This document describes the survey methodology, sources of error, response rates, nonresponse bias analysis, and statistical procedures for the Statistics in Brief report *Public High School Students' Career and Technical Education Coursetaking: 1992 to 2013* (NCES 2020-010). See https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2020010 for the body of that report.

Methodology and Technical Notes

Survey Methodology

The high school transcript data used in this report were collected through three longitudinal studies of secondary school students conducted by NCES between 1988 and 2009: NELS:88, ELS:2002, and HSLS:09. Descriptions of each of these datasets follow.

NELS:88 began in 1988 with a survey of a nationally representative sample of 24,599 eighth-grade students in 1,052 schools. Two in-school follow-ups were conducted in 1990 and 1992, when most sample members were in the 10th and 12th grades, respectively. For each in-school follow-up, the student sample was freshened to obtain a representative sample of 10th-grade students in 1990 and 12th-grade students in 1992. Dropouts and early graduates remained in the sample and were included in follow-up data collections. High school transcripts were collected from selected schools in 1992 (the year in which most sample members graduated from high school) for a subset of sample members, including dropouts and early graduates.

The 1992 analyses presented in this report are based on 10,626 NELS:88 students in grade 12 who graduated from public schools by August 31, 1992, and had transcripts deemed to be complete (recorded at least 16 Carnegie units and completed a positive, nonzero number of units in English). The demographic characteristics of 1992 high school graduates came from NELS:88 first and second follow-up data files, and coursetaking information came from the high school transcript

EXHIBIT 1. Variables Used

Data source and variable label	Variable name
NELS:88	
Course code[1]	F2CSSC
Number of credits earned	F2RSCRED
Grade level in which course was taken	F2RGRLEV
Sex	F2SEX
Race/ethnicity	F2RACE1
Spring 1992 senior cohort member	G12COHRT
High school completion status	F2TROUT
School control	TRNCTRL2
Weight	F2TRSCWT
Strata	SSTRATID
Cluster	SCH_ID
ELS:2002	
Course code[1]	F1CCSSC
Number of credits earned	F1CSCRED
Grade level in which course was taken	F1CGRLEV
Sex	F1SEX
Race/ethnicity	F1RACE
Spring 2004 cohort member	G12COHRT
High school completion status	F1RTROUT
Date student left high school	F1RDTLFT
School control	F1RSLCTR
Weights	F1TRSCWT, F1TRS1-F1TRS20
HSLS:09	
Course code[1]	T3SSCED
Number of credits earned	T3SCRED
Grade level in which course was taken	T3SGRLEV
Duplicate course indicator	T3SCRSE_DUP
Sex	X1SEX
Race/ethnicity	X2RACE
English was first language	X2NATIVELANG
IEP in grade 9	X1IEPFLAG
Parents' highest education	X2PAREDU
Locale	X3LOCALE
Grade 9 mathematics course level	X3THIMATH9

Table continued on next page

data file. Weights were developed to adjust information from graduates with complete records to represent all graduates in the NELS:88 cohort; these weights were used in this report. For more information on the NELS:88 transcript study, including detailed descriptions of response rates, see *User's Manual: NELS:88 Second Follow-up: Transcript Component Data File* (Ingels et al. 1995).

ELS:2002 started in 2002 with a survey of a nationally representative sample of 15,362 students in grade 10 in 752 schools. A second in-school data collection was conducted in 2004, when most sample members were high school seniors. As with NELS:88, the sample was freshened in 2004 to provide a nationally representative sample of 12th-graders, and students who had left school or graduated early continued to be followed. High school transcripts were collected in fall 2004 for students who completed either the base-year or first follow-up questionnaire.

The 2004 statistics presented in this report are based on data collected for 8,640 ELS:2002 students in grade 12 who graduated from public schools by August 31, 2004, and were deemed to have complete transcripts. Demographic data were drawn from the first follow-up data file, and coursetaking data were drawn from the high school transcript data file. Weights were developed to adjust information from graduates with complete records to represent all graduates in the ELS:2002 cohort; these weights were used in this report. For more information on the ELS:2002 transcript study, including detailed descriptions of response rates, see *Education Longitudinal Study of 2002 (ELS:2002) Base-Year to Second Follow-up Data File Documentation* (Ingels et al. 2007).

EXHIBIT 1. Variables Used (Continued)

Data source and variable label	Variable name
Grade 9 mathematics achievement score	X2TXMTSCOR
Sample member response status by round	X3UNIV1
2013 update response status	X3SQSTAT
High school completion status	X3HSCOMPSTAT
High school completion date	X3HSCOMPDATE
School control	X3CONTROL
Weights	W3W1STUTR, W3W1STUTR001-W3W1STUTR200

[1] Course names in NELS:88 and ELS:2002 were converted to codes using the School Courses for the Exchange of Data (SCED), version 2.0 (see Henke et al. 2019). HSLS:09 data were originally coded using the SCED, version 2.0. For this analysis, SCED-coded courses in all three datasets were classified into subject areas using the Secondary School Course Taxonomy (SSCT) (see Hudson 2019).

HSLS:09 began in 2009 with a survey of a nationally representative sample of 21,444 ninth-grade students attending 944 schools that included both grades 9 and 11. Sample members have been surveyed three more times to date: in 2012 when most were juniors; after the 2012–13 school year, when most had just graduated from high school; and in 2016 when most were 3 years out of high school. HSLS:09 did not freshen its sample when most of its sample members were 12th-graders as NELS:88 and ELS:2002 had done. Based on analyses of data from three NCES high school longitudinal studies prior to HSLS:09, Dalton et al. (2007) found no measurable differences in student characteristics or coursetaking estimates when using freshened and unfreshened samples. High school transcripts were collected following the 2012–13 school year for students who completed the base-year or the first follow-up questionnaire.

The 2013 analyses in this report are based on 11,499 HSLS:09 students who were in ninth grade in 2009; graduated from public schools by August 31, 2013; and were deemed to have complete transcripts. Demographic data were drawn from the base-year and 2013 update data files, and coursetaking data were drawn from the high school transcript data file. For more information on the HSLS:09 transcript study, including detailed descriptions of response rates, see *High School Longitudinal Study of 2009 (HSLS:09) 2013 Update and High School Transcripts Data File Documentation* (Ingels et al. 2015).

Sources of Error in the Estimates

Two broad categories of error occur in estimates generated from surveys: sampling and nonsampling errors. Sampling errors occur when observations are based on samples rather than on entire populations. The standard error of a sample statistic is a measure of the variation due to sampling and indicates the precision of the statistic. The complex sampling

designs used in NELS:88, ELS:2002, and HSLS:09 must be considered when calculating variance estimates such as standard errors. To adjust for these sampling designs, the standard errors for HSLS:09 and ELS:2002 estimates were generated using the balanced repeated replication method, and the standard errors for NELS:88 estimates were generated using Taylor series linearization.

Nonsampling errors can be attributed to several sources: incomplete information about all respondents (e.g., some students or institutions refused to participate, or students participated but answered only certain items); differences among respondents in question interpretation; inability or unwillingness to give correct information; mistakes in recording or coding data; and other errors of collecting, processing, and imputing missing data. It is difficult to identify and estimate the amount of nonsampling error or the bias it causes. In these high school longitudinal studies (as in all NCES studies), efforts were made to prevent such errors and compensate for them when possible (e.g., data collection instruments were field tested).

Response Rates and Nonresponse Bias Analysis

NCES Statistical Standard 4-4-1 states, "(A)ny survey stage of data collection with a unit or item response rate less than 85 percent must be evaluated for the potential magnitude of nonresponse bias before the data or any analysis using the data may be released" (U.S. Department of Education 2012). In the case of NELS:88, ELS:2002, and HSLS:09, this means nonresponse bias analysis could be required at any of three levels: high schools, study respondents, or questionnaire items.

Nonresponse bias analyses were conducted at the student and school levels for each of the three surveys when the response rate was less than 85 percent. Details about those analyses can be found in the data file documentation that accompanies each survey: *NELS:88 Second Follow-up: Transcript Component Data File User's Manual* (Ingels et al. 1995), *Education Longitudinal Study of 2002 (ELS:2002) Base-Year to Second Follow-up Data File Documentation* (Ingels et al. 2007), and *High School Longitudinal Study of 2009 (HSLS:09) 2013 Update and High School Transcripts Data File Documentation* (Ingels et al. 2015).

At the item level, three of the variables used for the analyses in this report required nonresponse bias analysis: F1RDTLFT (84.7 percent) in ELS:2002, and X2PAREDU (49 percent), and X1IEPFLAG (43 percent) in HSLS:09. Nonresponse bias analyses were conducted for each of these variables to determine whether there were differences between the characteristics of respondents and nonrespondents, using characteristics for which information was available for both groups. For ELS:2002, these characteristics consisted of student IEP status, race/ethnicity, and sex as reported on school enrollment lists, spring 2004 enrollment status, and school sampling frame characteristics. For HSLS:09, these variables consisted of student race/ethnicity and sex, and school sampling frame characteristics. After applying the nonresponse adjustments, the bias in ELS:2002 was reduced but not eliminated; for HSLS:09, no bias was statistically significant in any of the nonresponse bias tests.

Statistical Procedures

Comparisons of means and proportions were tested using Student's *t* statistic. Differences between estimates were tested against the probability of a Type I error or significance level. The statistical significance of each comparison was determined by calculating the Student's *t* value for the difference between each pair of means or proportions and comparing the *t* value with published tables of significance levels for two-tailed hypothesis testing. Student's *t* values were computed to test differences between independent estimates using the following formula:

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

where E_1 and E_2 are the estimates to be compared, and se_1 and se_2 are their corresponding standard errors.

There are hazards in reporting statistical tests for each comparison. First, comparisons based on large *t* statistics may appear to merit special attention. This can be misleading because the magnitude of the *t* statistic is related not only to the observed differences in means or percentages but also to the number of respondents in the specific categories used for comparison. Hence a small difference compared across a large number of respondents would produce a large (and possibly statistically significant) *t* statistic.

A second hazard in reporting statistical tests is the possibility that one can report a "false positive" or Type I error.[1] Statistical tests are designed to limit the risk of this type of error using a value denoted by alpha. The alpha level of 0.05 was selected for findings in this Statistics in Brief and ensures a difference of a certain magnitude or larger would be produced when there was no actual difference between the quantities in

[1] A Type I error occurs when one concludes that a difference observed in a sample reflects a true difference in the population from which the sample was drawn when no such difference is present.

the underlying population no more than 1 time out of 20.[2] When analysts test hypotheses that show alpha values at the 0.05 level or smaller, they reject the null hypothesis that there is no difference between the two quantities. Failing to reject a null hypothesis (i.e., detect a difference), however, does not imply the values are the same or equivalent.

[2] No adjustments were made for multiple comparisons.