHPIPE	Highest mathematics course taken	87.4	92.9
F2SES1Q	Socioeconomic status quartile	98.3	99.5
F2RSATV	SAT math score	28.0[1]	31.6
F2RACTM	ACT math score	24.4[1]	28.5
F2RHENG2	Average grade in English	81.1[1]	89.1
PSEFIRTY	Attendance at postsecondary school by 1994	95.1	95.8
REFITYPE	Postsecondary school type	98.8	99.1
HDEG	Highest degree received by 2000	100.0	100.0
REMMATH	Number of remedial math courses taken	100.0	100.0
REFSELCT	Selectivity of first postsecondary institution	92.3	93.3

† Not applicable

[1] Below 85 percent.

NOTE: Data are weighted. Item response rates for SAT math score and ACT math score include students who reported that they did not take the SAT or ACT in addition to students who reported taking one of the two college entrance exams, but for whom scores were not found on their high school transcripts. An SAT-M score was available for 82 percent of students who reported taking the SAT. An ACT math score was available for 81 percent of students who reported taking the ACT. NAEP = National Assessment of Educational Progress.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88).

A.4.2 Bias Analysis

The primary purpose of this report is to explore relationships among high school contextual factors, postsecondary outcomes and performance on the 1992 mathematics assessment as measured by the NELS:88-NAEP-scaled score. In order to address this focus, only students with a NELS:88-NAEP-scaled score (F22XNAEP) were analyzed. Of the 16,400 12th-graders, 3,500 do not have a NELS:88-NAEP-scaled score, yielding a reduced 12th-grade sample of 12,900. Thus, item response for the NELS:88-NAEP-scaled score is 76.5 percent, which is below the NCES standard of 85 percent. A bias analysis was undertaken to determine the extent to which the final analysis sample differs from, and thus may not be generalized to, the target population of American high school 12th-graders. Results of this analysis are reported and discussed in the next section. It should be noted that this is not an analysis of survey nonresponse for the population of 12th-grade students. That is, it does not investigate the possibility of bias owing to the fact that there may be systematic differences between responding and nonresponding 12th-graders; hence, 12th-graders who responded may not represent the population of all high school seniors in the United States. For an analysis of nonresponse bias, readers should consult the NELS:88 data file user's manuals. The analysis conducted here evaluates the possibility of systematic differences as a result of excluding from the analysis 12th-graders who participated in the study, but for whom a NELS:88-NAEP scaled score is missing. Substantial differences between those students with a NELS:88-NAEP scaled score and those students without could restrict the variation in the sample and, in turn, bias population estimates. Weights were employed for this analysis, which adjusted for unit nonresponse on the part of 12th-graders.

Results of the Bias Analysis. The purpose of this analysis was to evaluate the NELS:88-NAEP scaled score sample (i.e., 12th-graders who had a NELS:88-NAEP-scaled score versus those 12th-graders who did not). Table A-9 presents the results of the analysis. The table shows the NELS:88 12th-grade sample and selected student and school characteristics (row variables) by three populations (column variables): all 12th-grade students, 12th-grade students with a NELS:88-NAEP scaled score, and 12th-grade students without a NELS:88-NAEP-scaled score. Those students with a NELS:88-NAEP-scaled score are referred to as *takers* while those students without a NELS:88-NAEP-scaled score are referred to as *non-takers*.

The analysis revealed some differences between the takers and non-takers. When the takers were compared to the non-takers, differences were found with regard to five student characteristics and three school characteristics. Differences between the takers and non-takers were found for sex, race/ethnicity, fathers' education, 8th-grade mathematics score, 10th-grade mathematics score, school location, region, and the percentage of students eligible for free or reduced-price lunch. A greater percentage of takers were males when compared to non-takers and, conversely, a smaller percentage of takers were females when compared to non-takers. Differences were also found by race/ethnicity. A greater percentage of students who had a NELS:88-NAEP-scaled score (takers) were White when compared to students with no NELS:88-NAEP-scaled score (non-takers) (76 percent versus 72 percent). No other differences between takers and non-takers were found by race/ethnicity.

Table A-9. Results of bias analysis: Number and percentage distribution of all 12th-grade students, and 12th-grade students with and without NAEP-scaled score, by selected student and school characteristics: 1988

	All students				Students with NAEP-scaled score				Students without NAEP-scaled score			
Characteristic	Sampled	Weighted population	Weighted estimate	SE	Sampled	Weighted population	Weighted estimate	SE	Sampled	Weighted population	Weighted estimate	SE
Total	16,400	2,590,000	100.0	#	12,900	1,980,000	100.0	#	3,500	610,000	100.0	#
Sex												
Male	8,100	1,297,000	50.1	0.63	6,400	1,008,000	50.9	0.71	1,700	289,000	47.4	1.34
Female	8,300	1,293,000	49.9	0.63	6,500	972,000	49.1	0.71	1,800	321,000	52.6	1.34
Race/ethnicity[1]												
Asian	1,200	116,000	4.5	0.31	910	87,000	4.4	0.32	290	28,800	4.7	0.49
Hispanic	2,000	261,000	10.1	0.71	1,500	193,000	9.8	0.77	450	67,400	11.0	0.98
Black	1,500	308,000	11.9	0.77	1,200	227,000	11.4	0.77	350	81,800	13.4	1.49
White	11,500	1,871,000	72.2	1.09	9,200	1,451,000	73.3	1.10	2,300	420,000	68.9	1.82
American Indian	170	27,000	1.0	0.19	130	20,600	1.0	0.19	40	6,400	1.1	0.31
Missing	50	7,200	0.3	0.05	20	1,800	0.1	0.03	40	5,400	0.9	0.20
Fathers' education												
Did not finish high school	2,000	307,000	11.9	0.46	1,600	237,000	12.0	0.50	410	69,700	11.4	0.79
Graduated high school/GED	4,100	686,000	26.5	0.60	3,300	551,000	27.8	0.68	770	135,000	22.1	1.06
Some college after high school	2,700	452,000	17.4	0.49	2,200	346,000	17.5	0.51	510	106,000	17.3	1.13
Graduated college	2,500	373,000	14.4	0.51	2,000	297,000	15.0	0.56	480	76,200	12.5	0.88
Master's degree	1,400	206,000	8.0	0.40	1,100	160,000	8.1	0.47	320	46,400	7.6	0.61
Ph.D. or other advanced degree	1,100	117,000	4.5	0.29	830	92,700	4.7	0.34	230	24,000	3.9	0.40
Missing	2,600	449,000	17.4	0.53	1,900	296,000	15.0	0.49	730	153,000	25.1	1.45
Mothers' education												
Did not finish high school	1,900	301,000	11.6	0.45	1,500	237,000	12.0	0.52	380	63,800	10.5	0.75
Graduated high school/GED	5,000	848,000	32.7	0.64	4,000	660,000	33.3	0.71	970	188,000	30.8	1.25
Some college after high school	3,200	524,000	20.3	0.52	2,500	408,000	20.6	0.57	620	117,000	19.1	1.10
Graduated college	2,500	346,000	13.4	0.44	2,000	272,000	13.8	0.49	490	73,600	12.1	0.82
Master's degree	1,300	170,000	6.6	0.37	1,000	134,000	6.8	0.41	280	36,300	6.0	0.58
Ph.D. or other advanced degree	400	48,400	1.9	0.19	300	36,100	1.8	0.23	100	12,300	2.0	0.31
Missing	2,200	352,000	13.6	0.47	1,500	233,000	11.8	0.46	620	119,000	19.6	1.17
School sector												
Public	14,000	2,327,000	89.8	0.67	11,100	1,784,000	90.1	0.74	2,900	542,000	89.0	1.11
Catholic	910	147,000	5.7	0.44	770	118,000	5.9	0.50	140	29,100	4.8	0.77
NAIS	1,100	32,800	1.3	0.18	800	23,200	1.2	0.22	260	9,600	1.6	0.24
Other	380	73,300	2.8	0.46	280	54,000	2.7	0.51	100	19,400	3.2	0.64
Missing	40	10,000	0.4	0.10	#	†	†	†	30	9,300	1.5	0.40

See notes at end of table.

Table A-9. **Results of bias analysis: Number and percentage distribution of all 12th-grade students, and 12th-grade students with and without NAEP-scaled score, by selected student and school characteristics: 1988—Continued**

	All students				Students with NAEP-scaled score				Students without NAEP-scaled score			
Characteristic	Sampled	Weighted population	Weighted estimate	SE	Sampled	Weighted population	Weighted estimate	SE	Sampled	Weighted population	Weighted estimate	SE
Urban type												
Urban	4,700	718,000	27.7	1.39	3,700	526,000	26.6	1.45	1,100	192,000	31.6	1.99
Suburban	6,600	1,069,000	41.3	1.61	5,000	799,000	40.4	1.71	1,600	270,000	44.3	2.16
Rural	5,000	792,000	30.6	1.58	4,300	654,000	33.0	1.72	730	138,000	22.7	1.73
Missing	40	9,900	0.4	0.10	#	†	†	†	30	9,200	1.5	0.40
Region												
Northeast	3,200	506,000	19.5	0.94	2,400	394,000	19.9	1.09	730	112,000	18.4	1.31
South	4,300	897,000	34.6	0.81	3,500	694,000	35.0	0.94	830	144,000	33.4	1.76
Midwest	5,500	671,000	25.9	0.79	4,500	528,000	26.7	0.90	1,000	204,000	23.5	1.45
West	3,300	505,000	19.5	0.75	2,500	364,000	18.4	0.79	860	141,000	23.2	1.72
Missing	40	9,900	0.4	0.10	#	†	†	†	30	9,200	1.5	0.40
Percentage of students eligible for free or reduced-price lunch												
Less than 15	7,400	1,071,000	41.4	1.51	6,200	890,000	44.9	1.64	1,300	182,000	29.8	2.01
15-29	3,300	499,000	19.3	1.21	2,800	415,000	21.0	1.34	530	83,900	13.8	1.34
30-49	2,500	392,000	15.1	1.10	2,100	335,000	16.9	1.27	370	57,000	9.4	1.02
50-74	1,000	158,000	6.1	0.76	820	130,000	6.6	0.85	180	28,700	4.7	0.70
75 or more	530	83,300	3.2	0.48	440	70,000	3.5	0.56	100	13,100	2.1	0.44
Missing	1,600	386,000	14.9	#	610	140,000	7.1	0.74	990	245,000	40.2	1.78
8th-grade mathematics score												
Lowest quarter	2,400	397,000	15.3	0.55	1,800	299,000	15.1	0.58	560	97,700	16.0	1.09
Low middle quarter	3,300	534,000	20.6	0.52	2,600	416,000	21.0	0.59	620	119,000	19.5	1.02
High middle quarter	3,800	617,000	23.8	0.53	3,100	486,000	24.6	0.58	720	130,000	21.4	1.15
Highest quarter	4,900	687,000	26.5	0.71	4,000	557,000	28.1	0.78	860	130,000	21.3	1.27
Missing	2,100	354,000	13.7	0.62	1,400	221,000	11.2	0.63	700	133,000	21.8	1.18
10th-grade mathematics score												
Lowest quarter	2,600	423,000	16.4	0.54	2,000	313,000	15.8	0.58	630	110,000	18.1	1.06
Low middle quarter	3,500	559,000	21.6	0.52	2,800	445,000	22.5	0.61	630	114,000	18.7	0.99
High middle quarter	3,900	621,000	24.0	0.52	3,300	500,000	25.2	0.56	670	121,000	19.8	1.23
Highest quarter	4,800	657,000	25.4	0.65	4,000	551,000	27.8	0.74	790	106,000	17.4	0.98
Missing	1,600	329,000	12.7	0.54	870	171,000	8.7	0.49	750	158,000	25.9	1.40

† Not applicable.
# Rounds to zero.
[1] Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or other Pacific Islander, and American Indian includes Alaska Native. Race categories exclude Hispanic origin unless specified.
NOTE: NAEP = National Assessment of Educational Progress; NAIS = National Association of Independent Schools; SE = standard error.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS: 88).

Differences were found by the educational attainment of the students' fathers. For example, a greater percentage of students who were takers than non-takers had fathers whose highest level of education was a high school diploma or GED certificate, or bachelor's degree.

In terms of prior achievement, a greater percentage of takers were more likely to be students who scored in the upper two quarters on the NELS:88 8th-grade mathematics assessment when compared to non-takers who scored in the upper two quarters. In the case of 10th-grade mathematics achievement, differences were found between takers and non-takers across all quarters. Students scoring in the lowest quarter on the NELS:88 10th-grade mathematics assessment were more likely not to have a NAEP score than to have a NAEP score. Students scoring in all higher quarters on the NELS:88 10th-grade mathematics assessment were more likely to have a NAEP score than not to have a NAEP score.

Some differences between takers and non-takers were found in terms of school characteristics. Small differences were found for school location, region, and the percentage of students eligible for free or reduced-price lunch. A greater percentage of non-takers were from urban schools when compared to takers who attended schools located in urban areas. In addition, there were a greater percentage of takers who attended rural schools than non-takers. Differences were also found by region. A greater percentage of non-takers were found in the west compared to takers from that same region. Finally, there were a greater percentage of takers who attend school in which 30 to 40 percent of students are on free or reduced-price lunches compared to non-takers. All groupings of the percentages of students eligible for free or reduced-price lunch (e.g., less than 15 percent, 15 to 29 percent) were more likely to have a NAEP score than not, with the exception of the "missing" group where more students with missing information on free and reduced-price lunch eligibility were more likely not to have a NAEP score than to have one.

In short, 12th-graders who were least likely to have completed the NELS:88 12th-grade mathematics test, and therefore have a NELS:88-NAEP score, were females, urban students, and poor mathematics test performers. Differences between the two groups (takers and non-takers) may restrict the variation in the NELS:88-NAEP scaled score sample, and in turn, constrain the generalizability of the findings in this report.

A.5 Data Quality

Issues concerning the reliability and validity of NELS:88 questionnaire and transcript data have been addressed in a number of documents (see especially Ingels et al. 1995; Ingels, Scott, and Taylor 1998; Kaufman and Rasinski 1991; McLaughlin and Cohen 1997). Since NELS:88 repeats much of the content of High School and Beyond (HS&B), findings on the quality of HS&B questionnaire and transcript data are also in many cases germane (see especially Fetters, Stowe, and Owings 1984). Reliability and validity of test data is documented in Rock and Pollack (1995).

A.6 Statistical Procedures

A.6.1 Student's *t* Statistic

Comparisons that have been drawn in the text of this report have been tested for statistical significance (set at a probability level of .05) to ensure that the differences are larger than those that might be expected due to sampling variation. The statistical comparisons in this report were based on the *t* statistic. Whether the statistical test is considered significant or not is determined by calculating a *t* value for the difference between a pair of means or proportions and comparing this value to published tables of values, called critical values (cv). The alpha level is an *a priori* statement of the probability that a difference exists in fact rather than by chance.

The *t* statistic between estimates from various subgroups presented in the tables can be computed by using the following formula:

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

where x_1 and x_2 are the estimates to be compared (e.g., the means of sample members in two groups), and SE_1 and SE_2 are their corresponding standard errors. This formula is valid only for independent estimates. When the estimates are not independent, a covariance term must be added to the denominator of the formula.

A.6.2 Logistic Regression

Analyses presented in chapter 2 employ the technique of logistic regression for categorical outcomes (Long 1997). All odds ratios are tested for statistical significance at the $p \leq .05$ level. Logistic regression produces coefficients estimating the impact of an independent variable on the probability of the dependent outcome, but their meaning is difficult to interpret. Odds ratios are a transformation of the coefficients that produce a value that, *above 1*, represent an increased likelihood of the outcome, *below 1* represent a decreased likelihood of the outcome, and at *statistically indistinguishable from 1* indicate no increased or decreased likelihood of the given outcome.

The percentage likelihood associated with a continuous characteristic or independent (predictor) variable, such as students' socioeconomic status or high school English GPA, should be interpreted as *any 1-unit change* (increase or decrease) *between contiguous values* of the characteristic. For categorical student characteristics, such as comparison of Blacks to Whites (the reference category) or females to males (the reference category), c is always equal to 1.

The results of logistic regressions are presented in terms of odds ratios because outcomes examined with logistic regression are binary or dichotomous. More specifically, the odds ratio is the ratio of the odds that X *will occur* versus *not occur* given a unit change in the independent variable. For the analysis examining the dichotomous outcome variable of performance at the Basic level on the NELS:88 NAEP-scaled mathematics assessment versus performance at the below-Basic level, the odds ratio is the ratio of the odds of a particular subgroup performing at the Basic level (versus performing at the below-Basic level) to the odds of a reference group performing at the Basic level (versus performing at the below-Basic level).

An odds ratio of greater than 1 indicates an increase in the odds of a particular subgroup performing at the Basic level relative to odds of a reference subgroup performing at the Basic level; an odds ratio of less than 1 indicates a decrease in the odds of one subgroup relative to the odds of a reference subgroup of performing at the Basic level on the NELS:88 NAEP-scaled mathematics assessment. For example in table 4, for the outcome comparing the odds associated with performing at the Basic versus the below-Basic level, after taking all other factors into account, the odds ratio of 1.27 for students attending Catholic high schools indicates that the odds of performing at the Basic level for Catholic high school students are 1.27 as large as the odds of performing at the Basic level for public high school students (the reference group in the model). Another way to interpret odds ratios is as follows: holding all other factors constant (e.g., SES, future educational expectations), the odds of performing at the Basic level for Catholic high school students is 27 percent higher than the odds of performing at the Basic level for public high school students [computed: (odds ratio – 1) * 100].

The formula for calculating the odds ratio and percentage likelihood associated with a change between values of a student characteristic (or independent variable that is either categorical or continuous) is:

$$\exp\ (\text{beta}_j)^c$$

where exp equals base e, a constant equal to 2.71828182845904, the base of the natural logarithm; and c equals the number of units change in X (e.g., 1, 2, 30).

A.7 Standard Errors

Because the NELS:88 sample design involved stratification, the disproportionate sampling of certain strata, and clustered (i.e., multistage) probability sampling, the resulting statistics are more variable than they would have been had they been based on data from a simple random sample of the same size. The NELS:88 analyses included in this report used the Taylor Series procedure to calculate standard errors as generated by AM statistical software (http://am.air.org). This procedure is also found in advanced statistical programs like SUDAAN or STATA.

A.8 Glossary—Variables Used

Descriptions of the variables appear below. The Glossary is organized into four sections:

- Demographic and status variables
- Assessment variables
- Education variables (high school)
- Education variables (postsecondary outcomes)

Within each section, variables are listed alphabetically. Variable names are prefixed with an indicator of the specific round of their origin. (For example, BY stands for base year, the 1988 survey of eighth-graders; F2 stands for the second follow-up, the interview that was conducted in 1992, F4F2 stands for a variable denoting a panel, for example F4F2P3WT means a particular postsecondary transcript weight for the second follow-up through fourth follow-up panel). Where a single questionnaire item is the basis for the variable, the variable name bolded within the parentheses of the heading will suffice to identify it (for example, F2SEX below). However, if the variable is a composite and is drawn from multiple sources, then these variables, too, are listed (for example, six NELS:88 base year student and parent questionnaire items comprise BYRISK).

Demographic Characteristics and 12th-Grade Status Variables

At-Risk Status (BYRISK): This base-year variable is used as a predictor of the student's future risk of school failure (including such outcomes as later dropping out of school). The construct appears in a number of NCES NELS:88 reports (e.g., Green and Scott 1995; Hafner et al. 1990; Ingels et al. 2002) and was constructed specifically for NELS:88 based on the theoretical work of Pallas, Natriello, and McDill (1989). The six academic risk factors are taken from the base year parent and student questionnaires:

(1) single-parent family (BYFCOMP=4 or 5),

(2) parents with no high school diploma (BYPARED=1),

(3) a sibling who had dropped out of school (BYP6=one or more other children),

(4) home alone (in the base year) more than 3 hours per day (BYS41=4),

(5) limited English proficiency (BYLEP=1), and

(6) 1987 income less than $15,000 (BYFAMINC less than $15,000).

In constructing this variable, first, the six risk factors were summed to obtain the number of risk factors the student had in the eighth grade—living in a single-parent household, having neither parent complete high school, having an older sibling who dropped out of high school, being home alone after school more than 3 hours a day, being limited English proficient, and being in a low-income family (less than $15,000 annual income in 1987). This sum was then recoded into five categories: (1) None, (2) One risk factor, (3) Two risk factors, (4) Three risk factors, and (5) Four or more risk factors.

Educational Expectations at 12th Grade (F2S43): This variable is a recode of the question that asked 12th-grade students to indicate "how far in school they think they will get." Students could choose one of various categories ranging from (1) high school or less, (2) some vocational/trade/ business school, (3) professional/trade school certificate/degree, (4) some college, (5) Bachelor's degree, (6) Master's degree, or (7) Ph.D. or other advanced degree.

Race/ethnicity (F2RACE1): This variable indicates student's "best known" race, based on second follow-up New Student Supplement data (when available) or F1RACE composite. The categories of this variable are (1) Asian, (2) Hispanic, (3) Black, (4) White, and (5) American Indian.

Region of 12th-Grade School (G12REGON): This variable indicates in which of the four U.S. Census regions the student's 12th-grade school is located, based on the school state. It was created by recoding the sampled state of the student's second follow-up school into the four Census Bureau regions, including (1) Northeast (New England or Mid-Atlantic states); (2) Midwest (East North Central and West North Central states); (3) South (South Atlantic, East South Central, and West South Central states); and (4) West (Mountain and Pacific states).

School Type at 12th Grade (G12CTRL2): This variable classifies the student's 12th-grade school type as (1) public, (2) Catholic, (3) NAIS, or (4) other private, as reported by the school. (NAIS = National Association of Independent Schools, a group of non-profit private schools with a shared educational ethos).

Sex (F2SEX): Sex (male or female) of student.

Socioeconomic Status (F2SES1Q): Socioeconomic status (SES) is available both as a continuous variable and as a categorical variable based on weighted quarters. The categorical form of the variable (F2SES1Q) divides SES1 into quarters based on the weighted marginal distribution. F2SES1 (the continuous form of the variable from which F2SES1Q is drawn) is a NLS-72/HS&B-comparable composite constructed from parent questionnaire data when available (student data are substituted if parent data are missing). F2SES1 is based on five equally weighted, standardized components: father's/guardian's education, mother's/guardian's education, family income, father's/guardian's occupational prestige score, and mother's/guardian's occupational prestige score. For most sample members, the SES composite was built from 8th-grade (1988) data. However, for subsequent new participants, including freshened students, the SES composite was built using 1990 or 1992 data.

Urbanicity of 12th-Grade School (G12URBAN3): This variable indicates the urbanicity of the student's 12th-grade school. It was created directly from Quality Education Data (QED) records. The classifications are the Federal Information Processing Standards (FIPS) as used by the U.S. Census. The categories include (1) Urban (i.e., central city), (2) Suburban (i.e., area surrounding a central city within a county constituting the Metropolitan Statistical Area), and (3) Rural (i.e., outside of the Metropolitan Statistical Area).

Assessment Variables

ACT Mathematics Test Score (F2RACTM): 12th-grade students' ACT mathematics scores from high school transcripts collapsed into seven categories: (1) 1 to 5, (2) 6 to 10, (3) 11 to 15, (4) 16 to 20, (5) 21 to 25, (6) 26 to 30, and (7) 31 to 36.

NELS:88-NAEP Mathematics Equated Score (F22XNAEP): This variable is the 1992 NELS:88 mathematics assessment score (specifically, the IRT-estimated number right score, which is on a scale of 0-81) placed on the 1992 NAEP mathematics assessment scale (the NAEP scale has a range of 0-500). (Thus, for example, a NELS:88 score of 20 was converted to a NAEP score of 212.74, a NELS:88 score of 50 to 301.58, of 70 to 351.12, and so on.) F22XNAEP is a continuous variable that was collapsed into the three levels of proficiency used in NAEP: (1) below basic (> 0 and < 288), (2) basic (≥ 288 and < 336), (3) proficient (≥ 336 and < 367), and (4) advanced (≥ 367 and 500). While the score is described as "equated" on the data file and in the documentation (Ingels et al. 1994; Rock and Pollack 1995), this report makes claims only for a weaker linkage, specifically a concordance. In this report, the NELS:88 NAEP-equated score is referred to as the "NAEP-scaled" score.

NELS:88 NAEP-Scaled Mathematics Score: See entry for NELS:88-NAEP Mathematics Equated Score (F22XNAEP) above.

SAT Mathematics Test Score (F2RSATV): 12th-grade students' SAT math scores from high school transcripts collapsed into six categories: (1) 200 to 300, (2) 310 to 400, (3) 410 to 500, (4) 510 to 600, (5) 610 to 700, and (6) 710 to 800. PLEASE NOTE, on the NELS:88 N2R (base year to second follow-up restricted-use) and N2P (base year to second follow-up public-use) ECBs, variables names for the SAT Math and SAT Verbal variables are reversed. The SAT Math variable is F2RSATV and the SAT Verbal variable is F2RSATM.

Education Variables (High School) from Transcripts

Grades: English GPA (F2RHENG2): This high school transcript variable indicates the student's average GPA (grade point average) in high school English. The continuous variable (F2RHEG2) was recoded into four categories: (1) A, (2) B, (3) C, and (4) D and below. This 4-

level version of English GPA is used in bivariate tabulations (tables 3, 5, 6, 7, and 8) and in logistic regressions (tables 9 and 10).

Grades: Math GPA (F2RHMAG2): This high school transcript variable indicates the student's average GPA in high school mathematics. The continuous variable (F2RHMAG2) was recoded into four categories: (1) A, (2) B, (3) C, and (4) D and below. This 4-level version of mathematics GPA is used in bivariate tabulations (tables 3, 5, 6, 7, and 8).

However, the original 13-level continuous mathematics grade variable is used in the logistic regression analysis in table 4. The 13-category continuous mathematics GPA variable is reverse-coded on the NELS:88 data files. A numerical value of 1.00 is equal to an "A+" and the numerical value of 13.00 is equal to an "F." Hence, the results are reported in the negative or in the reversed direction. Values are: A+ =1, A =2, A- =3, B+ = 4, B =5, B- =6, C+ =7, C =8, C- =9, D+ = 10, D =11, D- =12, F =13.

Highest Math Course Taken in High School (MATHPIPE): The purpose of the mathematics pipeline measure (Burkam and Lee 2003) is to capture the nature of the most advanced-level mathematics course completed. The mathematics curriculum in most schools specifies a sequence of courses of increasing difficulty. The variable is broken down into eight categories:

1 = No math;

2 = Non-academic math (general mathematics I, general mathematics II, basic mathematics I, basic mathematics II, basic mathematics III, consumer mathematics, technical mathematics, vocational mathematics, and review mathematics);

3 = Low-academic math (pre-algebra, algebra I-part 1, algebra I-part 2, and informal geometry);

4 = Middle-academic math I (algebra I, plane geometry, plane and solid geometry, unified math I, unified math II, and pure math);

5 = Middle-academic math II (algebra II, and unified mathematics III);

6 = Advanced math I (algebra III, advanced algebra, advanced mathematics, college algebra, algebra and trigonometry, algebra and analytic geometry, trigonometry, trigonometry and solid geometry, analytic geometry, advanced geometry, linear algebra, algebra honors, probability, probability and statistics, statistics, statistics other, independent study);

7 = Advanced math II (introductory analysis); and

8 = Advanced math III (Advanced Placement [AP] calculus, calculus and analytic geometry, calculus, AP mathematics, mathematics honors).

New Basics (F2RNWB3B): Indicates whether the student earned at least four Carnegie units in English; three units in each of social studies, science, and mathematics; and two credits in foreign language in high school. This transcript-derived variable has two categories: (1) failed the threshold, and (2) met the threshold.

Education Variables (Postsecondary Outcomes) from Transcripts

Postsecondary Attainment: Highest Degree Attained as of 2000 (HDEG): This postsecondary transcript-derived dependent measure is a recode of HDEG from the NELS:88

PETS:2000 data file. HDEG is the transcript report of highest degree earned (for students who enrolled in postsecondary school). The original values are: 1=no degree, 2=certificate, 3=associate's degree, 4=bachelor's degree, 5=post-baccalaureate coursework or certificate, 6= incomplete graduate degree or first incomplete professional degree, 7=master's degree, 8=first professional degree, 9=doctoral degree, -1=no transcripts received, -8=no claim to PSE.

The original variable was recoded. Values 1, 2, and 3 were retained as 1=no degree, 2=certificate, and 3=associate's degree. Values 5 through 9 were collapsed into the category bachelor's degree or higher=4. Values -1 and -9 were set to system missing.

Postsecondary Enrollment: Students' "First True" Postsecondary School of Attendance (REFITYPE): This variable is from the NELS:88 postsecondary transcript (PETS:2000) data file. It is the aggregated Carnegie Class type of first true institution attended, excluding any institutions the student attended exclusively prior to high school graduation, any institutions the student attended only in summer between high school graduation and the beginning of the fall semester, and all cases of "false starts." The original variable has 8 legitimate values and two reserve codes (each indicated by a minus sign): 1=doctoral; 2=comprehensive; 3=baccalaureate; 4=specialized 4-year; 5=community college; 6=other 2-year; 7=sub-associate; 8=unclassified; -1=missing, indeterminable; and -8=no claim to postsecondary education (PSE).

Values 1 through 4 were collapsed into the category 4-year school. Value 5 was assigned to the category 2-year school. Values 6 and 7 were collapsed into the category Sub-associate/other 2-year. Value -8 was assigned to the category No postsecondary education. Values -1 and 8 were set to system missing.

Remedial Math Courses Taken in Postsecondary School (REMMATH): This dependent variable is a recode of REMMATH from the NELS:88 postsecondary transcript (PETS:2000) data file. Original values 0 (none), 1 (one), and 2 (two) were retained. Original values 3 through 6 (meaning 3, 4, 5, or 6 remedial math courses were taken) were collapsed into the category of 3 or more remedial math courses taken. Values -1 (no transcripts received) and -8 (no claim to PSE) were recoded system missing.

Selectivity of First True Institution of Attendance (REFSELCT): This dependent variable is a recode of REFSELCT from the NELS:88 PETS:2000 data file. The original variables are: 1=highly selective; 2=selective; 3=non-selective; 4=open door; 5=unrated; 8=unknown institution; -1=missing, indeterminable; and -8=no claim to PSE. The original values were recoded to: highly selective=1, selective=2, non-selective=3, open door=4 and system missing=5, 8, -1 and -8. The PETS:2000 REFSELCT variable draws on the selectivity cells used in the Cooperative Institutional Research Project (CIRP) for 1992. (CIRP is administered by the Higher Education Research Institute at UCLA.) The "open door" category includes community colleges and area-vocational technical institutes. The "not-ratable" category includes foreign institutions, sub-baccalaureate vocational schools, and specialized degree-granting institutions (e.g., colleges of art and design).

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Appendix B
Standard Error Tables

Table B-1. Standard errors for mean achievement, standard deviation (SD), and percentage of high school seniors scoring at various levels of proficiency on the 1992 NAEP-scaled mathematics assessment, by proficiency levels: 1992

12th-grade NAEP proficiency level	Mean	Percent
Totals	0.65	†
Below basic	0.28	0.89
Basic	0.17	0.71
Proficient	0.20	0.54
Advanced	0.43	0.15

† Not applicable.

NOTE: In the five NAEP content strands, Basic level students demonstrate procedural and conceptual knowledge in solving problems; Proficient level students consistently integrate mathematical concepts and procedures to the solutions of more complex problems; Advanced level students consistently demonstrate the integration of procedural and conceptual knowledge and the synthesis of ideas. See figure 2 for more information.

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

Table B-2. **Standard errors for percentage of high school seniors scoring at the various levels of proficiency on the NAEP-scaled mathematics assessment, by selected student characteristics: 1992**

			1992 NAEP-equated level of proficiency							
			Below basic		Basic[1]		Proficient[1]		Advanced[1]	
Student characteristic	Mean	Sample size	SE	Sample size	SE	Sample size	SE	Sample size	SE	Sample size
Sex										
Male	0.81	6,400	1.13	2,100	0.98	3,100	0.71	1,000	0.23	220
Female	0.75	6,500	1.08	2,300	0.92	3,200	0.72	860	0.13	110
Race/ethnicity[2]										
White	0.66	9,200	0.88	2,600	0.77	4,800	0.66	1,500	0.18	240
Black	1.39	1,200	2.17	750	2.04	400	0.66	50	†	#
Hispanic	1.21	1,500	2.11	800	1.88	610	0.89	80	0.17	10
Asian	2.45	910	2.74	210	2.62	420	1.98	220	0.99	70
American Indian	3.52	130	5.19	70	5.13	50	†	#	†	#
Socioeconomic status										
Lowest quarter	0.83	2,500	1.38	1,500	1.32	850	0.38	80	0.06	10
Middle-low quarter	0.87	3,100	1.38	1,300	1.33	1,500	0.66	230	0.13	20
Middle-high quarter	0.76	3,200	1.20	1,000	1.20	1,800	0.73	410	0.16	40
Highest quarter	0.90	4,100	1.28	560	1.29	2,200	1.25	1,100	0.44	250
12th-grade school type										
Public	0.65	11,100	0.89	4,200	0.73	5,300	0.49	1,300	0.14	210
Catholic	2.03	770	2.52	150	2.82	460	2.46	150	0.69	20
NAIS	3.71	800	1.45	40	5.71	360	8.89	320	5.36	90
Other private	4.57	280	6.43	60	6.23	150	5.27	60	1.02	10
12th-grade school location										
Urban	1.40	3,700	1.91	1,200	1.48	1,700	1.28	650	0.34	130
Suburban	1.00	5,000	1.40	1,600	1.20	2,500	0.83	770	0.25	140
Rural	0.96	4,300	1.34	1,700	1.10	2,000	0.71	450	0.19	60

See notes at end of table.

Table B-2. Standard errors for percentage of high school seniors scoring at the various levels of proficiency on the NAEP-scaled mathematics assessment, by selected student characteristics: 1992—Continued

			1992 NAEP-equated level of proficiency							
			Below basic		Basic[1]		Proficient[1]		Advanced[1]	
Student characteristic	Mean	Sample size	SE	Sample size	SE	Sample size	SE	Sample size	SE	Sample size
12th-grade school region										
Northeast	1.47	2,400	1.80	630	1.48	1,300	1.45	460	0.48	90
Midwest	1.01	3,500	1.40	1,100	1.26	1,800	0.90	520	0.24	90
South	1.07	4,500	1.53	1,800	1.25	2,100	0.85	530	0.23	100
West	1.58	2,500	2.15	950	1.68	1,100	1.14	350	0.27	50

† Not applicable.

Rounds to zero.

[1] In the five NAEP content strands, Basic level students demonstrate procedural and conceptual knowledge in solving problems; Proficient level students consistently integrate mathematical concepts and procedures to the solutions of more complex problems; Advanced level students consistently demonstrate the integration of procedural and conceptual knowledge and the synthesis of ideas.

[2] Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or other Pacific Islander, and American Indian includes Alaska Native. Race categories exclude Hispanic origin unless specified.

NOTE: Sample sizes are approximate and unweighted.

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

Table B-3. Standard errors for percentage of high school seniors scoring at various levels of proficiency on the NAEP-scaled NELS:88 mathematics assessment, by student background characteristics or high school performance measures: 1992

Student characteristic or high school performance measure	Mean	Sample size	1992 NAEP-equated level of proficiency							
			Below basic		Basic[1]		Proficient[1]		Advanced[1]	
			SE	Sample size	SE	Sample size	SE	Sample size	SE	Sample size
12th-grade student report of own educational expectation										
High school or less	1.75	580	2.49	410	2.50	170	0.81	10	†	#
Some vocational/trade/business school	1.29	600	2.22	390	2.19	200	0.46	10	†	#
Professional/trade school certificate/degree	1.33	660	2.57	410	2.56	240	0.37	10	†	#
Some college	0.91	1,600	1.84	930	1.82	670	0.38	30	†	#
Bachelor's degree	0.67	4,200	1.11	1,000	1.15	2,500	0.73	580	0.13	50
Graduate degree	0.99	4,300	1.21	730	1.19	2,100	1.23	1,200	0.43	270
8th grade math achievement										
Lowest quarter	0.65	1,800	0.80	1,600	0.79	190	†	#	†	#
Middle 1 quarter	0.54	2,600	1.45	1,600	1.45	1,100	0.21	10	†	#
Middle 2 quarter	0.58	3,100	1.19	590	1.19	2,400	0.41	140	†	#
Highest quarter	0.52	4,000	0.32	70	1.26	2,000	1.24	1,600	0.46	290
10th grade math achievement										
Lowest quarter	0.54	2,000	0.37	1,900	0.37	60	†	#	†	#
Middle 1 quarter	0.39	2,800	1.26	1,700	1.26	1,100	†	#	†	#
Middle 2 quarter	0.34	3,300	0.72	350	0.74	2,900	0.25	40	†	#
Highest quarter	0.46	4,000	0.10	20	1.36	1,900	1.33	1,700	0.46	300
At-risk status										
0 risk factors	0.68	7,500	0.87	1,900	0.81	3,900	0.73	1,400	0.23	250
1 risk factor	0.92	2,800	1.53	1,100	1.47	1,300	0.75	290	0.15	40
2 risk factors	1.38	1,100	2.47	610	2.25	460	0.76	70	0.23	10
3 risk factors	1.80	380	2.93	260	2.88	110	0.69	10	†	#
4 or more risk factors	3.21	110	6.37	80	6.37	20	†	#	†	#
SAT math score										
200 to 300	1.67	200	2.02	190	2.02	20	†	#	†	#
310 to 400	0.74	890	2.49	350	2.49	540	†	#	†	#
410 to 500	0.57	1,200	0.75	70	0.86	1,100	0.50	40	†	#
510 to 600	0.53	1,300	0.24	10	2.35	810	2.34	480	0.17	10
610 to 700	0.95	780	0.32	10	2.17	100	2.20	570	1.35	100
710 to 800	1.20	250	†	#	1.32	10	5.42	90	5.40	150
ACT math score										
06 to 10	3.77	10	#	10	†	#	†	#	†	#
11 to 15	1.23	500	2.29	380	2.29	130	#	#	†	#

See notes at end of table.

Table B-3. Standard errors for percentage of high school seniors scoring at various levels of proficiency on the NAEP-scaled NELS:88 mathematics assessment, by student background characteristics or high school performance measures: 1992—Continued

			1992 NAEP-equated level of proficiency							
			Below basic		Basic[1]		Proficient[1]		Advanced[1]	
Student characteristic or high school performance measure	Mean	Sample size	SE	Sample size	SE	Sample size	SE	Sample size	SE	Sample size
ACT math score—Continued										
16 to 20	0.71	1,500	2.28	380	2.27	1,100	0.42	30	†	#
21 to 25	0.54	1,200	0.42	30	1.41	890	1.40	250	†	#
26 to 30	0.82	630	†	#	2.18	140	2.29	430	1.16	50
31 to 36	1.84	120	†	#	†	#	6.47	50	6.30	70
Completion of new basics[2]										
Failed threshold	0.66	7,700	0.99	3,600	0.85	3,400	0.39	670	0.10	100
Met threshold	0.75	4,300	1.03	500	1.27	2,500	1.10		0.33	210
Average grade in math										
D or below	0.84	1,900	1.52	1,300	1.49	610	0.16	10	†	#
C	0.78	4,600	1.34	2,000	1.28	2,400	0.63	210	0.04	10
B	0.81	3,800	1.16	630	1.20	2,300	0.98	810	0.20	70
A	0.93	1,600	0.77	60	1.82	580	1.93	720	0.94	220
Highest math course taken[3]										
No math	6.90	70	7.19	50	6.52	20	†	#	†	#
Non-academic	1.11	720	0.91	680	0.91	40	†	#	†	#
Low academic	1.10	730	1.47	640	1.47	90	†	#	†	#
Mid academic I	0.73	2,600	1.43	1,600	1.42	960	0.23	20	†	#
Mid academic II	0.67	2,900	1.61	840	1.56	2,000	0.36	100	†	#
Advanced math I	0.89	1,900	1.51	210	1.65	1,400	1.12	290	0.14	10
Advanced math II: Pre-calculus	0.76	1,500	0.56	60	2.11	940	2.12	490	0.37	30
Advanced math III: Calculus	0.89	1,600	0.46	20	1.80	440	1.94	850	1.20	260

† Not applicable.

Rounds to zero.

[1] In the five NAEP content strands, Basic level students demonstrate procedural and conceptual knowledge in solving problems; Proficient level students consistently integrate mathematical concepts and procedures to the solutions of more complex problems; Advanced level students consistently demonstrate the integration of procedural and conceptual knowledge and the synthesis of ideas.

[2] Met threshold of new basics indicates that students earned at least four Carnegie units in English, three units in each of social studies, science, and math, and two units in foreign language.

[3] Non academic mathematics courses are such courses as general mathematics I, general mathematics II, basic mathematics I, and technical mathematics. Low academic mathematics courses are such courses as pre-algebra, algebra-I part 1, algebra II part 2, and informal geometry. Middle academic mathematics courses are such courses as algebra I, plane geometry, unified mathematics I, algebra II, and unified mathematics III. Advanced mathematics courses are such courses as algebra II, college algebra, probability and statistics, introductory analysis, calculus, and AP mathematics. For more information see technical appendix A.

NOTE: Sample sizes are approximate and unweighted. Details 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), “Base Year Student Survey, 1988;” “First Follow-up Student Survey, 1990;” and “Second Follow-up Student Survey, 1992.”

Table B-4. Standard errors for percentage of 1992 high school seniors attending postsecondary school, by selected student characteristics: 1994

Student characteristic	Postsecondary school of attendance							
	No postsecondary education		4-year school		2-year school		Sub-associate/ other 2-year school	
	SE	Sample size	SE	Sample size	SE	Sample size	SE	Sample size
Total	0.68	3,200	0.89	5,200	0.74	2,900	0.28	
12th-grade NAEP proficiency score								
Below basic	1.20	1,600	0.80	580	1.29	1,000	0.61	210
Basic[1]	0.73	790	1.20	2,400	1.10	1,200	0.36	150
Proficient[1]	1.03	70	1.51	1,100	1.07	130	0.39	10
Advanced[1]	1.22	10	2.21	190	1.40	10	†	#
Highest mathematics course taken in high school[2]								
No math	9.24	40	4.69	10	4.90	10	†	#
Non-academic	2.02	470	0.80	30	1.87	150	0.82	40
Low-academic	2.64	390	1.24	40	2.34	190	2.14	40
Middle academic I	1.42	980	1.07	340	1.43	840	0.59	150
Middle academic II	1.09	530	1.48	1,100	1.62	750	0.54	110
Advanced academic I	1.08	160	1.91	1,100	1.71	340	0.48	40
Advanced academic II (pre-calculus)	1.05	50	1.78		1.38	180	0.52	10
Advanced academic III (calculus)	0.69	50	1.34	1,100	1.09	90	0.32	10
Average grade in mathematics								
D or below	1.71	780	1.21	310	1.80	500	0.70	110
C	1.01	1,200	1.20	1,400	1.16	1,200	0.43	190
B	0.95	500	1.38	1,900	1.17	670	0.55	80
A	0.93	90	1.59	1,000	1.21	140	0.43	20
Average grade in English								
D or below	1.90	620	1.10	1,300	1.60	220	0.85	30
C	1.12	1,300	1.14	2,300	1.36	970	0.49	140
B	0.80	600	1.33	910	1.14	1,100	0.48	190
A	0.64	80	1.32	100	1.14	240	0.35	50
8th-grade mathematics test score								
Lowest quarter	1.56	930	1.12	290	1.39	500	1.02	120
Middle-low quarter	1.30	870	1.25	710	1.56	780	0.60	140
Middle-high quarter	1.07	670	1.34	1,400	1.32	760	0.41	110
Highest quarter	0.70	300	1.33	2,500	1.12	530	0.42	60
Student's educational expectations								
High school or less	1.83	520	0.47	10	1.73	40	0.50	10
Some vocational/trade/business school	2.32	380	0.73	20	1.95	130	1.45	50
Trade school certificate	2.54	330	1.10	30	2.36	160	1.81	80
Some college	1.65	610	1.08	180	1.69	590	1.21	120
Bachelor's degree	0.75	550	1.28	2,100	1.23	1,000	0.33	100
Graduate/professional degree	0.82	340	1.37	2,700	1.21	670	0.28	60
Socioeconomic status								
Lowest quarter	1.47	1,200	1.01	560	1.39	620	0.57	140
Middle-low quarter	1.19	990	1.02	880	1.33	790	0.49	140
Middle-high quarter	1.12	640	1.33	1,400	1.15	880	0.45	130
Highest quarter	0.67	240	1.57	2,400	1.36	550	0.65	60

See notes at end of table.

Table B-4. Standard errors for percentage of 1992 high school seniors attending postsecondary school, by selected student characteristics: 1994—Continued

	Postsecondary school of attendance							
	No postsecondary education		4-year school		2-year school		Sub-associate/ other 2-year school	
Student characteristic	SE	Sample size	SE	Sample size	SE	Sample size	SE	Sample size
Race/ethnicity[3]								
White	0.76	2,100	1.05	3,700	0.87	1,900	0.34	300
Black	2.13	390	1.97	500	1.83	240	0.83	60
Hispanic	1.93	490	1.71	440	2.17	460	0.71	80
Asian	1.83	140	2.77	550	2.40	250	1.30	30
American Indian	5.22	60	4.20	30	5.75	30	†	#
Sex								
Male	0.95	1,700	1.09	2,400	0.98	1,400	0.41	190
Female	0.83	1,400	1.12	2,800	0.92	1,500	0.39	290

† Not applicable.

Rounds to zero.

[1] In the five NAEP content strands, Basic level students demonstrate procedural and conceptual knowledge in solving problems; Proficient level students consistently integrate mathematical concepts and procedures to the solutions of more complex problems; Advanced level students consistently demonstrate the integration of procedural and conceptual knowledge and the synthesis of ideas.

[2] Non-academic mathematics courses are such courses as general mathematics I, general mathematics II, basic mathematics I, and technical mathematics. Low academic mathematics courses are such courses as pre-algebra, algebra I-part 1, algebra II-part 2, and informal geometry. Middle academic mathematics courses are such courses as algebra I, plane geometry, unified mathematics I, algebra II, and unified mathematics III. Advanced mathematics courses are such courses as algebra II, college algebra, probability and statistics, introductory analysis, calculus and AP mathematics. For more information see technical appendix A.

[3] Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or other Pacific Islander, and American Indian includes Alaska Native. Race categories exclude Hispanic origin unless specified.

NOTE: Sample sizes are approximate and unweighted.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study of 1988 (NELS:88), "Base Year Student Survey, 1988"; "Second Follow-up Student Survey, 1992"; "Third Follow-up Student Survey, 1994."

Table B-5. Standard errors for percentage of 1992 high school seniors who attended postsecondary school, by highest degree attained and selected student characteristics: 2000

	Highest degree attained							
	No degree		Certificate		Associate's degree		Bachelor's degree or higher	
Student characteristic	SE	Sample size	SE	Sample size	SE	Sample size	SE	Sample size
Total	1.00	3,200	0.42	380	0.49	670	1.07	4,000
12th-grade NAEP proficiency score								
Below basic	2.02	1,000	1.10	180	1.17	180	1.64	300
Basic[1]	1.13	1,300	0.63	120	0.71	330	1.38	1,800
Proficient[1]	1.78	200	0.20	10	0.47	30	1.83	960
Advanced[1]	2.26	20	†	#	†	#	2.46	170
Highest mathematics course taken in high school[2]								
No math	7.19	10	†	#	†	#	†	#
Non-academic	3.39	160	2.57	30	2.15	20	1.28	10
Low-academic	3.14	200	2.34	30	1.30	20	1.94	20
Middle academic I	2.16	830	1.32	130	1.34	170	1.72	190
Middle academic II	1.88	870	1.17	90	1.16	220	1.73	730
Advanced academic I	1.86	360	0.39	40	0.97	100	2.02	870
Advanced academic II (pre-calculus)	1.64	210	0.38	10	0.75	60	1.92	800
Advanced academic III (calculus)	2.31	150	0.23	10	0.65	20	2.36	940
Average grade in mathematics								
D or below	2.55	610	1.20	70	0.97	80	2.29	130
C	1.57	1,300	0.97	170	0.95	270	1.47	930
B	1.60	700	0.54	80	0.82	210	1.72	1,500
A	1.41	140	0.34	10	1.01	40	1.70	970
Average grade in English								
D or below	2.86	330	1.79	40	1.41	30	2.02	20
C	1.90	1,300	1.15	190	0.88	210	1.65	520
B	1.31	910	0.54	110	0.90	290	1.51	1,500
A	1.53	200	0.24	10	0.56	50	1.61	1,100
8th-grade math achievement level								
Lowest quarter	2.29	540	1.11	70	1.25	70	1.67	130
Middle-low quarter	1.84	730	0.87	100	0.94	150	1.69	420
Middle-high quarter	1.50	870	0.54	90	0.96	200	1.52	900
Highest quarter	1.29	690	0.64	40	0.50	130	1.41	1,800
12th-grader's educational expectations								
High school or less	7.47	90	5.76	20	3.31	10	5.86	10
Some vocational/trade/business school	3.77	130	2.86	40	2.86	30	1.50	10
Trade school certificate/degree	4.60	180	3.89	60	4.19	60	0.82	10
Some college	2.39	560	1.18	80	1.73	140	1.91	120
Bachelor's degree	1.49	1,310	0.70	100	0.67	220	1.48	1,500
Graduate/professional degree	1.54	860	0.42	60	0.67	150	1.60	1,900
Socioeconomic status								
Lowest quarter	2.28	620	1.55	120	1.56	120	1.56	190
Middle-low quarter	1.83	910	0.86	110	1.35	230	1.50	510
Middle-high quarter	1.67	1,100	0.55	100	0.87	190	1.62	1,000
Highest quarter	1.38	750	0.67	60	0.53	120	1.53	1,900

See notes at end of table.

Table B-5. Standard errors for percentage of 1992 high school seniors who attended postsecondary school, by highest degree attained and selected student characteristics: 2000—Continued

	Highest degree attained							
	No degree		Certificate		Associate's degree		Bachelor's degree or higher	
Student characteristic	SE	Sample size	SE	Sample size	SE	Sample size	SE	Sample size
Race/ethnicity[3]								
White	1.02	2,300	0.49	300	0.57	520	1.13	3,000
Black	3.61	460	1.26	40	1.15	40	3.25	240
Hispanic	2.97	460	1.21	40	1.68	60	2.48	180
Asian	3.72	160	1.60	20	3.03	30	4.19	210
American Indian	6.29	50	†	#	†	#	5.45	10
Sex								
Male	1.52	1,900	0.44	150	0.69	290	1.46	1,600
Female	1.21	1,600	0.69	250	0.69	370	1.34	2,100

† Not applicable.

Rounds to zero.

[1] In the five NAEP content strands, Basic level students demonstrate procedural and conceptual knowledge in solving problems; Proficient level students consistently integrate mathematical concepts and procedures to the solutions of more complex problems; Advanced level students consistently demonstrate the integration of procedural and conceptual knowledge and the synthesis of ideas.

[2] Non-academic mathematics courses are such courses as general mathematics I, general mathematics II, basic mathematics I, and technical mathematics. Low academic mathematics courses are such courses as pre-algebra, algebra I-part 1, algebra II-part 2, and informal geometry. Middle academic mathematics courses are such courses as algebra I, plane geometry, unified mathematics I, algebra II, and unified mathematics III. Advanced mathematics courses are such courses as algebra II, college algebra, probability and statistics, introductory analysis, calculus and AP mathematics. For more information see technical appendix A.

[3]Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or other Pacific Islander, and American Indian includes Alaska Native. Race categories exclude Hispanic origin unless specified.

NOTE: Sample sizes are approximate and unweighted. Details 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:88/2000), "Post Secondary Education Transcript Study (PETS), 2000."

Table B-6. Standard errors for percentage of 1992 high school seniors who attended postsecondary school, by number of remedial mathematics courses taken and selected student characteristics: 2000

	Number of remedial mathematics courses taken							
	#		1.00		2.00		3 or more	
Student characteristic	SE	Sample size	SE	Sample size	SE	Sample size	SE	Sample size
Total	1.02	5,900	0.80	1,100	0.55	480	0.43	360
12th-grade NAEP proficiency score								
Below basic	2.30	700	2.12	370	1.73	220	1.46	240
Basic[1]	1.13	2,800	0.97	470	0.53	150	0.46	60
Proficient[1]	0.54	1,200	0.52	20	†	#	†	#
Advanced[1]	0.63	180	†	#	†	#	†	#
Highest mathematics course taken in high school[2]								
No math	5.92	10	†	#	†	#	†	#
Non-academic	4.48	70	3.60	40	5.09	30	3.69	30
Low academic	4.53	110	3.26	60	2.15	30	2.92	40
Middle academic I	2.35	570	2.13	310	1.64	180	1.52	150
Middle academic II	2.11	1,300	1.92	370	0.95	120	1.02	70
Advanced academic I	1.83	1,200	1.57	130	0.73	40	0.49	20
Advanced academic II (pre-calculus)	2.04	1,000	1.78	40	1.08	20	†	#
Advanced academic III (calculus)	0.31	1,100	0.31	10	†	#	†	#
Average grade in mathematics								
D or below	2.99	390	2.89	210	1.97	110	2.52	100
C	1.70	1,700	1.57	510	1.00	220	0.64	160
B	1.10	2,100	0.81	230	0.56	70	0.41	50
A	1.61	1,100	1.59	20	0.33	10	†	#
Average grade in English								
D or below	3.87	170	2.83	90	2.97	40	2.14	50
C	2.11	1,200	1.94	430	1.02	190	1.16	180
B	1.37	2,500	1.01	390	0.79	160	0.38	90
A	1.28	1,400	1.25	60	0.32	20	0.16	10
8th-grade mathematics test score								
Lowest quarter	2.78	310	2.17	200	2.42	130	1.76	110
Middle-low quarter	2.06	860	1.84	330	1.28	160	1.30	120
Middle-high quarter	1.54	1,600	1.47	330	0.75	120	0.40	70
Highest quarter	0.81	2,800	0.78	150	0.22	30	0.11	10
Student's educational expectations								
High school or less	8.76	60	8.97	30	2.85	10	†	#
Some vocational/trade/business school	4.13	120	3.56	50	3.08	20	†	#
Trade school certificate	4.84	170	4.18	60	3.51	20	1.09	20
Some college	2.77	450	2.36	190	2.25	110	1.20	70
Bachelor's degree	1.46	2,200	1.26	420	0.76	180	0.67	150
Graduate/professional degree	1.33	2,600	1.11	280	0.46	110	0.64	80
Socioeconomic status								
Lowest quarter	3.02	680	2.09	230	2.40	120	1.05	100
Middle-low quarter	1.91	1,200	1.85	310	0.93	130	0.98	90
Middle-high quarter	1.72	1,600	1.49	320	0.86	140	0.99	110
Highest quarter	1.25	2,400	1.11	230	0.63	80	0.41	60

See notes at end of table.

Table B-6. Standard errors for percentage of 1992 high school seniors who attended postsecondary school, by number of remedial mathematics courses taken and selected student characteristics: 2000—Continued

	Number of remedial mathematics courses taken							
	#		1.00		2.00		3 or more	
Student characteristic	SE	Sample size	SE	Sample size	SE	Sample size	SE	Sample size
Race/ethnicity[3]								
White	0.97	4,400	0.84	730	0.44	270	0.40	180
Black	3.86	360	3.51	140	2.54	60	2.26	60
Hispanic	3.59	490	2.36	160	2.77	100	1.96	90
Asian	3.52	590	2.74	60	2.60	40	1.03	20
American Indian	10.85	40	4.91	10	†	#	5.49	10
Sex								
Male	1.48	2,800	1.20	480	0.73	210	0.74	160
Female	1.28	3,200	0.98	620	0.75	260	0.44	210

† Not applicable.

Rounds to zero.

[1] In the five NAEP content strands, Basic level students demonstrate procedural and conceptual knowledge in solving problems; Proficient level students consistently integrate mathematical concepts and procedures to the solutions of more complex problems; Advanced level students consistently demonstrate the integration of procedural and conceptual knowledge and the synthesis of ideas.

[2] Non-academic mathematics courses are such courses as general mathematics I, general mathematics II, basic mathematics I, and technical mathematics. Low academic mathematics courses are such courses as pre-algebra, algebra I-part 1, algebra II-part 2, and informal geometry. Middle academic mathematics courses are such courses as algebra I, plane geometry, unified mathematics I, algebra II, and unified mathematics III. Advanced mathematics courses are such courses as algebra II, college algebra, probability and statistics, introductory analysis, calculus and AP mathematics. For more information see technical appendix A.

[3]Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or other Pacific Islander, and American Indian includes Alaska Native. Race categories exclude Hispanic origin unless specified.

NOTE: Sample sizes are approximate and unweighted. Details 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:88/2000), "Post Secondary Education Transcript Study (PETS), 2000."

Table B-7. Standard errors for percentage of 1992 high school seniors who attended postsecondary school, by selectivity of first postsecondary school attended and selected student characteristics: 2000

	Selectivity of first postsecondary school attended							
	Highly selective		Selective		Non-selective		Open door	
Student characteristic	SE	Sample size	SE	Sample size	SE	Sample size	SE	Sample size
Total	0.46	340	0.73	1,100	1.02	3,400	1.15	3,000
12th-grade NAEP-scaled proficiency score								
Below basic	†	#	0.67	40	1.86	480	1.99	1,000
Basic[1]	0.26	40	0.94	390	1.38	1,800	1.46	1,300
Proficient[1]	1.48	130	2.48	360	2.44	560	1.38	130
Advanced[1]	5.59	70	6.67	70	5.88	40	1.57	10
Highest mathematics course taken in high school[2]								
No math	†	#	†	#	†	#	9.51	10
Non academic	†	#	†	#	2.41	20	2.48	160
Low academic	†	#	†	#	2.98	40	2.98	200
Middle academic I	0.62	#	0.47	20	1.83	300	1.95	890
Middle academic II	0.76	10	0.92	110	2.00	880	2.11	810
Advanced academic I	0.65	20	1.50	220	2.19	750	2.24	350
Advanced academic II (pre-calculus)	0.59	50	2.38	250	2.63	600	1.81	180
Advanced academic III (calculus)	1.66	220	2.7	360	2.71	430	1.10	90
Average grade in mathematics								
D or below	†	#	0.38	20	2.41	270	2.64	140
C	0.36	10	0.68	160	1.61	1,100	1.71	690
B	0.61	100	1.32	480	1.60	1,200	1.54	1,300
A	1.43	190	2.51	300	2.48	510	1.47	140
Average grade in English								
D or below	†	#	†	#	3.05	90	3.08	270
C	0.65	20	0.53	70	1.83	700	1.96	1,300
B	0.36	50	1.20	440	1.53	1,300	1.55	950
A	1.24	130	2.02	340	2.27	650	1.27	190
8th-grade mathematics test score								
Lowest quarter	†	#	0.48	20	2.43	230	2.45	530
Middle-low quarter	†	#	0.64	50	1.89	590	1.93	830
Middle-high quarter	0.59	10	0.97	220	1.74	1,100	1.70	850
Highest quarter	0.77	300	1.43	730	1.55	1,400	1.32	550
12th-grader's educational expectations								
High school or less	†	#	†	#	2.94	10	3.14	110
Some vocational/trade/business school	†	#	†	#	3.95	30	3.94	140
Trade school certificate	†	#	†	#	2.6	30	2.69	220
Some college	†	#	0.73	10	1.87	160	1.97	640
Bachelor's degree	0.41	40	0.82	290	1.5	1,500	1.63	1,200
Graduate/professional degree	1.01	200	1.44	640	1.66	1,300	1.59	700
Socioeconomic status								
Lowest quarter	0.79	10	0.84	40	2.47	320	2.58	590
Middle-low quarter	0.21	10	0.71	90	1.66	580	1.74	930
Middle-high quarter	0.78	50	0.88	200	1.75	1,000	1.86	1,000
Highest quarter	0.91	180	1.46	650	1.64	1,300	1.58	650

See notes at end of table.

Table B-7. Standard errors for percentage of 1992 high school seniors who attended postsecondary school, by selectivity of first postsecondary school attended and selected student characteristics: 2000—Continued

	Selectivity of first postsecondary school attended							
	Highly selective		Selective		Non-selective		Open door	
Student characteristic	SE	Sample size	SE	Sample size	SE	Sample size	SE	Sample size
Race/ethnicity[3]								
White	0.39	150	0.88	810	1.16	2,600	1.24	2,300
Black	2.17	30	1.65	60	3.51	300	4.09	320
Hispanic	1.22	20	2.34	60	3.29	210	3.32	400
Asian	2.56	50	2.46	70	3.27	130	3.83	160
American Indian	†	#	†	#	8.68	20	9.27	30
Sex								
Male	0.64	140	0.87	470	1.41	1,500	1.51	1,600
Female	0.50	130	1.03	520	1.31	1,800	1.47	1,600

† Not applicable.

Rounds to zero.

[1] In the five NAEP content strands, Basic level students demonstrate procedural and conceptual knowledge in solving problems; Proficient level students consistently integrate mathematical concepts and procedures to the solutions of more complex problems; Advanced level students consistently demonstrate the integration of procedural and conceptual knowledge and the synthesis of ideas.

[2] Non-academic mathematics courses are such courses as general mathematics I, general mathematics II, basic mathematics I, and technical mathematics. Low academic mathematics courses are such courses as pre-algebra, algebra I-part 1, algebra II-part 2, and informal geometry. Middle academic mathematics courses are such courses as algebra I, plane geometry, unified mathematics I, algebra II, and unified mathematics III. Advanced mathematics courses are such courses as algebra II, college algebra, probability and statistics, introductory analysis, calculus and AP mathematics. For more information see technical appendix A.

[3] Black includes African American, Hispanic includes Latino, Asian includes Native Hawaiian or other Pacific Islander, and American Indian includes Alaska Native. Race categories exclude Hispanic origin unless specified.

NOTE: Sample sizes are approximate and unweighted. Details 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:88/2000), “Post Secondary Education Transcript Study (PETS), 2000.”