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Foreword

This manual has been produced to familiarize data users with the overall Education Longitudinal Study of 2002 (ELS:2002) design. It also seeks to familiarize users with the procedures followed for data collection and processing over the four rounds of the study, with particular emphasis on the third follow-up. Additionally, this document provides information that will support research and policy analyses. The National Center for Education Statistics hopes that analysts will find that the ELS:2002 data are organized and equipped in a manner that facilitates users' straightforward production of statistical summaries and analyses of the ELS:2002 youth cohorts as they embark on the transition from high school to postsecondary education and to the labor market, and assume yet other roles that serve as markers of newly achieved adult status.

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Acknowledgments

The authors wish to thank the many individuals who helped plan, design, and conduct the various rounds of the Education Longitudinal Study of 2002 (ELS:2002). We are particularly indebted to the ELS:2002 Technical Review Panel, which met prior to each round to review plans for the study, help refine them, and provide important suggestions for instrument development.

We would be remiss if we did not acknowledge and thank the many schools and individuals who graciously participated in ELS:2002, especially those who were interviewed multiple times as they progressed from high school to adulthood. This study would not have been possible without their invaluable contributions.

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Chapter 1. Introduction

1.1 Overview of the Data File Documentation

This report provides guidance and documentation for users of the combined base-year to third follow-up data of the Education Longitudinal Study of 2002 (ELS:2002). ELS:2002 is sponsored by the National Center for Education Statistics (NCES) of the Institute of Education Sciences, U.S. Department of Education. The base-year and follow-up studies were conducted through a contract to RTI International,[1] a university-affiliated, nonprofit research organization based in North Carolina. This manual contains information about the purposes of ELS:2002, the base-year to third follow-up data collection instruments, the sample design, and data collection and processing procedures. The manual provides guidance for understanding and using data from all components of the base year and its three follow-ups.

The ELS:2002 dataset has been produced in both restricted-use and public-use versions. This document is based on the public-use data files; however, much of the assembled material is relevant to the restricted-use files as well. The public release data files reflect alteration or suppression of some of the original data. Such edits were imposed to minimize the risk of disclosing the identity of responding schools and individuals.

Although this document supplies needed information from the ELS:2002 base year and follow-ups, the first three rounds are treated in summary fashion, because the earlier guides to the study data remain available and provide information in more detail.[2] Chapter 1 addresses three main topics. First, it supplies an overview of the NCES education longitudinal studies program, thus situating ELS:2002 in the context of the earlier NCES high school cohorts studied in the 1970s, 1980s, and 1990s, to which ELS:2002 can at various points (including the third follow-up) be compared. Second, it introduces ELS:2002 by delineating its principal objectives. Third, it provides an overview of the base-year to third follow-up study designs.

In subsequent chapters, additional topics are addressed: instrumentation (chapter 2); sample design and weighting (chapter 3); data collection methods and results (chapter 4); data preparation and processing (chapter 5); weighting, imputation, and design effects (chapter 6); and data file contents (chapter 7). Appendixes include variable lists; questionnaire facsimile; third follow-up composite variables; glossary of terms; cross-cohort comparisons to the National

[1] RTI International is a trade name of Research Triangle Institute.

[2] For the 2002 base-year field test, see Burns et al. 2003 (NCES 2003-03) and for the base-year main study Ingels et al. 2004 (NCES 2004-405). For the 2004 first follow-up, Ingels et al. 2005 (NCES 2006-344). For the ELS:2002 high school transcript study, restricted documentation is in Bozick et al. 2006 (NCES 2006-338). Ingels et al. 2007 (NCES 2008-347) documents the full-scale second follow-up study and summarizes the high school transcript study.

Education Longitudinal Study of 1988 (NELS:88) in 2000; standard error and design effects tables; average weight adjustment factors; nonresponse bias; and across-round cross-walk of occupation codes.

1.2 Historical Background

1.2.1 NCES Education High School Longitudinal Studies Program

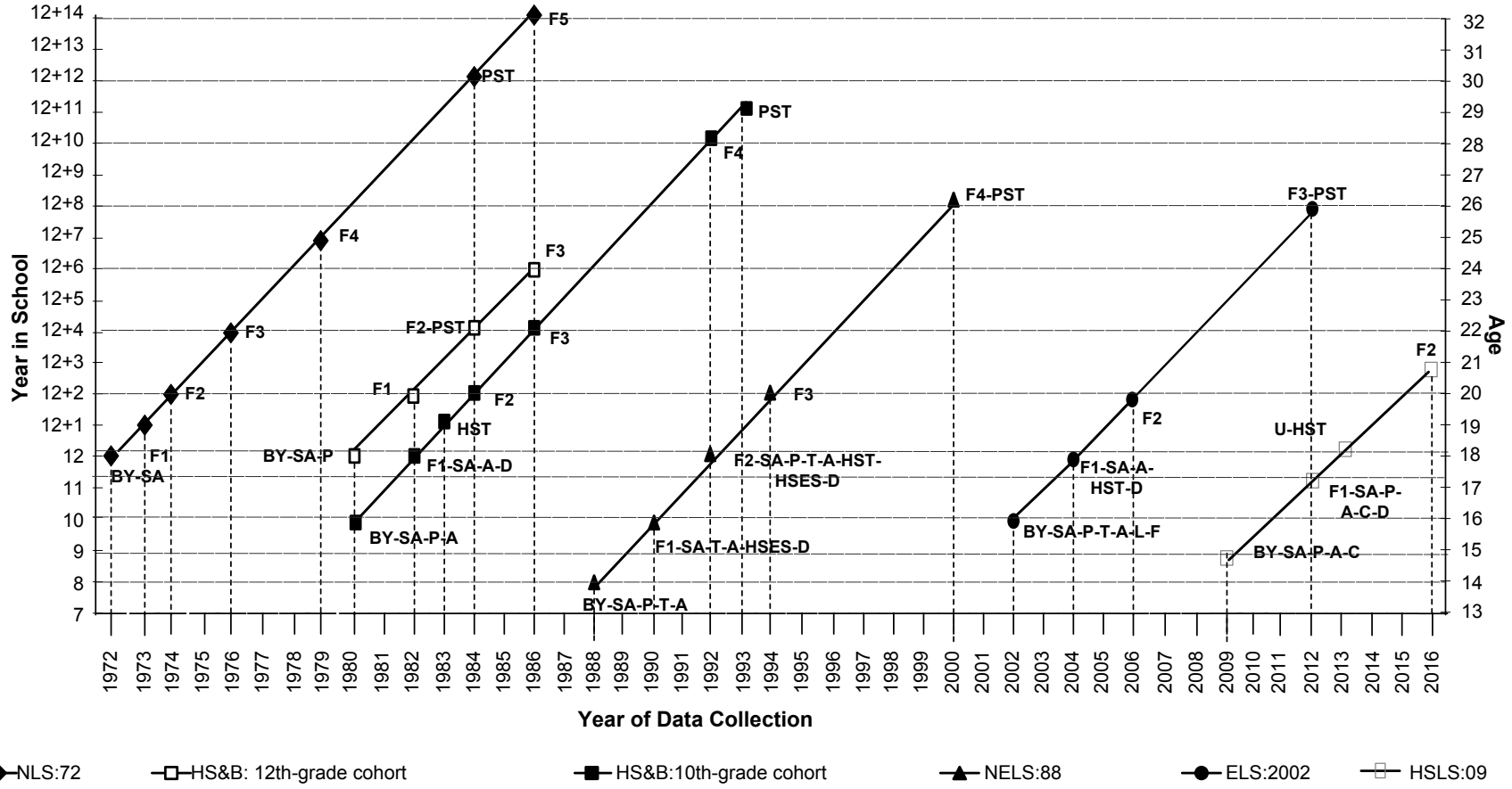
Because ELS:2002 was designed to be closely comparable to prior NCES secondary school cohort studies, it is important to understand ELS:2002's predecessors. In response to its mandate to "collect and disseminate statistics and other data related to education in the United States" and the need for policy-relevant, nationally representative longitudinal samples of elementary and secondary students, NCES instituted the Secondary Longitudinal Studies program. The aim of this continuing program is to study the educational, vocational, and personal development of students at various stages in their educational careers and the personal, familial, social, institutional, and cultural factors that may affect that development.

The Secondary Longitudinal Studies program comprises three completed studies: the National Longitudinal Study of the High School Class of 1972 (NLS:72), the High School and Beyond (HS&B) longitudinal study of 1980, and NELS:88. In addition, base-year to third follow-up data for ELS:2002, the fourth longitudinal study in the series, are now available, with the exception of postsecondary educational transcript data, which are currently being collected and processed.

A fifth study (successor to ELS:2002) is the High School Longitudinal Study of 2009 (HSLS:09). HSLS:09 began with ninth-graders in 2009 with a follow-up in the spring term of 2012. Further data collections (both interviews and transcripts) are scheduled, including 2013 interview and transcript collections.

Taken together, these studies describe (or will describe) the educational experiences of students from five decades. Figure 1 includes a temporal presentation of these five longitudinal education studies and highlights their component and comparison points.

Figure 1. Longitudinal design for the NCES high school cohorts: 1972–2016



NLS:72=National Longitudinal Study of the High School Class of 1972
HS&B=High School and Beyond: 1980
NELS:88=National Education Longitudinal Study of 1988
ELS:2002=Education Longitudinal Study of 2002
HSLS:09=High School Longitudinal Study of 2009

BY=Base-year data collection
F1=1st follow-up data collection
F2=2nd follow-up data collection
F3=3rd follow-up data collection
F4=4th follow-up data collection
F5=5th follow-up data collection

P=Parent survey
T=Teacher survey
A=Administrator survey
L=Library/media center survey
F=Facilities checklist
U=2013 update
HST=High school transcript
SA=Student assessment

PST=Postsecondary transcript
C=Counselor questionnaire
HSES=HS effectiveness study
D=Dropout survey

1.2.2 National Longitudinal Study of the High School Class of 1972

The secondary longitudinal studies program began more than 40 years ago with the implementation of NLS:72.[3] NLS:72 was designed to provide longitudinal data for education policymakers and researchers who link educational experiences in high school with important downstream outcomes such as labor market experiences and postsecondary education enrollment and attainment. With a national probability sample of 19,001 high school seniors from 1,061 public and religious and other private schools, the NLS:72 sample was representative of approximately 3 million high school seniors enrolled in 17,000 U.S. high schools during the spring of the 1971–72 school year. Each student was asked to complete a questionnaire and a cognitive test battery. In addition, administrators at the sample members' schools were asked to supply information about the schools' programs, resources, and grading systems, as well as survey data on each student. NLS:72 also included a counselor survey. Five follow-up surveys were completed with this cohort, with the final data collection taking place in 1986, when the sample members were 14 years removed from high school and approximately 32 years old. Postsecondary education transcripts were collected from the institutions attended by students. All of the secondary longitudinal studies from NLS:72 forward have had, as ELS:2002 will have, a final data collection comprising postsecondary education transcripts.

1.2.3 High School and Beyond

The second in the series of NCES longitudinal studies was launched in 1980. HS&B included one cohort of high school seniors comparable to the NLS:72 sample; however, the study also extended the age span and analytical range of NCES longitudinal studies by surveying a sample of high school sophomores. Base-year data collection took place in the spring term of the 1979–80 academic year with a two-stage probability sample. More than 1,000 schools served as the first-stage units, and 58,000 students within these schools were the second-stage units. Students completed a questionnaire and a cognitive test battery. Both cohorts of HS&B participants were resurveyed in 1982, 1984, and 1986; the sophomore group also was surveyed in 1992.[4] In addition, to better understand the school and home contexts for the sample members, data were collected from teachers (a teacher comment form in the base year asked for teacher perceptions of HS&B sample members), principals, and a subsample of parents. High school transcripts were collected for a subsample of sophomore cohort members. As in NLS:72, postsecondary transcripts were collected for both HS&B cohorts.

[3] For documentation on NLS:72, see Riccobono et al. (1981) and Tourangeau et al. (1987).

[4] For a summation of the HS&B sophomore cohort study, see Zahs et al. (1995). For further information on HS&B, see the NCES website: http://nces.ed.gov/surveys/hsb/.

1.2.4 National Education Longitudinal Study of 1988

Much as NLS:72 captured a high school cohort of the 1970s and HS&B captured high school cohorts of the 1980s, NELS:88 was designed to study high school students of the 1990s—but with a baseline measure of their achievement and status, prior to their entry into high school. NELS:88 tracked students from junior high or middle school through secondary and postsecondary education, labor market experiences, and marriage and family formation. Data collection for NELS:88 was initiated with the eighth-grade class of 1988 in the spring term of the 1987–88 school year. Along with a student survey, NELS:88 included surveys of parents (base year and second follow-up), teachers (base year, first and second follow-ups), and school administrators (base year, first and second follow-ups). The cohort was also surveyed twice after their scheduled high school graduation, in 1994 and 2000.[5] High school transcripts were collected in the fall of 1992 and postsecondary transcripts in the fall of 2000. Through a process of sample freshening, NELS:88 offers three nationally representative cohorts of students: spring-term 8th-, 10th-, and 12th-graders.

1.2.5 High School Longitudinal Study of 2009

HSLS:09, the successor study to ELS:2002, is not directly comparable to the other secondary longitudinal studies in that it takes a different measuring point (fall term of 9th grade and spring term of 12th grade). Nonetheless, it models the same transition, through high school to postsecondary education, the work force, and young adulthood—that is studied by NLS:72, HS&B, NELS:88, and ELS:2002, and uses many of the same methods.

HSLS:09 students were administered both a questionnaire and an assessment in algebraic reasoning, in both the base year (2009) and first follow-up (2012). HSLS:09 also captures contextual data sources, with a base-year survey of teachers, and base-year and first follow-up surveys of administrators, counselors, and parents. A 2013 update survey targets students or parents, and a high school transcript study is being conducted as well. Another major data collection will take place in 2016.[6]

1.3 Education Longitudinal Study of 2002

ELS:2002 represents a major longitudinal effort designed to provide trend data about critical transitions experienced by students as they proceed through high school and into postsecondary education or their careers. The 2002 sophomore cohort is being followed, initially at 2-year intervals, to collect policy-relevant data about educational processes and outcomes,

[5] The entire compass of NELS:88, from its baseline through its final follow-up in 2000, is described in Curtin et al. (2002). NCES maintains an updated version of the NELS:88 bibliography on its website. The bibliography encompasses both project documentation and research articles, monographs, dissertations, and paper presentations employing NELS:88 data (see http://nces.ed.gov/surveys/nels88/Bibliography.asp).

[6] For further information about HSLS:09, please see Ingels et al. 2013 (NCES 2014-361), the *High School Longitudinal Study of 2009 (HSLS:09) Base-Year to First Follow-up Data File Documentation*.

especially as such data pertain to student learning, predictors of dropping out, and high school effects on students' access to, and success in, postsecondary education and the workforce.

In the spring term 2002 base year of the study, high school sophomores were surveyed and assessed in a national sample of high schools with 10th grades. Their parents, teachers, principals, and librarians were surveyed as well.

In the first of the follow-ups, base-year students who remained in their base-year schools were resurveyed and tested (in mathematics) 2 years later, along with a freshening sample that makes the study representative of Spring 2004 high school seniors nationwide. Students who had transferred to a different school, switched to a homeschool environment, graduated early, or dropped out were administered a questionnaire but were not given the assessment, which took place only in a school setting. In the fall and winter after the 2004 first follow-up, high school transcripts were collected. The transcript data file is comparable to the high school transcript studies of HS&B and NELS:88, as well as the National Assessment of Educational Progress (NAEP) high school transcripts.

In the second follow-up (2006), data were collected from sample members, using questionnaires self-administered on the Web, or through interviewer-administered electronic instruments. In addition, administrative records were pursued, such as the National Student Loan Data System and Free Application for Federal Student Aid (FAFSA).

This section introduces ELS:2002, lists some of the major research and policy issues that the study addresses, and explains the three levels of analysis—cross-sectional, cross-cohort and trend, and longitudinal—that can be conducted with ELS:2002 data.

1.3.1 ELS:2002 Study Design

ELS:2002 is designed to monitor the transition of a national sample of young people as they progress from 10th grade through high school and on to postsecondary education or the world of work, or both.

ELS:2002 has two distinctive features. First, it is a longitudinal study, in which the same units (schools and students) are surveyed repeatedly over time. Individual students were followed through high school and for 8 years thereafter. The base-year schools were surveyed twice, in 2002 and in 2004. Second, in the high school years, ELS:2002 is an integrated, multilevel study that involves multiple respondent populations. The respondents include students, their parents, their teachers, and their schools (from which data are collected at four levels: from the principal, the librarian, a facilities checklist, and school course catalogues and records, which support a course offerings component in the first follow-up transcript study). Each of the two distinctive features—the longitudinal nature of the ELS:2002 design and its multilevel focus—will be explained in greater detail below.

The transition through high school and beyond into postsecondary institutions and the labor market is both complex (youth may follow many paths) and prolonged (it takes place over

a period of years). The complexity and time frame for this transition make longitudinal approaches especially appropriate. By surveying the same young people over time, it is possible to record the changes taking place in their lives. It is also possible to gather information about the ways that earlier achievements, aspirations, and experience predict what happens to the respondents later. In the baseline data collection (Spring 2002), ELS:2002 measured students' tested achievement in reading and mathematics. ELS:2002 also obtained information from students about their attitudes and experiences.

These same students were resurveyed 2 years later (in 2004), in the ELS:2002 first follow-up, to measure changes such as achievement gains in mathematics and changes in enrollment status (e.g., the situation of students who drop out of school compared with those who persist in their education). Resurveyed 4 years after the base year (2006), second follow-up data supply information about postsecondary educational access and choice, or transition to the labor market for cohort members who did not continue their education. In the third follow-up, sample members were interviewed between July 2012 and February 2013 to collect the study's final outcomes (e.g., persistence in higher education, sub-baccalaureate and baccalaureate attainment, transition into the labor market). Postsecondary transcripts are also being collected as part of the third follow-up, and restricted-use documentation for this component will be provided separately.

ELS:2002 gathers information at multiple levels. It obtains information not only from students and their school records, but also from students' parents, teachers, and the administrators (principal and library media center director) of their schools. Data from their teachers, for example, provide information both about the student's and the teacher's backgrounds and activities. This multilevel focus supplies researchers with a comprehensive picture of the home, community, and school environments and their influences on the student.

This multiple-respondent perspective is unified by the fact that, for most purposes, the student is the basic unit of analysis. In addition, administrative records have been pursued and made part of the ELS:2002 database, such as the decennial Census to the NCES Integrated Postsecondary Education Data System (IPEDS) and student application and loan sources (Central Processing System; CPS [FAFSA], the National Student Loan Data System). Using this multilevel and longitudinal information, the base year (2002) and first follow-up (2004) of ELS:2002 help researchers and policymakers explore and better understand such issues as the importance of home background and parental aspirations for student success; the influence of different curriculum paths and special programs; the effectiveness of different high schools; and whether a school's effectiveness varies with its size, organization, climate or ethos, curriculum, academic press, or other characteristics. These data facilitate understanding of the impact of various instructional methods and curriculum content and exposure in bringing about educational growth and achievement.

With the addition of postsecondary data in the 2006 second follow-up, ELS:2002 greatly enlarged its ability to connect high school antecedents to later outcomes. For students who continue on to higher education, researchers can use ELS:2002 to measure the effects of their high school careers on subsequent access to postsecondary institutions, their choices of institutions and programs, and as time goes on, their postsecondary persistence, attainment, and eventual entry into the labor force and adult roles. For students who go directly into the workforce (whether as dropouts or high school graduates), ELS:2002 can help to determine how well high schools have prepared these students for the labor market and how they fare within it. The third follow-up (2012) data illuminate the final outcomes of the study, speaking in particular to issues of postsecondary attainment, persistence, and entry into and success in the labor market.

Key elements in the ELS:2002 longitudinal design are summarized by round below.

Base Year (2002)

- Completed baseline survey of high school sophomores in the spring term of 2002.
- Completed cognitive tests in reading and mathematics.
- Completed survey of parents, English teachers, and mathematics teachers. Collected school administrator questionnaires.
- Included additional components for this study—a school facilities checklist and a media center (library) questionnaire.
- Established sample sizes of approximately 750 schools and more than 17,000 students. Schools are the first-stage unit of selection, with sophomores randomly selected within schools.
- Oversampled Asian[7] and Hispanic students and private schools.
- Designed linkages with the Program for International Student Assessment (reading and math) and NAEP (2005 math); scored reporting linkages to the prior longitudinal studies.

First Follow-up (2004)

- Most sample members were seniors, but some were dropouts or in other grades (early graduates or retained in an earlier grade).
- Student questionnaire (different versions for students who remained in the base-year school, transferred to a new school, completed high school early, or were homeschooled), dropout questionnaire, assessment in mathematics, and school administrator questionnaire were administered.

[7] Except where indicated otherwise, the race/ethnicity variable for this report includes six categories: (1) American Indian or Alaska Native; (2) Asian or Native Hawaiian or other Pacific Islander; (3) Black, including African American; (4) Hispanic or Latino; (5) More than one race; and (6) White. All race categories exclude individuals of Hispanic or Latino origin.

- Returned to the same schools but separately followed transfer students and surveyed them outside of school.
- Freshened for a senior cohort.
- High school transcript component in 2004 (coursetaking records at the student level for grades 9–12) and course offerings component at the school level.

Second Follow-up (2006) and Third Follow-up (2012, 2013)

- Survey 2 and 8 years after scheduled high school graduation.
- Post–high school follow-up with web-based instrument for self-administration, computer-assisted telephone interview, or computer-assisted personal interview.
- Use of administrative records sources to augment information about ELS:2002 sample members, including SAT, ACT, General Educational Development, CPS, and NSLDS.
- Postsecondary education transcripts.

1.3.2 ELS:2002 Research and Policy Issues

Apart from helping to describe the status of high school students and their schools, ELS:2002 will provide information to help address a number of key policy and research questions. The study is intended to produce a comprehensive dataset for the development and evaluation of education policy at all government levels. Part of its aim is to inform decision-makers, education practitioners, and parents about the changes in the operation of the educational system over time and the effects of various elements of the system on the lives of the individuals who pass through it. Issues that can be addressed with data collected in the high school years include the following:

- students' academic growth in mathematics;
- the process of dropping out of high school;
- the role of family background and the home education support system in fostering students' educational success;
- the relationship between coursetaking choices and success in the high school years (and thereafter);
- the distribution of educational opportunities as registered in the distinctive school experiences and performance of students from various subgroups; such subgroups include the following:
  - students in public and private high schools;
  - language minority students;
  - students with disabilities;
  - students in urban, suburban, and rural settings;

  - students in different regions of the country;
  - students from upper, middle, and lower socioeconomic status levels;
  - male and female high school students; and
  - students from different racial or ethnic groups.
- steps taken to facilitate the transition from high school to postsecondary education or the world of work.

Now that most ELS:2002 students have completed high school, a new set of issues can be examined with the help of data collected in 2006. These issues include the following:

- the later educational and labor market activities of high school dropouts;
- the transition of those who do not go directly on to postsecondary education or to the world of work;
- access to and choice of undergraduate and graduate educational institutions.

The 2012 data support further investigations:

- persistence in attaining postsecondary educational goals;
- rate of progress through the postsecondary curriculum;
- degree attainment;
- barriers to persistence and attainment;
- impacts of educational indebtedness;
- entry of new postsecondary graduates into the workforce;
- social and economic rate of return on education to both the individual and society; and
- adult roles, such as family formation and civic participation.

These various research and policy issues can be investigated at several distinct levels of analysis. The overall scope and design of the study provide for the three following analytical levels:

- cross-sectional profiles of the nation's high school sophomores (2002), seniors (2004), and dropouts in the last 2 years of high school (2004);
- longitudinal analysis (including examination of life course changes);
- intercohort comparisons with American high school students of earlier decades.

Data users may benefit from consulting and building on past research publications that use the ELS:2002 data. A bibliography is maintained at http://nces.ed.gov/surveys/els2002/Bibliography.asp.

1.3.2.1 Cross-sectional Profiles

Cross-sectional data permit characterization of the nation's high school sophomores in the spring term of the 2001–02 school year (the base year) and (owing to a freshening process), high school seniors in 2004 (the first follow-up).

1.3.2.2 Longitudinal Analysis

The primary research objectives of ELS:2002 are longitudinal in nature. The study provides the basis for within-cohort comparison by following the same individuals over time to measure achievement growth in mathematics and monitor enrollment status over the high school years (base year, first follow-up, and high school transcripts). With the second and third follow-ups, as well as postsecondary transcript data, the study records such key outcomes as postsecondary entry and attainment, labor market experiences, and family formation. In turn, these outcomes can be related to antecedents identified in earlier rounds, including individual, home, school, and community factors.

1.3.2.3 Intercohort Comparisons

Intercohort comparisons can be built on either a cross-sectional analysis (more specifically, comparison made on a time-lag basis with a temporal series anchored in sameness of grade for historically distinct cohorts with the intent of identifying and measuring trends) or longitudinally, that is, by taking the history of the age/grade cohort into account and modeling it vis-à-vis other panels. The cross-sectional time-lag approach has more often been used in the NCES secondary longitudinal studies than the intercohort panel approach. As part of an important historical series of studies that repeats a core of key items each decade, ELS:2002 offers the opportunity to analyze trends in areas of fundamental importance, such as patterns of overall and subgroup coursetaking, rates of participation in extracurricular activities, academic performance, and changes in goals and aspirations. Cross-cohort comparisons can be made with high school sophomores (HS&B, NELS:88, and ELS:2002), and seniors (including coursetaking information gathered from secondary longitudinal studies transcripts in HS&B, NELS:88, and ELS:2002 as well as NAEP transcripts for graduates in 1987, 1990, 1994, 1998, 2000, 2005, and 2009). Analysis can also be conducted with high school cohorts in the postsecondary years (NLS:72, HS&B, NELS:88, and ELS:2002 senior cohorts 2 years out of high school; NELS:88 and ELS:2002 8 years out of high school).

Chapter 2. Instrumentation

2.1 Base-year to Second Follow-up Instruments

The base-year (2002) data collection instruments for the Education Longitudinal Study of 2002 (ELS:2002) consisted of five questionnaires (student, parent, teacher, school administrator, and library media center), two achievement tests (assessments in reading and mathematics), and a school observation form (facilities checklist).

The first follow-up (2004) data collection instruments comprised seven questionnaires: a student questionnaire (in full-length and abbreviated forms), a transfer student questionnaire, a new participant student questionnaire (administered to students who were part of the freshened sample or base-year nonrespondents), a homeschool student questionnaire, an early graduate questionnaire, a dropout (not currently in school) questionnaire, and a school administrator questionnaire. The first follow-up also included an achievement test in mathematics as well as a high school transcript component, with academic transcripts collected from fall of 2004 to early 2005.

In the second follow-up (2006), there was a single questionnaire administered to study participants (the eligible student cohort members sampled in the base year or brought in through freshening in the first follow-up), designed in an electronic format, for self- or interviewer administration.

The base-year and first, second, and third follow-up questionnaires can all be found on the National Center for Education Statistics (NCES) ELS:2002 website (http://nces.ed.gov/surveys/els2002/questionnaires). The base-year (Burns et al. 2003, NCES 2003-03), first follow-up (Ingels et al. 2004, NCES 2004-405), and second follow-up (Ingels et al. 2007, NCES 2008-347) data file documentation are also available from the NCES website. The high school transcript study is documented in Bozick et al. 2006 (NCES 2008-338) (document restricted to data license holders), and Ingels et al. 2007 (NCES 2008-347) (public use document).

2.2 Third Follow-up Instrument Development Process and Procedures

The ELS:2002 third follow-up questionnaire was designed for electronic self-administration (web) or computer-assisted interviewer administration (computer-assisted telephone interview–CATI or computer-assisted personal interview–CAPI). Items were selected primarily for their intracohort value, that is, their relevance, as final outcomes, to the antecedent or predictor variables gathered in earlier rounds. Of secondary importance was the intercohort value of items, that is, whenever possible variables were used which would prove comparable to

those employed in the final round of NELS:88 in 2000, when the NELS:88 cohort was approximately the same age (and years beyond high school) as the third follow-up ELS:2002 sample (for a cross-walk between NELS:88 in 2000 and ELS:2002 in 2012, see appendix B of this document; for further information on the NELS:88 fourth follow-up, see Curtin et al. 2002 [NCES 2002-323] and Ingels et al. 2002 [NCES 2002-321]).

In general, the development and review process for the third follow-up questionnaire consisted of the following nine steps.

First, a literature review was conducted. This review covered the following domains: (1) *Employment and career outcomes*, including labor force activities and establishing careers, military employment and careers, and job-related training, certification, and licensure; (2) *Education outcomes*, including high school completion, postsecondary education enrollment history, postsecondary education attainment: credentials earned, retrospective on the college experience, educational expectations and aspirations, other adult education, social-cognitive measures of job orientation; and educational debt and financial aid; and (3) *Other outcomes reflective of attaining to adult status*, including geographic location and living arrangements, family formation, income and assets, health, perceived adulthood, life and career values, and civic engagement, such as community service and voting. This review guided subsequent discussions with the Technical Review Panel (TRP) (see below for an account of the role of this body).

Second, questionnaire drafts were circulated across programs at NCES and between RTI International and NCES, and revisions made on the basis of the resulting comments.

Third, new topics and constructs, and prioritizations of these and past constructs, were recommended in commissioned papers from three ELS:2002 TRP members, representing three distinct academic disciplines—psychology (particularly social cognitive theory), economics (particularly labor economics), and sociology (particularly life course perspective). These memoranda were shared with the other panelists.

Fourth, certain items that were both new and of critical importance were tested in two series of cognitive interviews. The first series of cognitive interviews (pre-field test) focused on social cognitive career theory items that were developed for ELS:2002 by Professor Robert Lent; the second series (pre–full-scale study) focused on potential new items concerning financial aid and economic literacy.

Fifth, before and after the field test, draft instruments were reviewed by the ELS:2002 third follow-up TRP, a specially appointed independent group of substantive, methodological, and technical experts. The panel met twice in 2-day meetings (September 2010 and November 2011).

Sixth, justifications were written for questionnaire items for Office of Management and Budget (OMB) review.

Seventh, actual development of the questionnaire, including specification, routing, programming, and testing, took place within an electronic survey editor.

Eighth, a field test was conducted to test questionnaire items; results of the field test are documented in the field test methodology report (Ingels et al. 2012, NCES 2012-03).

Ninth, on the basis of the field test, recommendations were generated for the ELS:2002 third follow-up questionnaire, and full-scale clearance sought and received from OMB, after a final review of the proposed questionnaire items.

Although the questionnaire is a key source of information for the study, it should be noted that the survey component will be complemented by a postsecondary transcript collection, and the tapping of ancillary administrative records data.

2.3 Third Follow-up Instrument Content

As noted earlier in chapter 1, because the primary research objectives of ELS:2002 are longitudinal in nature, the first priority for questionnaire development was to select the items that would prove most useful in a longitudinal context—in the third follow-up, these items are the outcomes, predicted by the antecedents measured in past survey rounds. The second priority was to obtain needed cross-sectional data, whenever consistent with the longitudinal objectives, particularly data that could be used for intercohort comparison with past studies or linkage to certain current data collection efforts. Wherever possible, all ELS:2002 instruments were designed to provide continuity and consistency with the earlier education longitudinal studies of high school cohorts. For the third follow-up, there is only one strictly comparable point in time with which to link on a cross-cohort basis, the NELS:88 fourth follow-up in 2000.

Below, content of the third follow-up questionnaire is summarized, followed by a summary of the abbreviated version of the instrument.

Current status. The interview asks about the respondent's current activities, such as labor market status and educational status.

High school completion. For sample members who had not completed high school (or General Educational Development [GED]) by the second follow-up or whose completion status was unknown, the third follow-up interview obtained updated information.

Postsecondary education. This section of the interview focused on the postsecondary enrollment and attainment at all levels of credentialing and degree completion and includes all forms and levels of sub-baccalaureate, baccalaureate, and graduate and professional enrollment. It also gathers information such as primary or secondary major or program of study. First, sample members were asked to identify postsecondary institutions they had attended; second, they were asked to identify any postsecondary credentials earned. Attendance information will be used to conduct the postsecondary education transcript component of the study in 2013–14. Reasons for leaving school were also elicited.

The college experience. Although most sample members were, by 2012, out of school, it was still possible to ask some questions retrospectively, about the college experience, and its perceived role and impact as carried into the mid-twenties of the cohort.

Education finance. The questionnaire explores the issue of educational borrowing and its impact. Information about receipt of scholarships, fellowships, and grants is also obtained.

Educational expectations. Following in the tradition of the prior NCES high school cohort studies, all respondents were asked to report the highest level of education they expected to achieve by age 30 (average age at time of interview is about 26).

Employment and income. The interview gathered information on employment and income. A brief employment history is collected. Respondents were asked to answer a series of questions about job title and duties, hours worked, earnings, and employer type. Both the employed and the unemployed were asked about perceived employment barriers they may have faced or be facing. All respondents were asked for their annual income and whether they have any dependents. These questions will allow analysts to roughly estimate net earnings after taxes. The questionnaire asked separately about employment through the military. In addition, some scales have been added on job orientation and satisfaction, that are informed by social-cognitive career theory, and that were written specially for ELS:2002.

Family formation. The interview collected information about family life and civic engagement (including both voting and community service). With respect to family, the questions determine marital status, whether the respondent has children, and members of the household.

Life values. As included in earlier rounds of ELS:2002 as well as in some of the prior NCES secondary longitudinal studies, questions are asked about the life values (acquisition of money, friendships, helping others, a good marriage, etc.) that are important to the respondent.

Additional topics. Additional topics include civic engagement, assets/debt, and certification licensure.

The third follow-up questionnaire is available at several levels. First, and simplest, the ELS:2002 homepage on the NCES website includes a facsimile of the questionnaire without routing logic. A facsimile of the questionnaire with routing logic appears in appendix C of this document. Finally, a flow chart of the questionnaire may be found in appendix D of this document.

2.4 Third Follow-up Abbreviated Questionnaire

In part because of sensitivity to the time between the second and third follow-ups and sensitivity to the busy lives of the study participants, to give response rates an added boost, an abbreviated questionnaire was offered—in place of the full-length questionnaire—for the final 4 weeks of third follow-up data collection (early January through early February 2013). At this late

point in data collection, this abbreviated questionnaire was completed by approximately 1 percent of participants eligible for the third follow-up. In creating the abbreviated questionnaire, a subset of full-length questionnaire items was selected such that (1) the overall average length of the abbreviated questionnaire would be approximately 10 minutes (as opposed to the ~35-minute full-length questionnaire), and (2) questionnaire items necessary for a successful postsecondary transcript data collection (e.g., names of attended postsecondary schools) and other items of key analytic importance would be retained. Items retained for the abbreviated questionnaire included those regarding current activities, high school completion (if unknown or incomplete as of the second follow-up), postsecondary schools attended, postsecondary credentials earned, educational expectations, current/most recent job type (including rate of pay at said job), past/present unemployment status, expected age-30 occupation, family formation (marital status and biological children), 2011 employment earnings, and current debt.

The format of abbreviated questionnaire items (in terms of question wording, response options, etc.) were identical to the format of those same items as they appeared in the full-length questionnaire. To see the full set of abbreviated questionnaire items, please see items marked as such (by a triple asterisk—***) in appendix C (facsimile of the third follow-up questionnaire) of this report.

Administrative records linkages will be implemented in the course of the postsecondary transcript collection (for example, SAT and ACT scores). Information from GED, Central Processing System/ Free Application for Federal Student Aid, and National Student Loan Data System are included in the current data delivery and are described in detail in appendix K.

Chapter 3. Sample Design

3.1 Base-year, First Follow-up, and Second Follow-up Sample Design

3.1.1 Overview

This chapter describes the Education Longitudinal Study of 2002 (ELS:2002) base-year to third follow-up sample designs.

Section 3.1 provides a historical summary of sample design issues for the base year, first follow-up, and second follow-up. Section 3.2 provides an expanded discussion of the sample design in the context of the ELS:2002 third follow-up in 2012.

3.1.2 Base-year Sample Design

Full information on the base-year sample design can be found in chapter 3 and appendix J of the Base-year Data File User's Manual (Ingels et al. 2004, NCES 2004-405).

The ELS:2002 base-year sample design comprises two primary target populations—*schools* with 10th grades and *sophomores* in those schools—in the spring term of the 2001–02 school year. ELS:2002 used a two-stage sample selection process. First, schools were selected. These schools were then asked to provide sophomore enrollment lists, from which students were selected.

Schools and students are the study's basic units of analysis. School-level data reflect a school administrator questionnaire, a library media center questionnaire, a facilities checklist, and the aggregation of student data to the school level. Student-level data consist of student questionnaire and assessment data and reports from students' teachers and parents. (School-level data, however, can also be reported at the student level and serve as contextual data for students.)

The target population of schools for the ELS:2002 base year consisted of regular public schools, including state Department of Education schools and charter schools, and Catholic and other private schools that contained 10th grades and were in the United States (the 50 states and the District of Columbia).

The sampling frame of schools was constructed with the intent to match the target population. However, selected schools were determined to be ineligible if they did not meet the definition of the target population. Responding schools were those schools that had a Survey Day

(i.e., data collection occurred for students in the school).[8] Of the 1,268 sampled schools, there were 1,221 eligible schools and 752 responding schools (68 percent weighted participation rate).

A subset of most but not all responding schools also completed a school administrator questionnaire and a library or media center questionnaire (99 percent and 96 percent weighted response rates, respectively). Most nonresponding schools or their districts provided some basic information about school characteristics, so that the differences between responding and nonresponding schools could be better understood, analyzed, and adjusted. Additionally, RTI field staff completed a facilities checklist for each responding school.

The target population of students for ELS:2002 consisted of spring-term sophomores in 2002 (excluding foreign exchange students) enrolled in schools in the school target population. The sampling frames of students within schools were constructed with the intent to match the target population. However, selected students were determined to be ineligible if they did not meet the definition of the target population. Of the 19,218 sampled students, there were 17,591 eligible sophomores. The 15,362 participants on the public-use file represent a weighted student response rate of 87 percent.

The ELS:2002 base-year survey instruments comprised two assessments (reading and mathematics) and a student questionnaire. Participation in ELS:2002 was defined by questionnaire completion. Although most students were asked to complete the assessment battery in addition to the questionnaire, there were some cases in which a student completed the questionnaire but did not complete the assessments. Guidelines were provided to schools to assist them in determining whether students would be able to complete the ELS:2002 survey instruments.

Students who could not complete the ELS:2002 questionnaire (by virtue of limited English proficiency or physical or mental disability) were part of the expanded sample of Spring 2002 sophomores who were followed in the study and eligibility status was reassessed 2 years later. There were 163 such students. To obtain additional information about their home background and school experiences, contextual data were collected from the base-year parent, teacher, and school administrator surveys.

The student sample was selected, when possible, in the fall or early winter so that sample teachers could be identified and materials could be prepared well in advance of Survey Day. However, selecting the sample in advance meant that some students transferred into the sample schools and others left between the time of sample selection and Survey Day. To address this issue, sample updating was conducted closer to the time of data collection. Complete enrollment lists were collected at both the time of initial sampling and the time of the sample update.

[8] One eligible school had no eligible students selected in the sample. This school was considered a responding school.

One parent of the sample student and English and mathematics teachers of the sample student were also included in the base-year sample.

3.1.3 First Follow-up Sample Design

The first follow-up collected information for eligible base-year participants and also during the first follow-up the sample was freshened[9] to be representative of students enrolled in 12th grade during the spring term of the 2003-04 school year. The first follow-up fielded sample comprised 16,763 sample members (16,525 eligible from the base-year collection; 238 identified as part of sample freshening). Figure 2 shows the distribution of the sample members over time. For additional details, see the Base-year to First Follow-up Data File Documentation (Ingels et al. 2005, NCES 2006-344).

3.1.3.1 High School Transcript Study Sample Design

In the fall of 2004, high school transcripts were requested for all sample members who participated in at least one of the first two student interviews: the base-year interview or the first follow-up interview. Thus, sample members who were dropouts, freshened sample members, transfer students, homeschooled students, and early graduates are included if they were respondents in either the 2002 or 2004 interview. Transcripts were also requested for students who could not participate in either of the interviews because of a physical disability, a mental disability, or a language barrier. Further information about the transcript component may be found in Bozick et al. 2006 (NCES 2006-338), available to licensed users of the transcript data.

3.1.4 Second Follow-up Sample Design

The basis for the ELS:2002 second follow-up sampling frame was the sample of students selected in the base year when they were 10th-graders in 2002 combined with the sample of freshened students who were in the 12th grade in 2004.

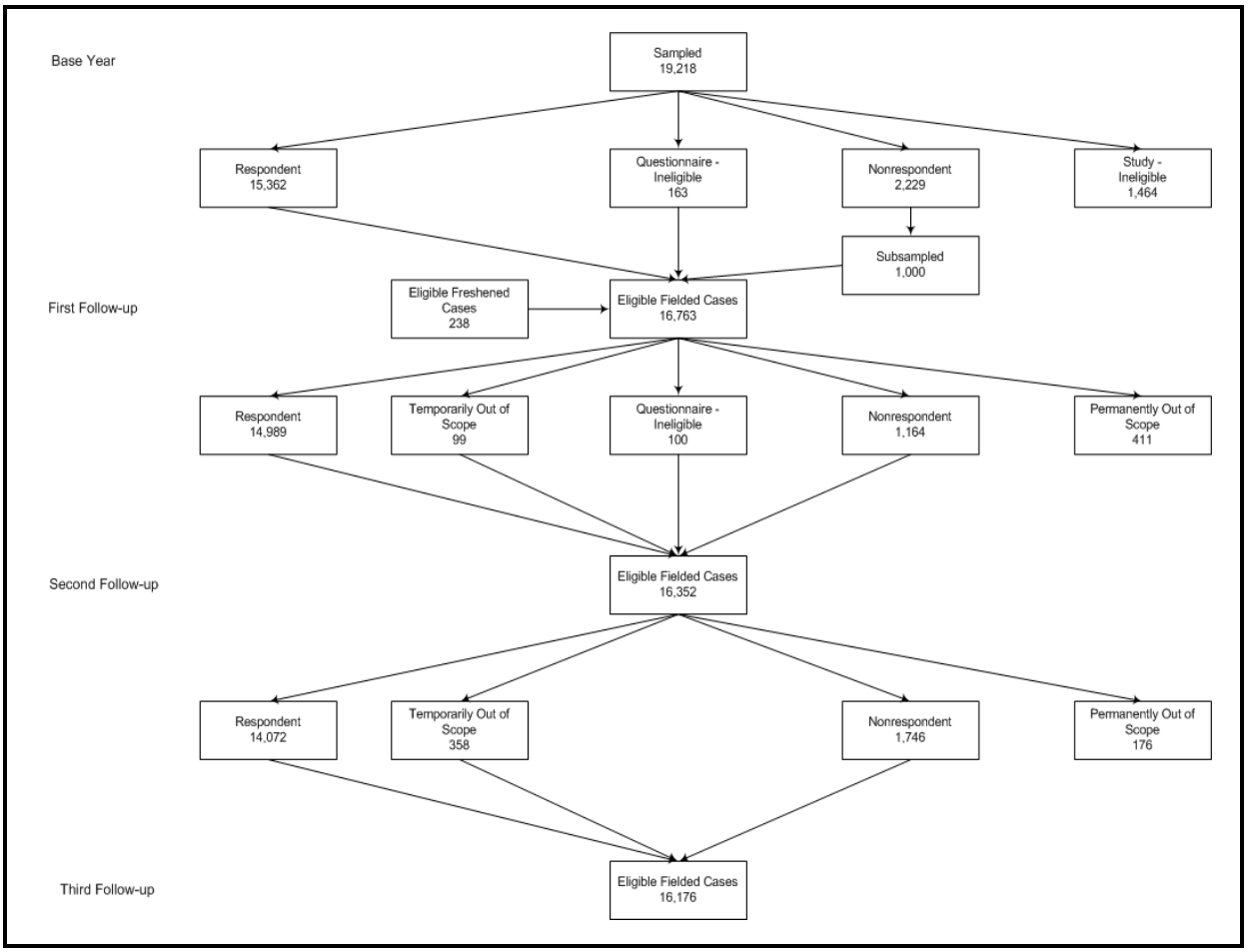
The second follow-up included all first follow-up eligible sample members except deceased students, students who were determined to be study ineligible at prior rounds, and sample members who were out of scope[10] in the first follow-up study. Eligible sample members who had not responded in the base year and the first follow-up were not fielded for the third follow-up. Similarly, freshened sample nonrespondents were not fielded for the third follow-up. Therefore, the second follow-up fielded sample consisted of 16,352 sample members. Figure 2 shows the distribution of sample members over time.

[9] For more information on sample freshening, please see the Base-year to First Follow-up Data File Documentation (Ingels et al. 2005, NCES 2006-344).

[10] Out-of-scope sample members include individuals who had not responded in any prior round, prior-round respondents who were incarcerated or out of the country, and prior-round study refusals.

For additional details, see the Base-year to Second Follow-up Data File Documentation (Ingels et al. 2007, NCES 2008-347).

Figure 2. ELS:2002 third follow-up full-scale sample: 2012



NOTE: Permanently out-of-scope cases include study withdrawals, deceased, study ineligibles, and some individuals who did not respond in the prior two rounds.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Base Year, First Follow-up, Second Follow-up, and Third Follow-up.

3.2 Third Follow-up Sample Design

No additional sampling was performed for the third follow-up. The target populations for the third follow-up are the same as those in the first and second follow-ups; namely, those students who were enrolled in the 10th grade in 2002 and those students who were enrolled in the 12th grade in 2004.

Figure 2 shows the distribution of the 17,754 eligible students sampled from approximately 750 schools in the base year plus the 238 students added during freshening in the first follow-up. (Some 1,464 of the 19,218 base-year sample members were found to be ineligible thus leading to 17,754 eligible base-year sample members). Eligible sample members who had not responded in the second follow-up and in the first follow-up were not fielded for the

third follow-up. The third follow-up sample consisted of 16,352 sample members fielded for the second follow-up excluding 176 individuals who were out of scope[11] for the third follow-up. A total of 16,176 sample members were fielded for the third follow-up.

[11] Approximately one-third of the out-of-scope individuals were deceased, one-third were questionnaire-incapable or otherwise incapacitated, and one-third were a mix of study refusals, individuals who had not responded in the prior two rounds, and those who were institutionalized or incarcerated.

Chapter 4. Data Collection Methodology, Results, and Response Rates

The first two sections of this chapter present information on the data collection methodology and results. Next the chapter presents the responsive design methodology that was used in the third follow-up of the Education Longitudinal Study of 2002 (ELS:2002) to better target nonresponse follow-up efforts. Finally, this chapter presents information on response rates.

More detailed accounts of the base-year, first follow-up, and second follow-up data collections can be found in the following National Center for Education Statistics (NCES) publications:

- *Education Longitudinal Study of 2002: Base-Year Data File User's Manual* (Ingels et al. 2004; NCES 2004-405);
- *Education Longitudinal Study of 2002: Base-Year to First Follow-up Data File Documentation* (Ingels et al. 2005; NCES 2006-344);
- *Education Longitudinal Study of 2002: First Follow-up Transcript Component Data File Documentation* (DFD)[12] (Bozick et al. 2006; NCES 2006-338); and
- *Education Longitudinal Study of 2002: Base-Year to Second Follow-up Data File Documentation (including Field Test report)* (Ingels et al. 2007; NCES 2008-347).

4.1 Third Follow-up Data Collection Methods

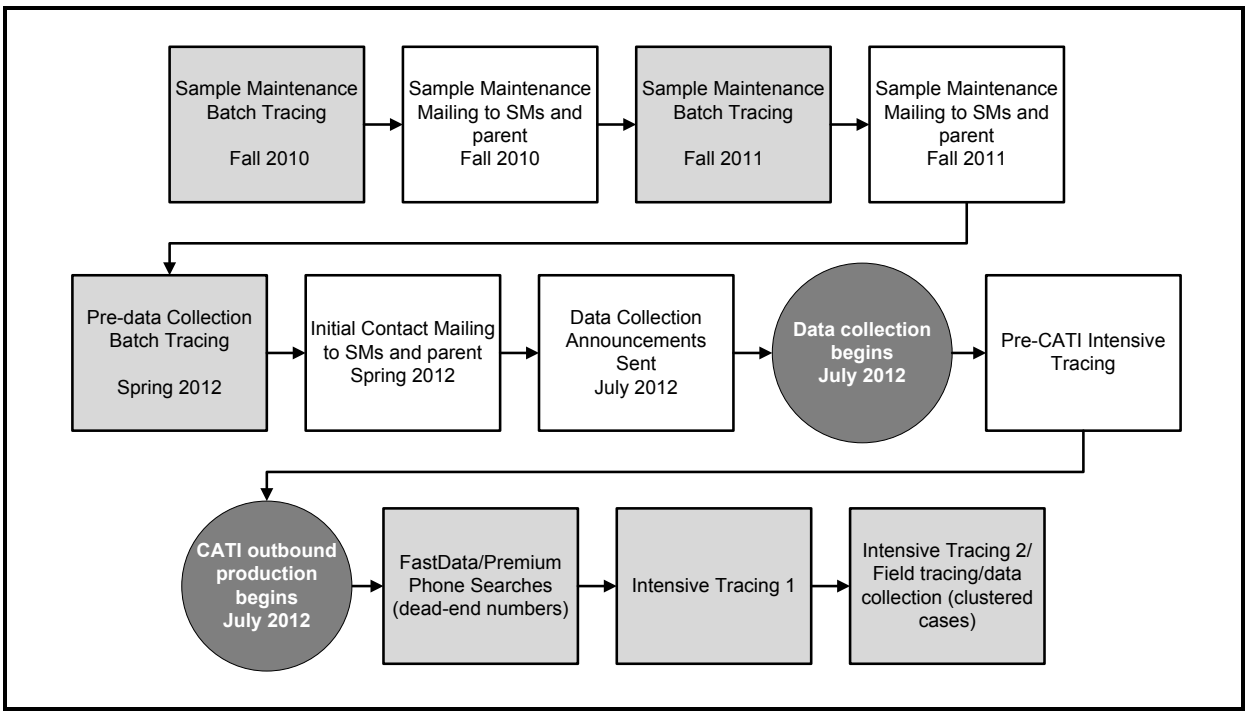
This section details the data collection activities and procedures followed, including sample maintenance, tracing, responsive design methodology, survey modes, and refusal conversion. Section 4.2 provides quantitative information on the data collection outcomes.

4.1.1 Locating and Tracing Activities

Several locating methods were used to find and collect up-to-date contact information for the ELS:2002 third follow-up sample (figure 3). Batch searches of national databases and address update mailings to sample members and a parent were conducted prior to the start of data collection. Follow-up locating methods were employed for those sample members not found after the start of data collection (figure 4), including computer-assisted telephone interview (CATI) locating, computer-assisted personal interview (CAPI) field tracing, and intensive tracing.

[12] The transcript DFD report (NCES 2006-338) is available only to licensed users of the transcript data; however, substantial attention is given to the transcript component in the Base-Year to Second Follow-up DFD (NCES 2008-347) as well.

Figure 3. Overview of the sample tracing process



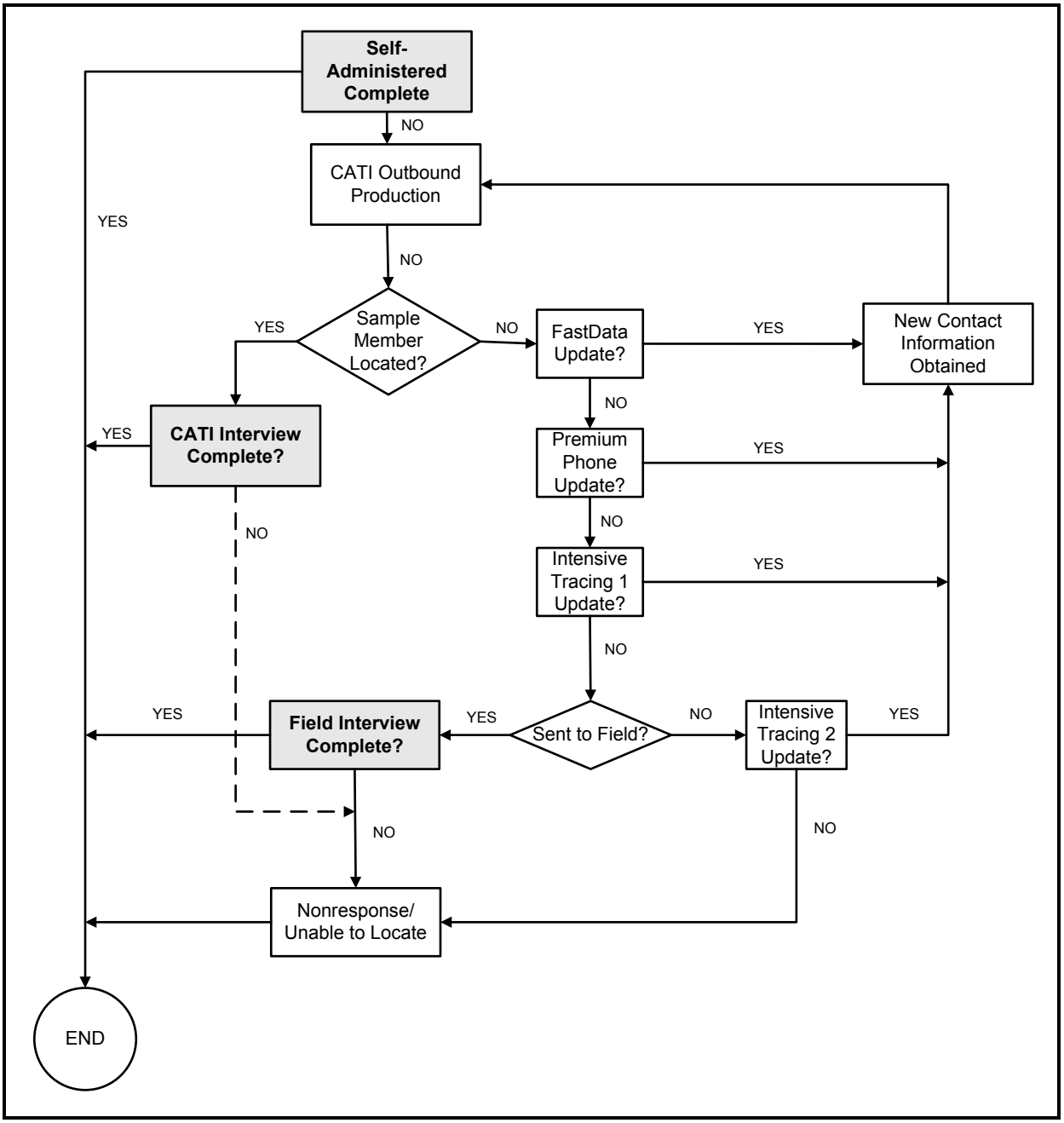
NOTE: CATI = computer-assisted telephone interview. SMs = sample members.

Batch Tracing. Batch database searches were conducted on all sample members to update contact information in preparation for mailing activities. These searches used the U.S. Department of Education's Central Processing System (CPS) and U.S. Postal Services (USPS) National Change of Address databases. Then, just prior to the start of outbound telephone interviewing, all sample members were sent to Phone Append, which searches more than 400 million landline, voice over Internet protocol, and wireless numbers in the United States, Puerto Rico, and Canada. All information obtained from these sources was compared with the information previously available from the ELS:2002 third follow-up locator database to identify any new contact information.

Mailings. An initial letter announcing the data collection was mailed to sample members beginning on July 3, 2013, by USPS first-class mail. The mailing to all sample members included the following:

- a letter, signed by both the project director and the NCES project officer, that announced the start of data collection;
- information about the incentive;
- a link to the study website;
- login credentials for accessing the web interview;
- the ELS:2002 e-mail address and toll-free help desk number; and
- a brochure about ELS:2002 third follow-up.

Figure 4. Tracing process during data collection: 2012



NOTE: CATI = computer-assisted telephone interviewing.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

In addition to the letter, an e-mail was sent to sample members 2 days later. Both the letter and the e-mail encouraged sample members to complete the survey online during the early response period. Additional mailings during this early period included a reminder postcard and letter and additional e-mail reminders to encourage early interview response. Once outbound telephone interview efforts began, periodic reminder mailings as well as weekly e-mails were sent to sample members throughout the course of data collection.

Approximately 3 weeks after the sample member letter was mailed, a letter announcing the start of data collection was also sent to one parent for each sample member. Two to 3 days later an e-mail was sent to the parent, if any e-mail address was known. A letter was also sent to parents of nonrespondent sample members in December 2012 so that parents could pass along the study information and reminder to the sample members.

CATI Locating and Pre-intensive Tracing. Once outbound telephone interviewing began, telephone interviewers (TIs) conducted limited tracing and locating activities, as needed. The telephone number believed to be the best known number for contacting the sample member was attempted first. If the sample member could not be reached at that number after several attempts, any other numbers associated with the sample member, including parent and other contacts, were called. The interviewers attempted to gather locating information for the sample member from the contact who answered the call. If the sample member could not be located, the case was sent for intensive interactive tracing.

Intensive Tracing. Cases that could not be located through batch tracing or CATI locating efforts underwent intensive tracing. Using a number of public domain and proprietary databases, intensive tracing personnel uses a two-tiered strategy. The first tier used Social Security numbers (SSNs) to search for sample members in consumer databases such as FastData's SSN search and Experian, which contains current address and telephone listings for the majority of consumers with credit histories. If a search generated a new telephone number for the sample member, tracers attempted to confirm the information by speaking with the sample member or with someone else who could confirm the information. If the number was confirmed, the case was sent back to CATI for telephone interviewing. This first level of effort minimized the time that cases were in tracing and unavailable for CATI efforts.

If cases were not located (or locating information not confirmed) at the end of the first level of intensive tracing, the cases underwent a more intensive level of tracing, which included calls to other possible sources of information, such as directory assistance, alumni offices, and contacts with neighbors or landlords. Whenever any of these sources provided information that indicated that a sample member was not available for the study (e.g., deceased, incarcerated, or out of the country), no further contact efforts were made.

4.1.2 Interviewing

Data collection for ELS:2002 third follow-up consisted of the following phases:

- *Pre-CATI*. This phase began with the first mailings occurring on July 3, 2012, and lasted until August 5, 2012. Sample members were encouraged to complete the survey over the Web during this phase. The telephone interview was available to sample members who contacted the help desk, but no outbound telephone calls were made. Sample members who completed the interview were eligible to receive an incentive of $25.

- Sample members who ever dropped out of high school were mailed to in the same period but their cases went straight into CATI production (in early July) and did not have a pre-CATI phase. These sample members were offered $55 throughout the data collection period.
    - *CATI production and increased incentives for targeted cases.* The CATI production phase began on August 6, 2012. During this phase, interviewers called to encourage sample members to complete the interview by telephone or on the Web. Sample members who completed the interview in this phase were eligible to receive an incentive of $25 or $55 based on their response propensity group assignment (see section 4.3 for more information on the methodology). The sample members were divided into two groups, high propensity and low propensity. Sample members in the high-propensity group were offered $25 while the low-propensity cases were offered $55. Sample members were alerted with a letter and e-mail, and by interviewers if successful contact was made.
    - *Consideration for field interviewing and increased incentives for targeted cases*. The increased incentive phase began on September 21, 2012. During this phase, newly identified low-propensity cases were offered an increased amount of $55. Sample members were alerted with a letter and e-mail, and by interviewers if successful contact was made. Low-propensity cases from the current selection or the prior selection were considered for CAPI field work. Cases that were deemed a good fit for field work were assigned to field interviewers (FIs) beginning September 27, 2012.
    - *Prepaid $5 incentive express mailing and increased incentives for targeted cases.* This phase began on November 6, 2012. During this phase, the incentive value was increased to $55 for newly identified low-propensity cases. Sample members were alerted with a letter and e-mail, and by interviewers if successful contact was made. Low-propensity cases received their letter via express mail and it included a $5 check in advance for completing the interview. All other cases received a reminder letter in a 9x12 envelope via USPS and it did not include a prepaid check.

Sample members could complete the interview on the Web or by telephone throughout the entire data collection period. For the TI and FI, the interview screens were identical to those in the web interviews completed by respondents, except that instructions on how to administer each question were visible at the top of each screen for telephone and field interviews. Following are details of the administration of the interview through the various modes.

An additional method used to increase the number of interview completions was to offer an abbreviated interview. Beginning on January 7, 2013, all nonrespondent sample members were eligible for the approximately 10-minute abbreviated interview and the full-length interview was no longer accessible. Sample members were notified via a letter and e-mail. The letter was sent via an express shipping service.

Study Website and Help Desk. Sample members were provided with a link to the ELS:2002 third follow-up website prior to the start of data collection. The website provided general information about the study, including the study sponsor and contractor, how the data are

used, answers to frequently asked questions (FAQs), confidentiality assurances, and selected findings from earlier rounds of ELS:2002. The website also provided contact information for the study help desk and project staff at RTI, as well as a link to the NCES website. Sample members were able to log in to the secure website to provide updated contact information and complete the sample member interview once it became available.

Designed according to NCES web policies, the study website used a three-tier security approach to protect all data collected. The first tier of security included secure logins, with a unique study ID and strong password provided to sample members. The second tier of security protected any data entered on the website with secure socket layer technology, allowing only encrypted data to be transmitted over the Internet. The third tier of security stored any collected data in a secured SQL Server database located on a server machine that was physically separate from the web server.

Sample members were provided with a toll-free telephone number, which was answered by help desk agents. Help desk staff were available to sample members who had questions or technical issues related to completion of the web interview. For each call received, staff confirmed contact information for the sample member and recorded a description of the problem and resolution. If technical difficulties prevented sample members from completing the web interview, help desk staff were able to complete a telephone interview. Two common types of help desk incidents were requests for login credentials and requests to complete the interview over the telephone. To minimize the need for help desk assistance, a "Forgot Password?" link was included on the study website and the need to disable pop-up blockers to launch the survey was eliminated.

Web Interviews. Sample members were informed of the web interview in all project communications including mailings, e-mails, and telephone contacts. During the early response period (the first 4 weeks of data collection), only web interviews were completed unless sample members initiated a telephone interview by calling the help desk or sending an e-mail asking to be called. Dropout cases were an exception; they began receiving CATI calls a few days after their initial mailing. Reminder mailings and e-mails were sent throughout all phases of data collection to encourage sample members to complete the interview online. The website was accessible 24 hours a day, 7 days a week, throughout the data collection period, providing sample members with the option to complete the interview online at any time.

Telephone Interviews. For sample members who ever dropped out of high school, outbound telephone follow-up began in early July. For all other cases, outbound telephone follow-up began on August 6, 2011, after the 4-week pre-CATI response period ended. TIs attempted to locate, gain cooperation from, and interview sample members who had not yet completed the interview. Interviewers encouraged sample members to complete the interview by telephone; however, the web survey remained available throughout data collection for sample members who preferred that option. Sample members who did express a preference to complete

a web interview were called back 5 days later for follow-up if the interview had not yet been completed.

The CATI Case Management System (CATI-CMS) included an automated call scheduler that assigned cases to interviewers by case priority, time of day, day of week, existence of previously scheduled appointments, and type of case. Case assignment was designed to maximize the likelihood of contacting and interviewing sample members, and cases were assigned to various queues accordingly. For example, the CATI-CMS included queues for new cases that had not been called, Spanish-language cases, initial refusals, and various appointment queues. In addition, available telephone numbers for each case were automatically prioritized for the interviewers. As new telephone numbers were added—as a result of CATI tracing, other tracing efforts, and information from other sources such as respondent e-mails or help desk call-ins—available telephone numbers were reprioritized based on the new information.

Some cases required special treatment. To gain cooperation from those sample members who initially refused to participate (and from contacts such as parents and roommates who acted as gatekeepers to the sample member), interviewers were trained in refusal conversion techniques. For example, a TI will recontact the person and acknowledge the issue or concern the person conveys and listen carefully. He or she will then speak to the specific concern and also explain the importance of the study and the importance that individuals similar to the sample member are represented in the data.

Quality control measures in CATI. In addition to training and certification procedures, a number of procedures were implemented to ensure and maintain data quality in CATI interviewing. Supervision and monitoring were maintained throughout data collection. Supervisors and monitors attended training alongside CATI staff so that they were familiar with the CATI interviewing procedures.

Project staff regularly monitored telephone interviews during data collection to meet the following data quality objectives:

- identification of problem items in the interview;
- reduction in the number of interviewer errors;
- improvement in interviewer performance through reinforcement of effective strategies; and
- assessment of the quality of the data collected.

Staff monitored interviews on all shifts, including live and recorded interviews, using RTI's monitoring interface, QUEST. Interview monitors recorded their feedback on standardized monitoring forms that covered such topics as interviewer professionalism, question administration, and knowledge of the instrument. Interviewers received feedback from the session, and Quality Circle (QC) meetings frequently incorporated issues identified during monitoring to improve the overall quality of telephone interviews.

Quality Circle meetings. Weekly QC meetings were conducted to serve as an essential feedback loop for ensuring that project staff and call center staff were communicating on a regular basis about the goals of the study and addressing challenges encountered along the way. These meetings provided a forum for discussing elements of the instrument design and interview cooperation tactics, motivating the group toward the goals of the study, and obtaining feedback on data collection issues. Weekly QC meetings for telephone staff were held at the call center. Issues discussed at these meetings were documented in meeting notes and stored where staff could access them as needed. The interviewers were informed of counts of interview completions to date, general data collection issues and issues specific to the survey instrument, and project staff responses to questions from interviewers.

Throughout the study, a variety of issues were addressed at the QC meetings that reinforced specific content from training and contributed to prompt problem solving. Some of the issues covered in these meetings included the following:

- clarification of questions and item responses and reinforcement of positive interviewing techniques;
- methods of gaining cooperation from sample members and gatekeepers (e.g., spouses, parents, and roommates);
- problem sheets submitted during contacting and interviewing;
- the importance of providing and reviewing detailed case comments;
- data security protocols; and
- study progress and general morale boosting.

TIs and their supervisors were given the opportunity to ask questions in QC meetings, and as needs were identified, additional training topics were highlighted and addressed in subsequent meetings.

Field Interviews. Field interviewing assignments began on September 27, 2012. FIs attempted to locate, gain cooperation from, and interview sample members who had not yet completed the interview. Interviewers encouraged sample members to complete the interview either in person or by telephone; however, the web survey remained available throughout data collection for sample members who preferred that option. Sample members who did express a preference to complete a web interview were called back 5 days later for follow-up if the interview had not yet been completed.

Case assignment was designed to maximize the likelihood of contacting and interviewing sample members, based on factors such as location of the last known address of the sample member and feasibility of sending a traveling FI.

Quality control measures in CAPI. Like CATI efforts, CAPI data collection included multiple procedures to ensure that data quality standards were being maintained. The CAPI manager and field supervisors closely monitored CAPI production on a daily basis so that they

could quickly address production issues and other field data collection challenges. Field supervisors held weekly conference calls with each of their FIs to discuss the status of each assigned case and ensure that appropriate efforts were being made for each case. During these calls, particular emphasis was placed on handling refusal cases and determining appropriate steps for locating cases. The CAPI manager also held weekly conference calls with each field supervisor to discuss field production and strategies and to communicate any updates on data collection plans.

To maintain control of quality in CAPI data collection, verification interviews were conducted for a sample of each FI's completed interviews. At the end of each CAPI interview, respondents were told that they might be contacted for quality control purposes. Verification calls and interviews were completed by in-house TIs.

Completed CAPI interviews were sampled randomly within interviewer but care was taken to ensure that at least 10 percent of each interviewer's completed interviewers were verified. The verification interview included a brief set of questions about the procedures followed during the original interview, including the date on which the interview occurred, the mode in which the interview was completed (by telephone or in person), the approximate duration of the interview, and the amount of the incentive paid. In addition, two key factual questions from the interview were asked again in the verification interview. Any problems detected through verifications were coded and reported to the CAPI manager. The CAPI manager and field supervisors ensured that issues were addressed with the field staff member in a timely manner.

4.1.2.1 Training of Data Collectors

The in-house data collection staff included quality control supervisors (QCSs), quality experts (QEs), TIs, and intensive-tracing staff. Prior to beginning work on ELS:2002 third follow-up, all data collection staff completed a comprehensive training program. Topics covered in the training program included the following:

- a review of confidentiality requirements;
- an overview of the study;
- FAQs;
- administrative procedures for case management; and
- hands-on practice.

The training program was designed to maximize active participation of the trainees. Help desk support staff were trained on July 5, 2012, and interviewers were trained on help desk support and interviewing in two sessions before and during data collection. A total of 63 help desk staff/TIs were trained. The specific roles and duties of data collection staff are summarized in the following subsections, along with a description of the training program.

Quality Control Supervisors and Quality Experts. QCSs provided support and guidance for the TIs and helped troubleshoot problems, and QEs monitored interviewer production. They attended ELS:2002 third follow-up project supervisor training and also participated in TI project training. The project supervisor training included an overview of the study, active listening techniques expected of interviewing staff, problem resolution, and other specific project procedures and protocols.

Telephone Interviewers. As a primary point of contact with sample members, TIs were responsible for gaining cooperation from and conducting interviews with sample members, avoiding interview refusals, and addressing the concerns of reluctant sample members. Because of this integral role in the study, TIs received a project manual and 12 hours of training that included

- an overview of ELS:2002 third follow-up;
- an in-depth review of the questionnaire;
- hands-on practice administering the telephone interview;
- review of interviewing techniques; and
- review of proper methods in handling inbound calls.

To conclude the training and verify that the material had been learned, all TIs were certified by successfully conducting mock telephone interviews and by providing satisfactory responses to the study's FAQs.

In addition to the training described above, QCSs and TIs were also cross-trained as help desk agents who assisted any sample members who had questions or problems while completing web interviews or called in to complete the telephone interview.

Tracing Staff. Tracing staff (tracers) used intensive measures, described in section 4.1.1, to locate sample members who lacked good telephone contact information. The 23 tracers attended a comprehensive 16-hour training session led by RTI tracing managers and covered all tracing procedures. Many ELS:2002 third follow-up tracers were cross-trained as TIs on the same project.

Additionally, weekly QC meetings were routinely conducted as an extension of the training program for continual quality improvement. QC meetings are discussed in greater detail earlier in this section.

Field Interviewers. In addition to the in-house staff described above, off-site FIs were also employed as data collectors. As a primary point of contact with sample members, FIs were responsible for gaining cooperation from and conducting interviews with sample members, avoiding interview refusals, and addressing the concerns of reluctant sample members. Because of this integral role in the study, the 44 FIs received a project manual and 30 hours of training that included

- an overview of ELS:2002 third follow-up;
- an in-depth review of the questionnaire;
- hands-on practice administering the telephone interview;
- review of interviewing techniques; and
- specifics of the laptop computer and CMS.

To conclude the training and verify that the material had been learned, all FIs were certified by successfully conducting mock interviews; providing satisfactory responses to the study's FAQs; appropriately coding postsecondary fields of study, institutions, and occupations; and accurately completing an exercise on selecting and keying event codes.

4.1.2.2 Refusal Conversion

Another important challenge in planning data collection was developing procedures for sample members who initially refuse to participate or who otherwise prove difficult to include in the study. The design of the incentive plan considered factors likely to increase the difficulty of including certain sample members, such as those who did not participate in the previous round and those who had dropped out of high school. The incentive plan was intended to reduce the potential for sample members to hesitate or refuse to participate when first contacted about the data collection. Because the incentive plan could not avert initial hesitation or refusal among all sample members nor address all reasons for hesitation or refusal, procedures were needed to overcome hesitation and avoid refusals among sample members. In addition, because not all refusals or difficult situations could be avoided, contingency procedures were needed to address initial refusals or other difficult-to-complete cases during data collection. This section describes the procedures in place to avoid refusals, manage initial refusals, and handle other difficult situations.

Procedures for avoiding refusals. Procedures for avoiding refusal situations included four activities: interviewer training sessions, web/CATI QC meetings, field conferences, and sample management. Efforts to avoid sample member refusals began in the training sessions of web help desk and telephone and field interviewing staff. Training modules addressed common reasons for reluctance or refusal, strategies to address potential refusal situations, and consideration of specific reluctance or refusal statements and behaviors. Presentations, discussion, role-playing exercises, and a team competition were all used to prepare interviewers to address potential refusal situations. These training modules included specific objections from sample members or parents and potential interviewer responses that were directly based on experiences from prior rounds of ELS:2002 and other current education studies of young adults.

Another important focus of interviewer training was addressing potential reluctance or specific objections among gatekeepers. Experience from prior rounds of ELS:2002 demonstrated the ways in which parents and other household members can either help or hinder efforts to contact sample members. Training modules also focused discussion and exercises on how

interviewers can successfully address common gatekeeper concerns and objections. To assist CATI interviewers, the CATI-CMS program included scripted probes for interviewers to use when asking for parents' or other contacts' cooperation in reaching sample members. Because many sample members had completed high school and moved out of their parents' household, gaining parent assistance in contacting sample members was often the first step in the survey participation process.

These training sessions all followed the same general strategy for addressing reluctant sample members or gatekeepers, including the following:

- understanding the reason(s) for the subject's or gatekeeper's reluctance as quickly as possible;
- being prepared to address the concern(s) quickly and directly;
- focusing responses on why the sample member's participation is important to ELS:2002; and
- using an effective tone and maintaining a professional approach.

This strategy was illustrated through specific examples used in training modules.

In addition, all interviewers were required to complete an exercise in responding to sample member or gatekeeper concerns as part of the certification process. This certification process reinforced using the refusal avoidance strategy to communicate the importance of sample members' participation in ELS:2002. The most important points interviewers were trained to communicate to sample members and other contacts included:

- reminding sample members and parents of their previous participation;
- the importance of sample members' continued participation;
- the importance of ELS:2002 for education in the United States;
- the incentive payment provided to sample members;
- explanations of the 2012 data collection procedures and options; and
- a toll-free number to talk with the data collection manager about the study.

Key talking points and refusal avoidance strategies were regularly reinforced in QC meetings and field conference calls held with the help desk and interviewing staff. QC meetings and field conferences were held weekly during 2012 data collection to ensure that procedures were being followed correctly. The meetings provided a forum for interviewers to discuss specific examples of reluctance or refusal responses among sample members and possible steps to address these concerns. After the first few meetings focused on basic issues, data collection managers began to regularly add a session at the end of each meeting devoted to role-playing potential refusal situations. These sessions provided regular practice and discussion for interviewing staff so that they were prepared to address these situations effectively.

Sample management activities in CATI data collection were also an important part of refusal avoidance procedures. Call scheduling procedures were designed to avoid inundating

households in the sample with too-frequent calls. For example, when answering machines were reached and a message left, the CATI-CMS call scheduling system held these cases for at least 3 days to give sample members or their parents some time to return the call. When sample members or parents requested a callback for a specific day and time, interviewers entered these appointments in CATI-CMS so that the appointment cases would be delivered to interviewers at the appropriate time. Telephone supervisors were continually aware of the need to keep all appointments, and monitored the status of upcoming appointments to ensure that all appointments were covered. These procedures ensured that appointments were kept regularly, which was a significant issue for sample members and parents with busy schedules. Another important feature of CATI-CMS that provided assistance in avoiding refusal situations was the call history log. After each call, interviewers entered relevant information about the results of the call and any interaction with sample members or other contacts in this log. These notes ensured that interviewers who made subsequent calls to contact sample members were aware of the results of previous calls. The call history log allowed interviewing staff to be sensitive to any concerns sample members, parents, or other contacts had about the 2012 data collection process and to be prepared to address those concerns in subsequent contacts.

CAPI staff also used sample management techniques to avoid refusal situations. A key difference between CAPI and CATI was that field efforts to avert refusals were based on collaborations between field supervisors and FIs. FIs worked with their supervisors to develop an individual approach to each case based on the CATI call history for the case and the results of any initial contact attempts by the CAPI interviewer. Field staff maintained detailed documentation of contact attempts in an event log in the laptop CMS. FIs could then review this information when planning future contacts with each sample member and, if the case was transferred to another interviewer, provide information for those subsequent contact attempts.

Procedures for converting refusals. Whenever a call resulted in a refusal, CATI interviewers followed a predetermined set of steps to classify the refusal situation. CATI-CMS produced a series of screens that allowed interviewers to specify the following information:

- person who refused (sample member or other);
- point at which the refusal occurred (prior to, during, or after the introduction);
- strength of refusal (mild, firm, or hostile); and
- any specific reasons mentioned for the refusal.

Interviewing staff used both general strategies and the specific information in CATI-CMS, including the call history log, to develop a refusal conversion approach to each individual case. After a call resulted in a refusal and the information about the interaction was entered, CATI-CMS moved the case to a special refusal queue. Cases in the refusal queue were held for at least 1 week after the initial refusal before being made available by the call scheduler for subsequent refusal conversion attempts. In practice, the time interval between the initial refusal

and the next contact was often longer than 1 week because multiple subsequent calls were often required to contact these sample members again.

Delaying subsequent contact attempts was a key sample management procedure used to maximize the success of refusal conversion efforts. This break provided a short period to allow sample members to reconsider their participation in the study and, in some cases, to be in a more favorable situation to participate. For the same reason, CAPI interviewers who were assigned initial refusal cases from CATI data collection typically waited a week before attempting to contact these sample members. All refusal cases assigned to field data collection were reviewed carefully by the field supervisor and FI. Field staff would review the statements made by the prospective respondent or gatekeeper when he or she declined participation and develop a refusal conversion approach for each individual case. The approach of field staff sometimes included having the supervisor contact the household first or transferring the case to another CAPI interviewer when the original interviewer was unable to make progress with the case.

Because data collection staff anticipated that a significant number of refusals would ultimately transpire, plans were made early in data collection to conduct specialized refusal conversion training sessions for telephone interviewing staff within a few weeks after the start of outbound CATI calling. The first refusal conversion training was conducted about 3 weeks after outbound CATI data collection, and a second training session was held 2 weeks later. For both training sessions, data collection staff selected interviewers with strong performance ratings to attend these trainings. Interviewers were also identified based on qualitative feedback from telephone supervisors and monitors. As a general rule, interviewers selected to be refusal conversion specialists were interviewers who had demonstrated skills in enlisting cooperation among sample members and avoiding initial refusals. The training sessions emphasized specific refusal conversion techniques tailored to the ELS:2002 sample of young adults, including overcoming objections, addressing concerns of gatekeepers, and providing alternatives for participation. Both group discussions and individual role-playing exercises were used in refusal conversion training. Only interviewers who had successfully completed one of these training sessions were allowed to call initial refusals. Table 12 in section 4.2 presents the results of refusal conversion efforts.

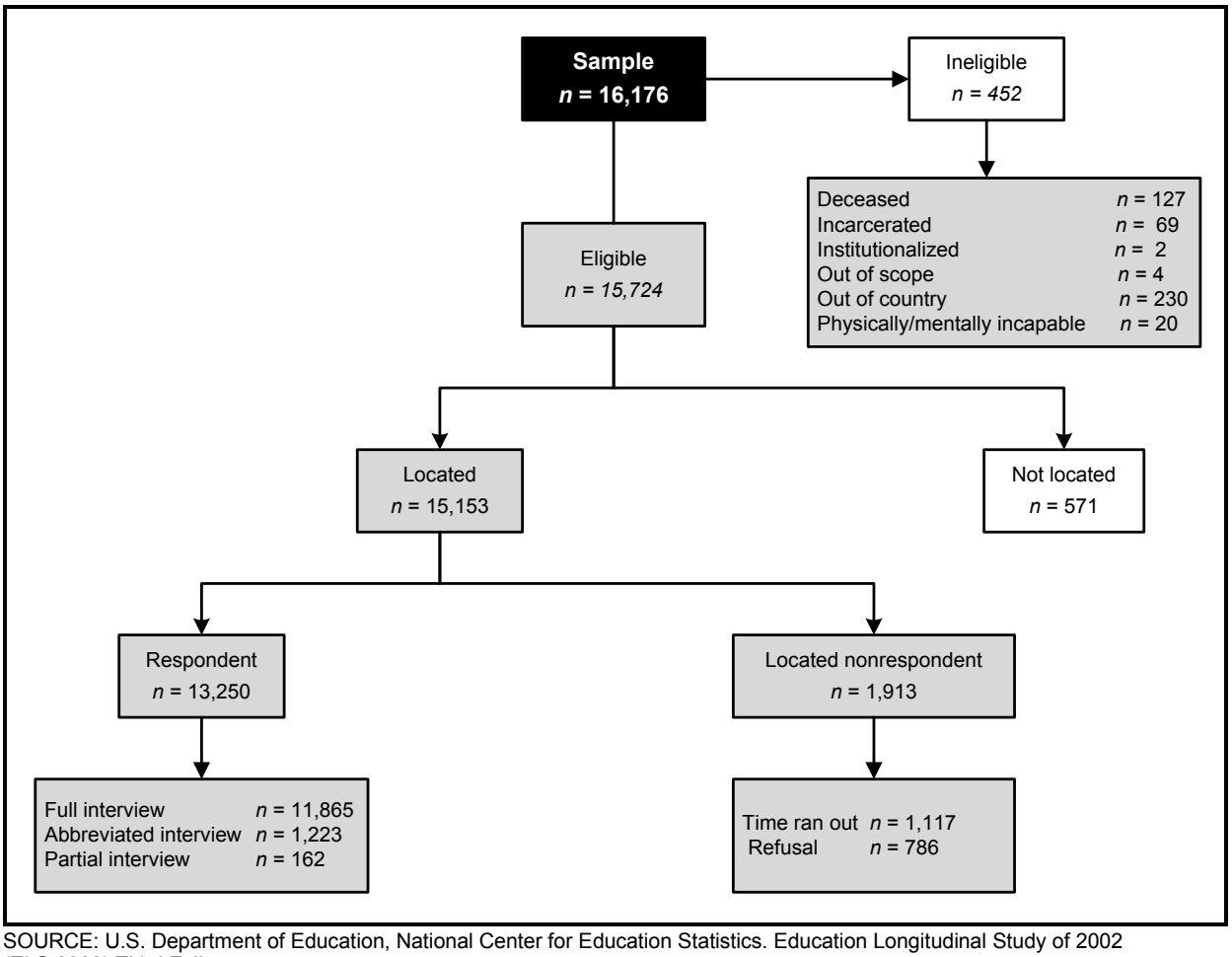
4.2 Third Follow-up Data Collection Outcomes

ELS:2002 third follow-up interviews were administered between July 4, 2012, and February 3, 2013. Of the 16,176 sample members, 15,724 were deemed to be in scope for the study after removing those who were ineligible (e.g., deceased) or out of scope for reasons such as being institutionalized, incarcerated, or out of the country. Of these eligible members, 13,250 sample members (84 percent weighted and unweighted) completed a full interview or a partial

interview.[13] The average length of a full interview was 32.8 minutes; the average length of an abbreviated interview was 12.8 minutes. The results presented in the remainder of this section, including those shown in all tables, refer to unweighted rates. Section 4.4 contains weighted response rates.

The overall locating and interviewing results for the ELS:2002 third follow-up data collection effort, including sample members who were located but later excluded, are presented in figure 5. A sample member was considered located if an interview was completed, the sample member was successfully contacted despite not completing the interview, or the contact information in the study database had not been proven out of date or incorrect during contact attempts. As will be illustrated later in this section, second follow-up nonrespondents were particularly challenging to locate.

Figure 5. Sample member locating and third follow-up response status: 2012



SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

[13] A partial interview is defined as any case where the respondent began the interview, completed it through the high school completion section, but broke off and did not return to complete the interview.

Locating and Interview Results. Overall locating status varied by high school dropout status and prior-round response status, as shown in table 1. The unweighted locating rate was defined as the percentage of cases in which an interview was completed, the sample member was successfully contacted, or the contact information in the study database was not proven out of date or incorrect during contact attempts. The locate rate was significantly higher for those who responded to the ELS:2002 second follow-up compared to those who did not respond to the second follow-up.

Table 1. Sample member locating in the third follow-up, by dropout status and second follow-up response status: 2012

ELS:2002 dropout status and second follow-up response status	Total eligible	Located		Responding sample members		
		Number	Percent of total	Number	Percent of located	Percent of total
Total	15,724	15,153	96.4	13,250	88.8	84.3
Dropout status						
Ever dropped out	1,762	1,610	91.4	1,384	87.4	78.5
Not ever dropped out	13,962	13,543	97.0	11,866	88.9	85.0
Second follow-up response status						
Respondent	13,837	13,497	97.5	12,135	91.0	87.7
Nonrespondent	1,887	1,656	87.8	1,115	70.4	59.1

NOTE: Count includes sample members who completed enough of the interview to count as a respondent. For "ever dropped out," classified as dropout if at least one of the following conditions was met after the second follow-up: school reported that respondent had dropped out of school at any one of the enrollment status updates, respondent earned a General Educational Development credential, respondent did not receive a high school credential, or respondent's high school transcript indicates dropped out, dismissed, or incarcerated.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

A concerted effort was made to convince parents of the value of the study so that they would cooperate and share information with their children. In some cases, parents continue to act as gatekeepers for the sample members even though the sample members are several years removed from being minors. Dual mailings to both the sample members and their parents were sent. These procedures ensured at both the panel maintenance and data collection stages that parents were aware of the plans for the third follow-up. Direct mail and e-mail contacts with parents allowed parents to provide updated contact information for their young adults. Also, because some phone numbers available for sample members are numbers for their parents' homes, CATI procedures were in place to guide interviewers on how to appropriately ask for and record new contact information for sample members from parents. Successful contacts with parents were an important part of interviewer training.

Locate Rates by Source of Batch Update. Before and during the ELS:2002 third follow-up data collection, batch matching was conducted to gather the latest contact information for the 16,176 sample members. Multiple records were sent for matching per case. This effort confirmed contact information or provided new contact information for thousands of records for

full-scale cases, as shown in table 2. The highest proportion of matches was obtained through FirstData Phone Append, 41 percent of records sent. CPS for the Free Application for Federal Student Aid (FAFSA) matching was completed late in the data collection period and only nonrespondents at the time were sent. In part because of which cases were sent, only 9.9 percent of records sent were matched through CPS. Further, because CPS relies on postsecondary student loan application data, it is unsurprising that it matched the fewest records because only 74 percent of ELS:2002 second follow-up respondents reported attending postsecondary institution(s), and it had been 8 years since the majority of sample members completed high school, so the numbers attending postsecondary institutions were likely to be low. Also, not all postsecondary students fill out the application for federal student aid and those students would not appear in the CPS data.

Table 2. Batch processing record match rates in the third follow-up, by tracing source: 2012

Method of tracing	Number of records sent	Number of records matched	Percent matched
NCOA	15,230	710	4.7
Phone Append	15,230	6,281	41.2
Premium Phone	8,637	4,237	49.1
CPS	5,962	589	9.9

NOTE: Percent is based on the number of records sent for batch tracing. Because records were sent to multiple tracing sources, multiple record matches were possible. Match rate includes instances when sample member contact information was confirmed and when new information was provided. Numbers may not sum to total because of rounding. CPS = Central Processing System for the Free Application for Federal Student Aid. NCOA = National Change of Address.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

Address Update Mailing Results. The three most recent panel maintenance address update mailings for the cohort, in which sample members and one parent were asked to confirm or update contact information, were conducted in fall 2010, fall 2011, and Spring 2012. For the 2011 mailing, a $10 incentive was offered to sample members if they or a parent updated or confirmed contact information. As shown in table 3, address updates or confirmations were received from 4,709 sample members (29 percent unweighted) in response to the request, which was sent via mail and e-mail. For the 2010 and 2012 mailings, the response was also successful with address updates or confirmations being received from 3,993 sample members (25 percent unweighted) in response to the request in 2010 and 3,831 sample members (24 percent unweighted) in response to the request in 2012. In 2010, we began mailing not only to the sample member but also to one parent. A clear increase in response can be seen between 2010 and the prior years.

Table 3. Panel maintenance participation rates for the ELS:2002 full-scale sample, by round of panel maintenance: 2012

Round of panel maintenance	Sample[1]	Responded	
		Number	Percent
2012	16,176	3,831	23.7
2011	16,176	4,709	29.1
2010	16,176	3,993	24.7
2008	16,197	1,760	10.9
2007	16,197	1,998	12.3

[1] The third follow-up sample consists of the second follow-up sample but excludes second follow-up sample members who were determined to be ineligible at the end of the second follow-up or during panel maintenance, such as deceased sample members, study-ineligible members, and other individuals determined to be permanently out of scope.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

Interview Completion by Address Update Participation. Sample members who responded to a panel maintenance address update request in 2010, 2011, or 2012 responded to the third follow-up interview at a higher rate than those who did not respond to the request. Table 4 contains the third follow-up interview completion rates by panel maintenance address update response.

Table 4. Interview completion rate in the third follow-up, by panel maintenance participation in 2010, 2011, or 2012: 2012

	Number of eligible cases	Interview respondent	
		Number	Percent
Total	15,724	13,250	84.3
Panel maintenance respondent	6,519	6,348	97.4
Panel maintenance nonrespondent	9,205	6,902	75.0

NOTE: Count includes sample members who completed enough of the interview to count as a respondent.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

Table 5 shows combined panel maintenance participation (participation in 2010, 2011, or 2012) and of those respondents, how many completed the third follow-up interview. Of the 42 percent of sample members who were panel maintenance participants (in 2010, 2011, or 2012), 97 percent completed the third follow-up interview. The table also contains panel maintenance response and interview response by sample member characteristics. For all but one characteristic, over 90 percent of the panel maintenance respondents completed the third follow-up interview. The exception was second follow-up nonrespondents; 84 percent of those panel maintenance respondents completed the interview.

Table 5. Interview completion rate in the third follow-up, by panel maintenance participation in 2010, 2011, or 2012: 2012, broken down by sample member characteristics

	Panel maintenance combined response			Interview respondent of panel maintenance combined respondents	
Characteristic	Eligible	Number	Percent of eligible	Number	Percent
Total	15,724	6,519	41.5	6,348	97.4
Sex					
Male	7,744	2,856	36.9	2,752	96.4
Female	7,980	3,663	45.9	3,596	98.2
Race/ethnicity					
Asian or Pacific Islander	1,582	633	40.0	613	96.8
Black or African American	2,104	502	23.9	484	96.4
Hispanic or Latino	2,352	655	27.8	641	97.9
Other/more than one race	881	333	37.8	322	96.7
White	8,805	4,396	49.9	4,288	97.5
Second follow-up response status					
Second follow-up respondent	13,837	6,295	45.5	6,159	97.8
Second follow-up nonrespondent	1,887	224	11.9	189	84.4
Dropout status					
Ever dropped out	1,762	400	22.7	382	95.5
Not ever dropped out	13,962	6,119	43.8	5,966	97.5
Regular high school diploma (not GED, certificate of completion)					
Received regular diploma	14,028	6,198	44.2	6.050	97.6
Did not receive regular diploma	1,696	321	18.9	298	92.8
Postsecondary attendance (if known)					
Attended postsecondary institution(s)	12,527	5,973	47.7	5,882	98.5
Did not attend postsecondary institution(s)	2,405	510	21.2	465	91.2

NOTE: Panel maintenance respondent count includes those who provided a panel maintenance update in 2010, 2011, or 2012. Interview respondent count includes sample members who responded to the ELS:2002 third follow-up survey. The "Other/more than one race" subgroup includes American Indian/Alaska Native cases. For "ever dropped out," classified as dropout if at least one of the following conditions was met after the second follow-up: school reported that respondent had dropped out of school at any one of the enrollment status updates, respondent earned a GED, respondent did not receive a high school credential, or respondent's high school transcript indicates dropped out, dismissed, or incarcerated. GED = General Educational Development credential.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

Sample Members Requiring Intensive Tracing. Overall, 2,897 (18 percent) of the 15,724 eligible sample members required intensive tracing (table 6). Twenty-eight percent of sample members who ever dropped out of high school required intensive tracing, compared with 17 percent of sample members who never dropped out. Forty-four percent of second follow-up nonrespondents required intensive tracing, compared with 15 percent of second follow-up respondents. Of the 2,897 traced, 2,561 were located (88 percent) and of these, 1,375 (54 percent) completed an interview.

Table 6. Sample members requiring intensive tracing in the third follow-up, by dropout status and second follow-up response status: 2012

Dropout status and second follow-up response status	Total eligible	Cases requiring intensive tracing	
		Number	Percent
Total	15,724	2,897	18.4
Dropout status			
Ever dropped out	1,762	495	28.1
Never dropped out	13,962	2,402	17.2
Second follow-up response status			
Respondent	13,837	2,067	14.9
Nonrespondent	1,887	830	44.0

NOTE: Numbers may not sum to total because of rounding. Count excludes cases initiated to intensive tracing that were not traced. For "ever dropped out," classified as dropout if at least one of the following conditions was met after the second follow-up: school reported that respondent had dropped out of school at any one of the enrollment status updates, respondent earned a General Educational Development credential, respondent did not receive a high school credential, or respondent's high school transcript indicates dropped out, dismissed, or incarcerated.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

Interview Outcomes by Mode. ELS:2002 third follow-up interviews were completed on the Web, by CATI with a TI, or by CAPI with an FI. Table 7 shows that 36 percent of interviews were completed on the Web without telephone contacts, 37 percent of interviews were completed on the Web after calls by TIs, 19 percent were completed with a TI, and 8 percent were completed with an FI. Summed, 73 percent of interviews were completed on the Web. This is in line with the expected increased Internet use over time and the greater proportion of web interviews expected closer to the beginning of the data collection period. The ELS:2002 second follow-up produced only 37 percent of the completed interviews on the Web, although it is important to keep in mind that the third follow-up took place over a shorter time period than the time period for the second follow-up.

Table 7. Distribution of respondents in the third follow-up, by mode of administration: 2012

Mode of administration	Respondents	
	Number	Percent of all respondents
Total	13,250	100.0
Web, without telephone calls	4,786	36.1
Web, with telephone calls	4,838	36.5
Telephone (CATI) interview	2,573	19.4
Field (CAPI) interview	1,053	7.9

NOTE: Detail may not sum to totals because of rounding. Count includes sample members who completed enough of the interview to count as a respondent. CAPI = computer-assisted personal interview. CATI = computer-assisted telephone interview.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

Table 8 shows the distribution of respondents by interview mode as well as characteristics including sex, race/ethnicity, socioeconomic status, second follow-up response status, and "ever high school drop-out" status.

Table 8. Distribution of respondents in the third follow-up, by select characteristics and mode: 2012

		Web		CATI		CAPI	
Subgroup	Total	Number	Percent of total	Number	Percent of total	Number	Percent of total
Total	13,250	9,624	72.6	2,573	19.4	1,053	7.9
Sex							
Male	6,271	4,317	68.8	1,347	21.5	607	9.7
Female	6,979	5,307	76.0	1,226	17.6	446	6.4
Race/ethnicity							
Asian or Pacific Islander	1,310	1,093	83.4	143	10.9	74	5.6
Black or African American	1,702	928	54.5	543	31.9	231	13.6
Hispanic or Latino	1,885	1,198	63.6	410	21.8	277	14.7
Other/more than one race	726	516	71.1	146	20.1	64	8.8
White	7,627	5,889	77.2	1,331	17.5	407	5.3
Socioeconomic status (SES)							
Lowest quarter	2,946	1,701	57.7	733	24.9	512	17.4
Second quarter	3,106	2,120	68.3	717	23.1	269	8.7
Third quarter	3,396	2,622	77.2	596	17.6	178	5.2
Highest quarter	3,788	3,169	83.7	526	13.9	93	2.5
Second follow-up response status							
Second follow-up respondent	12,135	8,995	74.1	2,325	19.2	815	6.7
Second follow-up nonrespondent	1,115	629	56.4	248	22.2	238	21.3
Dropout status							
Ever dropped out	1,384	702	50.7	262	18.9	420	30.3
Not ever dropped out	11,866	8,922	75.2	2,311	19.5	633	5.3

NOTE: Count includes sample members who completed enough of the interview to count as a respondent. In this table, the "Other/more than one race" subgroup includes American Indian/Alaska Native cases. For SES status, 14 respondents were unclassified. For "ever dropped out," classified as dropout if at least one of the following conditions was met after the second follow-up: school reported that respondent had dropped out of school at any one of the enrollment status updates, respondent earned a General Educational Development credential, respondent did not receive a high school credential, or respondent's high school transcript indicates dropped out, dismissed, or incarcerated. CAPI = computer-assisted personal interview. CATI = computer-assisted telephone interview.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

Response by Phase of Data Collection. Thirty-one percent of ELS:2002 third follow-up interviews were completed during the pre-CATI phase. Fifty-four percent of interviews were completed during the CATI phase. Fourteen percent were completed during the CAPI phase. Section 4.1.2 contains details of the phases of data collection.

Interview response, by phase of data collection, is shown in table 9. Each phase of data collection can be evaluated individually. The pre-CATI phase of data collection yielded 4,291 responses, translating to a 31 percent completion rate during the pre-CATI phase (4,291 completed of 13,984 pre-CATI cases) (table 9). The next phase of data collection, CATI, yielded a 62 percent completion rate (7,110 completed of 11,459 eligible for the second phase). The third

phase, CAPI, yielded a 63 percent completion rate (1,849 completed of 2,953 eligible assigned to the field).

Table 9. Number of cases and percentage of completed interviews by data collection phase in the third follow-up: 2012

Data collection phase	Number of cases in phase	Completed interviews	
		Number	Percent of cases
Pre-CATI phase	13,984	4,291	30.7
CATI phase	11,459	7,110	62.0
Ever dropped out	1,766	732	41.4
Never dropped out	9,693	6,378	65.8
CAPI phase	2,953	1,849	62.6
Ever dropped out	1,009	652	64.6
Never dropped out	1,944	1,197	61.6

NOTE: Partial interviews were not included because partially completed interviews could be resumed by sample members through the end of data collection. Sample members who ever dropped out of high school all started data collection in the CATI phase of the third follow-up. The cases include 26 sample members found to be ineligible (e.g., deceased) or otherwise out-of-scope (e.g., out-of-country, incapacitated, incarcerated) during the data collection period. For "ever dropped out," classified as dropout if at least one of the following conditions was met after the second follow-up: school reported that respondent had dropped out of school at any one of the enrollment status updates, respondent earned a General Educational Development credential, respondent did not receive a high school credential, or respondent's high school transcript indicates dropped out, dismissed, or incarcerated. CAPI = computer-assisted personal interviewing. CATI = computer-assisted telephone interviewing.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 ELS:2002) Third Follow-up.

Interview completeness, by dropout status and second follow-up response status, is shown in table 10. Respondents who ever dropped out completed a higher proportion of abbreviated interviews than full interviews compared to those who never dropped out (15.5 percent versus 9.6 percent). In a similar pattern, respondents who did not complete the ELS:2002 second follow-up interview completed a markedly higher proportion of abbreviated interviews than full interviews compared to those who did complete the ELS:2002 second follow-up interview (28.2 percent versus 8.8 percent).

Table 10. Interview completeness in the third follow-up, by dropout status and second follow-up response status: 2012

ELS:2002 dropout status and second follow-up response status	Total	Full interview		Abbreviated interview	
		Number	Percent	Number	Percent
Total	13,250	12,027	90.8	1,223	10.2
Dropout status					
Ever dropped out	1,384	1,198	86.6	186	15.5
Never dropped out	11,866	10,829	91.3	1,037	9.6
Second follow-up response status					
Respondent	12,135	11,157	91.9	978	8.8
Nonrespondent	1,115	870	78.0	245	28.2

NOTE: For "ever dropped out," classified as dropout if at least one of the following conditions was met after the second follow-up: school reported that respondent had dropped out of school at any one of the enrollment status updates, respondent earned a General Educational Development credential, respondent did not receive a high school credential, or respondent's high school transcript indicates dropped out, dismissed, or incarcerated.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

Telephone Interviewer Call Counts. During the course of ELS:2002 third follow-up data collection, 308,717 CATI telephone calls were completed. TI time was spent administering the interview as well as performing case management activities such as locating and contacting sample members, prompting sample members to complete interviews, reviewing call history, scheduling appointments for callbacks, and entering detailed comments and suggestions to assist with reaching and interviewing sample members. Some of the time was also spent responding to incoming help desk calls.

On average, 20 calls were made per ELS:2002 third follow-up sample member during the data collection period.[14] Of the sample, cases that completed the third follow-up interview required an average of 15 calls, while third follow-up nonrespondents received an average of 47 calls during the interviewing period. There were no significant differences in call counts between respondents who completed interviews over the telephone and respondents who completed interviews over the Web but with phone prompting. The average number of CATI telephone calls is shown in table 11.

Table 11. Number and average of CATI calls, by dropout status and prior- and current-round response status and mode of interview in the third follow-up: 2012

Response status and mode	Number of cases	Number of calls	Average number of calls
Total	15,735	308,717	19.6
Dropout status			
Ever dropped out	1,764	17,446	9.9
Never dropped out	13,971	291,271	20.9
Second follow-up response status			
Respondent	13,844	255,868	18.5
Nonrespondent	1,891	52,849	28.0
Current-round response status			
Respondent	13,250	192,669	14.5
Web interview	9,624	107,260	11.2
Web with telephone calls	4,838	107,260	22.2
Telephone interview	2,573	61,809	24.0
Field interview	1,053	23,600	22.4
Nonrespondent or ineligible	2,485	116,048	46.7

NOTE: Count includes sample members who completed enough of the interview to count as a respondent. The cases (and the nonrespondent or ineligible category) include 11 sample members found to be ineligible (e.g., deceased) or otherwise out-of-scope (e.g., out-of-country, incapacitated, incarcerated) during the data collection period. For "ever dropped out," classified as dropout if at least one of the following conditions was met after the second follow-up: school reported that respondent had dropped out of school at any one of the enrollment status updates, respondent earned a General Educational Development credential, respondent did not receive a high school credential, or respondent's high school transcript indicates dropped out, dismissed, or incarcerated.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

[14] This includes sample members who required no call attempts.

Averting and Converting Refusals. Refusal aversion and conversion techniques were integrated into TI training and were reinforced throughout data collection in QC meetings. Interviewers were encouraged to share their experiences gaining sample member cooperation and to seek guidance from the group. Refusal cases were placed in a separate queue and worked by a subset of interviewers selected for additional refusal conversion training. Overall, 12 percent of eligible cases ever refused (i.e., refused and later completed an interview or refused and never completed an interview). Of these refusals, 47 percent subsequently completed the interview (table 12) after refusal conversion attempts were made. In the previous round (second follow-up), 13 percent of eligible cases ever refused and, of these, 8 percent subsequently completed the interview.

Table 12. Refusal and refusal conversion rates in the third follow-up, by dropout status and second follow-up response status: 2012

		Ever refused interview		Respondent, given refusal		
ELS:2002 dropout status and second follow-up response status	Total cases	Number	Percent of total	Number	Percent of refused	Percent of total
Total	15,750	1,880	11.9	892	47.4	5.7
Dropout status						
Ever dropped out	1,766	149	8.4	59	39.6	3.3
Not ever dropped out	13,984	1,731	12.4	833	48.1	6.0
Second follow-up response status						
Respondent	13,849	1,443	10.4	740	51.3	5.3
Nonrespondent	1,901	437	23.0	152	34.8	8.0

NOTE: Numbers may not sum to total because of rounding. Count includes sample members who completed enough of the interview to count as a respondent. The cases include 26 sample members found to be ineligible (e.g., deceased) or otherwise out-of-scope (e.g., out-of-country, incapacitated, incarcerated) during the data collection period. For "ever dropped out," classified as dropout if at least one of the following conditions was met after the second follow-up: school reported that respondent had dropped out of school at any one of the enrollment status updates, respondent earned a General Educational Development credential, respondent did not receive a high school credential, or respondent's high school transcript indicates dropped out, dismissed, or incarcerated.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

Field Interviewing. During the course of ELS:2002 third follow-up data collection, 1,849 CAPI interviews were completed. CAPI interviews were conducted in person and by phone, and sample members were still able to complete the web interview or call the help desk to complete a telephone interview once a case was sent to the field. Table 13 contains located and completed field interviews by dropout status and second follow-up response status.

Table 13. Located and completed field interview cases in the third follow-up, by dropout status and second follow-up response status: 2012

ELS:2002 dropout status and second follow-up response status	Eligible cases sent to field	Located	Percent of total	Responded	Percent of total	Percent of located
Total	2,940	2,533	86.2	1,849	62.9	73.0
Dropout status						
Ever dropped out	1,006	859	85.4	652	64.8	75.9
Not ever dropped out	1,934	1,674	86.6	1,197	61.9	71.5
Second follow-up response status						
Respondent	2,076	1,848	89.0	1,415	68.2	76.6
Nonrespondent	864	685	79.3	434	50.2	63.4

NOTE: Count includes sample members who completed enough of the interview to count as a respondent. Sample members were still able to complete the web interview or call the help desk to complete a telephone interview once a case was sent to the field. For "ever dropped out," classified as dropout if at least one of the following conditions was met after the second follow-up: school reported that respondent had dropped out of school at any one of the enrollment status updates, respondent earned a General Educational Development credential, respondent did not receive a high school credential, or respondent's high school transcript indicates dropped out, dismissed, or incarcerated.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

4.3 Responsive Design Methodology

4.3.1 Responsive Design for ELS:2002 Third Follow-up Nonresponse Follow-up

NCES and RTI are researching new strategies for conducting more effective nonresponse follow-up during the data collection period. There is a general recognition in the survey literature that nonresponse follow-up should be a strategic activity that prioritizes cases with the goal of minimizing bias in the final survey estimates (see for example, Peytchev et al. 2010; Rosen et al. 2011; Wagner 2012). Furthermore, there is strong evidence that the overall survey response rate is an inadequate measure of data quality (e.g., Curtin et al. 2000; Groves and Peytcheva 2008; Keeter et al. 2000). The greatest danger in nonresponse follow-up may be when a study brings in sample members who resemble those most likely to respond or those who have already responded (Schouten, Cobben, and Bethlehem 2009). Under this scenario, resources are spent on increasing participation, but little is done to minimize bias. Decreasing bias during the nonresponse follow-up depends on the cases that are ultimately interviewed (Peytchev, Baxter, and Carley-Baxter 2009). The critical factor is that nonresponding cases selected for targeting should be substantively different from the respondent set at any one point during data collection. The question remains how to go about selecting those cases.

In the ELS:2002 third follow-up, a responsive design (Groves and Heeringa 2006) was implemented in an attempt to minimize nonresponse bias. The following sections describe the implementation approach.

4.3.2 Responsive Design Approach

The goal of the responsive design is to identify and target, via specific protocols or interventions, the nonresponding cases that are different from the respondent set at any one point. Although numerous approaches are available to identify cases (i.e., critical subgroups, propensity to respond), the ELS:2002 third follow-up used a Mahalanobis distance function to identify nonrespondent cases most unlike the existing respondent set. A large number of survey variables, paradata, and sampling frame variables were incorporated into the distance function calculation, providing an opportunity to target the cases most unlike respondents and therefore, if completed, most likely to reduce nonresponse bias.

Following Li and Valliant (2009), the Mahalanobis Distance (MD) may be defined as:

$$MD = \frac{n\bar{w}h_{ii}}{w_i} - 1$$

where h_{ii} is the leverage (hat diagonal) for the ith case, w_i is the sample weight for the ith case, n is the number of cases or observations, and $\bar{w}$ is the average sample weight. The hat diagonals are the diagonal elements of the hat matrix (H):

$$H = X(X^T WX)^{-1}X^T W$$

where W is a diagonal matrix of sample weights and X is a matrix of variables that define the dimensions along which distances are calculated.

In the context of its use in the ELS:2002 third follow-up, Mahalanobis distance is defined as the distance between a nonresponding case and the weighted mean value of the complete set of responding cases. Therefore, cases with larger distance scores can be thought of as cases demonstrating large differences from the respondent set. That is, these large distance cases would be characterized by larger differences in the input variables from the weighted means of the variables for respondents. Identifying these cases and presenting the specifically targeted nonresponding cases with a higher incentive will in turn attempt to boost their participation and potentially reduce bias in estimates and also improve analytic power through higher sample sizes for these groups of cases of analytic interest.

A distance function was calculated at three points during data collection:

1. right before outbound CATI began, 4 weeks into data collection;
2. right before the CAPI period began, 9 weeks into data collection; and
3. just prior to the prepaid incentive period, approximately 8 weeks prior to the end of data collection.

At these points, the cases with the largest distance scores were offered a $55 incentive while the $25 base incentive remained intact for all other cases (not including ever dropout cases, which were offered $55 to complete the survey from the start of data collection). At each juncture, the cases identified for targeting were those with the largest distance scores but not

targeted in the prior phase(s). At the third and final case selection point, cases identified for targeting received a $5 prepaid incentive in addition to the $55 incentive and other nonmonetary activities, such as enhanced tracing. Case targeting was based on distance scores and the anticipated yield. At the first intervention point, 1,169 cases were targeted; at the second point, 2,390 cases were targeted; and at the third point, 1,721 cases were targeted. At each of these points, the Mahalanobis values were calculated and targeted cases were selected.

4.3.3 Mahalanobis Model Specification

Variable Selection. Choosing variables to include in the distance function calculation is an important process. The goal is to identify variables that are (1) known for respondents and nonrespondents, and (2) important analytically so that bias in the final survey estimates would be problematic. Table 14 shows the variables used in calculating the Mahalanobis distance.

Table 14. Variables used in the Mahalanobis calculation in the third follow-up: 2012

Frame variables	Survey variables	Paradata[1]
School control (public, Catholic, other private) School urbanicity (urban, suburban, rural)	• Parent's highest level of education • High school transcript-reported cumulative GPA • Whether English is student's native language • Ever earned GED/equivalency • Sex • Socioeconomic status • Diploma or certificate most likely to receive • Took or plans to take SAT or ACT • Took or plans to take Advanced Placement test • F1 enrollment status • Highest level of education respondent expects to complete • F1 sample member in-school grade-level status	• F2 response status • F1 nonresponse type • Ever responded to a panel maintenance • F2 call count • Number of contact attempts • Response status for F3 panel maintenance • F1 and BY combined response status

[1] Paradata refers to data surrounding the survey interviewing process.
NOTE: BY = base year. F1 = first follow-up. F2 = second follow-up. F3 = third follow-up. GED = General Educational Development credential. GPA = grade point average.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Base Year to Third Follow-up, and Common Core of Data/Private School Survey.

Technical Issues With Mahalanobis Calculation. Multiple approaches are available for generating Mahalanobis distance scores. The initial approach for the phase 1 calculations was to take advantage of the close relationship between the leverage statistic and the Mahalanobis distance. Distance scores were generated for phase 1 by outputting the hat matrix from an ordinary least squares regression (unweighted), which forced into the regression all the variables of interest. In other words, no insignificant variables were dropped. From the hat diagonal value, the Mahalanobis distance was generated for each case. Upon further examination of this approach, it was apparent that the method used for generating scores compared nonrespondents to the full sample. Because the approach seeks to identify nonresponding cases that differ from the existing respondent set, the phase 1 approach was modified for use in phase 2.

For the phase 2 distance calculations, the approach was adjusted to ensure a comparison between nonrespondents and the existing set of respondents. For this, a Stata program called Mahascore (Kantor 2006) was used. Before implementation, it was confirmed that the Mahascore program was calculating Mahalanobis scores in a theoretically justifiable manner by determining that, in test cases, the produced scores matched the scores defined in Li and Valliant (2009). The Li and Valliant method for calculating Mahalanobis scores that incorporate sampling weights was implemented in the R programming language and applied to sets of test data. The Mahascore program was also applied to the test data and the resulting Mahalanobis scores were compared to these scores produced using the Li and Valliant method. The Mahalanobis scores produced using Mahascore matched the scores produced using the Li and Valliant method. Several other technical issues arose. Using the Stata Mahascore program, categorical variables have to be represented as binary variables. Some input variables that had all derived binary variables included in the Mahascore program (no reference or dropped category) did not end up contributing to the calculation of the Mahalanobis scores. In sum, these variables were not accounted for in the final distance score. It was then necessary to analyze the selected cases when binary variables were handled appropriately. A post-case selection analysis was performed and it was determined that 95 percent of the selected cases would have been selected if the binary variables had been properly handled in Mahascore. The second issue involved small cell sizes in the respondent set of cases. Small cell sizes among respondents resulted in the inability to invert the variance-covariance matrix calculated from just respondent data and therefore the final Mahalanobis score could not include those variables. Refer to section 4.4 for response rates by responsive design group and chapter 6 for a discussion of the results of the responsive design in relation to bias scores.

4.4 Base-year to Third Follow-up Response Rates

Response rates for ELS:2002 are calculated by dividing the number of sample units who completed a particular study component by the number of sample units eligible for participation that are fielded. Sample members are not eligible if they are classified as deceased, sampling errors, or temporarily out of scope (unavailable for duration of study, out of the country, ineligible, incarcerated, or institutionalized). Eligible (in-scope) cases who were not contacted for participation (i.e., unfielded cases) are not counted in the response rate. All weighted response rates are calculated using the base weight appropriate for a given survey.[15] For each round of data collection, nonresponse bias analyses were performed to ensure that any identified biases resulting from nonresponse were small or were adjusted for, and that the data could be used with confidence. Response rate data for ELS:2002 are summarized in table 15.

[15] For example, the third follow-up used the first follow-up design weight adjusted for unknown eligibility and scope.

Table 15. Summary of ELS:2002 base-year to third follow-up school and student response rates: 2002–2012

Survey	Eligible	Participated	Weighted percent	Unweighted percent
Base-year school sample	1,221	752	67.8	61.6
Base-year student questionnaire	17,591	15,362	87.3	87.3
First follow-up questionnaire	16,515	14,989	88.7	90.8
First follow-up high school transcripts	16,373	14,920	90.7	91.1
Second follow-up questionnaire	15,892	14,159	88.4	89.1
Third follow-up questionnaire	15,724	13,250	83.8	84.3
2002 sophomore cohort in 2012	15,568	13,133	83.9	84.4
2004 senior cohort in 2012	13,635	11,652	84.8	85.5

NOTE: Base-year student questionnaire and first follow-up questionnaire rates based on public release file. Second follow-up questionnaire and third follow-up questionnaire rates based on fielded in-scope cases.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Base Year to Third Follow-up.

Base-year school and student questionnaire response rates. Of 1,221 eligible contacted schools, 752 participated in the survey for an overall weighted school participation rate of 68 percent. These schools are nationally representative of public and private schools. Of 17,591 selected eligible students, 15,362 participated, for a weighted student response rate of approximately 87 percent. A nonresponse bias analysis was performed and it confirmed that any identified biases resulting from nonresponse were small and that the data could be used with confidence.

First follow-up student questionnaire response rates. In the first follow-up, there were 16,515 eligible sample members, which included 15,362 base-year participants and 1,153 retained base-year nonparticipants. This subsample of nonrespondents was pursued to further improve the representativeness and reduce the bias of the base-year sophomore cohort participating sample. A total of 14,989 sample members responded to the questionnaire for a first follow-up response rate of 89 percent. First follow-up weighted response rates are reported at the student level only (the school sample was not strictly representative of the nation's high schools that had a 12th grade in 2003–04).

High school transcript response rates. A total of about 1,500 base-year and transfer schools provided at least one transcript for sample members. Ninety-one percent (weighted) of the student sample have some transcript information (14,920 of 16,373).

Second follow-up response rates. The second follow-up consisted of 16,352 fielded sample members. Of these, 15,892 sample members were found to be eligible and 14,159 responded to the second follow-up interview, for a weighted response rate of 88 percent overall.

Third follow-up response rates. The third follow-up sample consisted of 16,352 sample members fielded for the second follow-up but excluded 176 individuals who were not fielded or

out-of-scope[16] for the third follow-up. Thus, 16,176 sample members were fielded for the third follow-up. During the third follow-up data collection, 452 sample members were determined to be ineligible, resulting in 15,724 eligible sample members. A total of 13,250 sample members responded to the interview, for a weighted response rate of 84 percent overall. For the second and third follow-ups (but not the base year or first follow-up), the response rate is a conditional one, based on the cases that were fielded.[17] Weighted response rates were calculated using the design weight (i.e., the third follow-up used the first follow-up design weight adjusted for unknown eligibility and scope).[18] The third follow-up weighted response rate, therefore, represents the proportion of the combined 10th- and 12th-grade population that was in-scope for the third follow-up, was fielded, and that responded. Response rates for the third follow-up, by select characteristics and interview mode, are shown in table 16.

Table 16 also contains weighted and unweighted response rates for the three responsive design groups. Seventy-three percent (weighted) of cases targeted for treatment completed the ELS:2002 third follow-up interview. The group targeted at the start of CATI yielded 882 completed interviews for a 77 percent weighted response rate. The group targeted at the start of CAPI yielded 1,641 completed interviews for a 70 percent weighted response rate. The third group, targeted at the start of the prepaid incentive mailings, yielded 1,257 completed interviews for a 73 percent weighted response rate. Refer to chapter 6 for a discussion of the results of the responsive design in relation to bias scores.

[16] Approximately one-third of the individuals were deceased, one-third were questionnaire-incapable or otherwise incapacitated, and one-third were a mix of study refusals, individuals who had not responded in the prior two rounds, and those who were institutionalized or incarcerated.

[17] An unconditional response rate would include cases that were not fielded in the third follow-up: double (base-year + first follow-up) nonrespondents, senior freshening sample nonrespondents, and sample members who withdrew from the study. The unconditional weighted response rate (overall weighted response rate) was 78.2 percent. Permanently out-of-scope cases do not count in the response rate calculation although their numbers have been documented.

[18] Weighted response rates using the base weight appropriate for the survey are presented because of the importance of population estimation and because NCES survey response standards are based on weighted completions. This chapter's methodological tables in section 4.2 show unweighted proportions, because of their different focus.

Table 16. Third follow-up response rates, by select characteristics and mode: 2012

Subgroup	Total eligible	Respondents	Weighted percent	Unweighted percent
Total	15,724	13,250	83.8	84.3
Sex				
Male	7,744	6,271	80.4	81.0
Female	7,980	6,979	87.1	87.5
Race/ethnicity				
Asian or Pacific Islander	1,582	1,310	83.8	82.8
Black or African American	2,104	1,702	81.1	80.9
Hispanic or Latino	2,352	1,885	78.7	80.1
Other/more than one race	881	726	79.6	82.4
White	8,805	7,627	86.2	86.6
Socioeconomic status (SES)				
Lowest quarter	3,756	2,976	78.4	79.2
Second quarter	3,723	3,088	82.5	82.9
Third quarter	3,884	3,278	84.4	84.4
Highest quarter	4,361	3,908	90.0	89.6
Second follow-up response status				
Second follow-up respondent	13,837	12,135	87.3	87.7
Second follow-up nonrespondent	1,887	1,115	60.8	59.1
Dropout status				
Ever dropped out	1,762	1,384	79.0	78.5
Not ever dropped out	13,962	11,866	84.5	85.0
Responsive design group				
All groups	5,196	3,780	72.6	72.7
Targeted at CATI start	1,146	882	76.9	77.0
Targeted at CAPI start	2,320	1,641	70.1	70.7
Targeted at pre-pay start	1,730	1,257	72.9	72.7
Interview mode				
Web	15,724	9,624	60.0	61.2
CATI	11,469	2,573	22.7	22.4
CAPI	2,940	1,053	37.0	35.8

NOTE: Numbers may not sum to total because of rounding. The weighted percent uses the first follow-up design weight adjusted for unknown eligibility and scope. Respondent count includes sample members who completed enough of the interview to count as a respondent. The “Other/more than one race” subgroup includes American Indian/Alaska Native cases. SES status applies to the parent of the respondent. Interview mode total eligible counts may overlap because a respondent could have been eligible for multiple modes. For total eligible CATI mode, 36 cases completed via CATI during the pre-CATI phase. For “ever dropped out,” classified as dropout if at least one of the following conditions was met after the second follow-up: school reported that respondent had dropped out of school at any one of the enrollment status updates, respondent earned a General Educational Development credential, respondent did not receive a high school credential, or respondent’s high school transcript indicates dropped out, dismissed, or incarcerated. CAPI = computer-assisted personal interview. CATI = computer-assisted telephone interview.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

Chapter 5. Data Preparation and Processing

This chapter documents the automated systems, data processing, cleaning, and editing activities of the Education Longitudinal Study of 2002 (ELS:2002) third follow-up.

5.1 Overview of Systems Design, Development, and Testing

Many of the systems and processes used in the ELS:2002 third follow-up were designed during the first follow-up field test with improvements implemented for the main study and later for the second follow-up. The following systems were developed and used for the first follow-up and employed and improved thereafter:

- Integrated Management System (IMS)—a comprehensive tool used to exchange files between RTI and the National Center for Education Statistics (NCES), post daily production reports, and provide access to a centralized repository of project data and documents;
- Survey Control System (SCS)—the central repository of the status of each activity for each case in the study;
- Hatteras Survey Engine and Survey Editor—a web-based application used to develop and administer the ELS:2002 instrument;
- Computer-assisted telephone interview (CATI) Case Management System (CMS)—a call scheduler and case delivery tracking system for telephone interviews;
- Integrated Field Management System (IFMS)—a field reporting system to help field supervisors track the status of in-school data collection and field interviewing;
- ELS:2002 survey website—public website hosted at NCES and used to disseminate information, collect sample data, and administer the survey; and
- Data-cleaning programs—SAS programs developed to apply reserve code values where data are missing, clean up inconsistencies (because of respondents backing up), and fill data where answers are known from previously answered items.

System development included the following phases: planning, design, development, testing, and execution and monitoring. Specifications were developed in word processing documents and flowchart applications. Specifications were updated to reflect what changed between the field test questionnaires and the full-scale questionnaires.

Each system implements safeguards to handle personally identifying information (PII) as applicable. Systems such as the IMS, Hatteras, and the SCS are standard RTI systems used successfully in the ELS:2002 third follow-up field test and were developed using the latest software tools such as Microsoft .NET and Microsoft SQL Server database.

Processing of PII by all systems was developed in accordance with the Federal Information Processing Standards (FIPS) moderate security standard. Movement of the data containing PII was handled appropriately, meeting the security requirements between the locations. Data when moved between locations were encrypted, which met the FIPS 140.2 standards, and were decrypted once they successfully reached the destination. The automated systems were developed to handle the need of moving data and files between locations in an efficient and secure manner.

5.2 Data Processing and File Preparation

Item documentation procedures were developed to capture variable and value labels for each item. Item wording for each question was also provided as part of the documentation. This information was loaded into a documentation database that could export final data file layouts and format statements used to produce formatted frequencies for review. The documentation database also had tools to produce final electronic codebook (ECB) input files.

5.3 Data Cleaning and Editing

Questionnaire data were stored in an SQL database that was consistent across data collection modes for a particular questionnaire. The instrument used to administer the web survey was the same instrument as the CATI instrument and CAPI instrument, and the questionnaire data were stored in the same SQL database. This ensured that skip patterns were consistent across applications.

Editing programs were developed to identify inconsistent items across logical patterns within the questionnaire. These items were reviewed, and rules were written to either correct previously answered (or unanswered) questions to match the dependent items or blank out subsequent items to stay consistent with previously answered items.

Programs were also developed to review consistencies across multiple sources of data and identify discrepancies that required further review and resolution. Consistency checks included unlikely patterns across rounds (e.g., inconsistencies between second follow-up and third follow-up reports) as well as across sources within a given round.

5.3.1 Cleaning and Editing Methods

Variables drawn directly from third follow-up questionnaire items (i.e., variables following the naming convention F3A##, F3B##, F3C##, or F3D##) were edited in three ways: (1) they were edited via the application of reserve codes (section 5.3.2); (2) they were edited by carrying forward known information from previously administered items/variables to downstream items/variables which were legitimately skipped during survey administration (section 5.3.3); and (3) they were edited to address inconsistent responses (section 5.3.4).

5.3.2 Application of Reserve Codes

Reserve codes employed by third follow-up questionnaire variables follow conventions established in prior rounds of ELS:2002 data: that is, values of -3 indicate "item legitimate skip/ item not applicable"; values of -4 indicate "nonrespondent"; values of -5 indicate "suppressed"[19]; values of -7 indicate "not administered—abbreviated interview or break-off"[20]; values of -8 indicate "survey component legitimate skip"; and values of -9 indicate "missing." For more information see chapter 7, section 7.3.1. Editing programs were developed to apply reserve codes as follows: (1) values of -4 and -8 were globally applied across all third follow-up questionnaire variables based on nonparticipation status (-4s for third follow-up nonrespondents, and -8s for third follow-up out-of-scope sample members); (2) values of -3 were conditionally applied to reflect the routing logic of the third follow-up survey instrument; and (3) values of -7 were conditionally applied based on the type of questionnaire to which the sample member responded (full-length or abbreviated), and whether the variable in question was included in both the full-length and abbreviated questionnaire, or whether it was included in the full-length questionnaire only. After application of reserve codes, cross-tabulations for each third follow-up questionnaire variable were produced and reviewed, and editing programs were subsequently revised as necessary. This process continued iteratively until reserve codes were properly applied across all third follow-up variables.

5.3.3 Filling Forward Known Information

In addition to the application of reserve codes, editing programs were also developed to fill forward known information into items/variables which were legitimately skipped during survey administration. For example, quite a number of third follow-up respondents were not administered the question (corresponding to variable F3B09), "Since January 2006, have you ever held a job for pay?" This was primarily because the majority of respondents had already indicated during initial survey questions about their current activities (i.e., F3A01A—F3A01H) that they were currently working for pay, thereby making administration of F3B09 unnecessary. Editing programs set the variable F3B09 to "yes" for all respondents who indicated that their current activities included some form of paid employment.

Instances of this filling forward of known information can be identified by using the "administered to" and "applies to" information included in the ECB, Education Data Analysis

[19] Values of -5 were used to indicate the suppression of values for third follow-up restricted-use variables appearing on public-use data products. For those variables, the label for -5 will read "Suppressed." It should be noted that in prior rounds, values of -5 were used to identify out-of-range responses, so the label for -5 in those instances will read "Out of Range."

[20] Values of -7 are labeled as "not administered—abbreviated interview or partial interview break-off" for all variables across all study rounds. However, data users should note that for second follow-up variables, -7 indicates a missing value resulting from partial interview break-off; meanwhile, for third follow-up variables, -7 is applied—in cases where the sample member responded to the third follow-up abbreviated questionnaire—for items/variables that were included in the full-length questionnaire only.

Tool (EDAT), and PowerStats data analysis tool documentation for each third follow-up questionnaire variable (i.e., variables following the naming convention F3A##, F3B##, F3C##, or F3D##). Specifically, the "administered to" information describes the set of respondents who actually saw/heard the associated questionnaire item, while the "applies to" information describes the set of respondents who have nonmissing data for the particular variable; in instances where the "applies to" text describes a superset of the respondents described in the "administered to" text, information has been filled forward. See figure 6 (which shows the documentation window for variable F3B09) as an example of the distinction between "administered to" text and "applies to" text.

Figure 6. Documentation window for variable F3B09

Variable Name: F3B09

Record #1, Position: 8511–8512, Format: N2.

Variable Label: Held a job for pay since January 2006

Variable Description:

- Since January 2006, have you ever held a job for pay?

  1=Yes

  0=No

NOTE: Administered to ELS:2002 third follow-up respondents who had not already provided evidence of working for pay or serving in the military (i.e., respondents where F3A01A ≠ 1, F3A01B ≠ 1, F3A01H ≠ 1, F3A03A ≠ 1, F3A03B ≠ 1, F3A03H ≠ 1, and F3B01 ≠ 1). Applies to all ELS:2002 third follow-up respondents (F3B09 is set to 1 for cases where F3A01A = 1, F3A01B = 1, F3A01H = 1, F3A03A = 1, F3A03B = 1, F3A03H = 1, or F3B01 = 1).
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

5.3.4 Addressing Inconsistent Responses

Editing programs were developed to output inconsistent items across logical patterns within the questionnaire. These items were reviewed, and in some cases, edits were made to either correct previously answered (or unanswered) questions to match the dependent items or blank out subsequent items to stay consistent with previously answered items. Examples of inconsistent responses which were edited include small numbers of respondents who provided a last-employed date which preceded the date they began their most recent job; in these instances, one or both dates were edited based on other information provided by the respondent (e.g., the number of weeks they reported being employed during 2010, 2009, or 2008). Other examples of inconsistent responses which were edited include mismatches between the date of first postsecondary attendance and the date of last postsecondary attendance; mismatches between the date a postsecondary credential was earned and the date the credential-awarding institution was first attended; mismatches between the type of postsecondary credential earned and the institutional level of the credential-awarding institution; and mismatches between the number of hours per week respondents reported working at their current job, and whether they identified

that job as a full-time job (35 hours/week or more) or a part-time job (fewer than 35 hours/week) when reporting their current activities.

5.4 Coding

The survey instrument collected data on major fields of study, occupations, and postsecondary institutions, all of which required coding. The survey instrument included applications which allowed respondents or interviewers to code text strings to widely used taxonomies. All text strings that were not coded during the interview were coded as part of data processing. This section describes the types of data requiring coding, the coding applications, the coding process, quality control procedures, and measures of coding quality.

5.4.1 Major Field of Study Coding

Respondents identified the primary and secondary (when applicable) fields of study for each credential reported to have been earned. The instruments included a coding application that allowed major coding using the NCES 2010 Classification of Instructional Programs (CIP)[21] taxonomy. On the restricted-use third follow-up student-institution data file, researchers will find both a 2-digit version and a 6-digit version of the CIP code for fields of study.

- F3ICREDGEN_1—Credential #1 (highest or only credential from the given institution): field-of-study 2-digit (general) code
- F3ICREDSPE_1—Credential #1: field-of-study 6-digit (specific) code
- F3ICREDGEN2_1—Credential #1: second major field-of-study 2-digit (general) code
- F3ICREDSPE2_1—Credential #1: second major field-of-study 6-digit (specific) code
- F3ICREDGEN_2—Credential #2 (additional credential from the given institution): field-of-study 2-digit (general) code
- F3ICREDSPE_2—Credential #2: field-of-study 6-digit (specific) code
- F3ICREDGEN2_2—Credential #2: second major field-of-study 2-digit (general) code
- F3ICREDSPE2_2—Credential #2: second major field-of-study 6-digit (specific) code

Only the 2-digit versions of these variables appear on the public-use data file.

5.4.1.1 Major Field of Study Coding Methods

To use the coding application, respondents or interviewers first entered text to describe the field of study. Then, a list of majors, customized based on the text string, was presented. The respondent or interviewer could choose one of the options listed, or choose "none of the above." If "none of the above" was selected, a two-tiered dropdown menu appeared. The first dropdown menu contained a general list of majors; the second was more specific and was dependent on the

[21] http://nces.ed.gov/ipeds/cipcode/

first. Interviewers were trained to use probing techniques to assist in the coding process via the instrument-provided coding tool. Self-administered web respondents were provided supporting text on-screen. If the respondent or interviewer was unable to find a good match, he or she could proceed with the interview without selecting a code. In this case, the text string and any selections from the dropdown menus were retained.

All major text strings that were not coded during the interview were processed by RTI. First, the major text strings that appeared more than once were assigned a code by an expert coder. This code was then applied to all other exact-matching text strings to ensure consistency of codes for duplicate text strings. The remainder of the text strings was "upcoded" to the CIP taxonomy by coding experts using an application that used the same search function as the application in the instruments. The coding expert could assign a CIP field of study code or assign a value of 999999 to indicate that the text string was too vague to code.

5.4.1.2 Major Field of Study Coding Quality Control Procedures and Results

To evaluate the quality of the coding completed during the interview, a random sample of approximately 10 percent of the pairs of verbatim strings and codes was selected for recoding and analysis. RTI coding personnel evaluated text strings and assigned codes without knowledge of the codes that were selected during the interview. If the code selected differed from the code assigned during the interview, the coding expert was then shown both codes. The coding expert was instructed to only override the code selected during the interview if it was clearly incorrect. When a code was overridden, the new code was included on the data file in place of the original code. Text strings were designated "too vague to code" when they lacked sufficient clarity or specificity.

Results of recoding of strings coded during the interview are given in table 17. Nearly all of the codes selected during the interview were deemed to be accurate to the most detailed 6-digit level (97 percent). The coding expert disagreed with the CIP code selected during the interview for only 3 percent of the strings. In these instances, the code selected by the expert coder replaced the code selected during the interview.

Table 17. Match/disagree results of quality control recoding and upcoding of major: 2012

Results for sample of strings coded during interview	Percent
Match at 6-digit and 2-digit	97.0
Match at 2-digit, but not 6-digit	0.1
Disagree	2.9

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

5.4.2 Occupation Coding

The ELS:2002 third follow-up data collection instrument included occupation coding tools that facilitated coding of literal responses of occupation job title and duties to the 2010

Standard Occupational Classification[22] (SOC) taxonomy. Occupation job title and duties were matched to occupation descriptions from the Occupational Information Network (O*NET).[23] Interview respondents were asked to identify their current occupation and the occupation they anticipated having at age 30. For technical information on these variables, see appendix E.

On the restricted-use data file, researchers will find both a 2-digit version and a 6-digit version of the O*NET code for respondents' occupations:

- F3ONET2CURR—2-digit ONET code for current/most recent job
- F3ONET6CURR—6-digit ONET code for current/most recent job
- F3ONET2AGE30—2-digit ONET code for expected age-30 occupation
- F3ONET6AGE30—6-digit ONET code for expected age-30 occupation

Only the 2-digit versions of these variables appear on the public-use data file.

5.4.2.1 Occupation Coding Methods

Respondents were asked to provide a job title and job duties for each occupation. All respondents completing the English version of the web interview were also asked to code the occupation to the SOC taxonomy. To code the occupation, interviewers or respondents who were self-administering the web questionnaire first entered the job title and duties. These strings were automatically matched to the occupation descriptions from O*NET and a customized list of occupations was presented. Interviewers or respondents could choose one of the options listed, or choose "none of the above." In the occupation coding application, selecting "none of the above" presented the coder with a set of three sequential dropdown menus, each with choices increasing in their level of specificity. The first dropdown menu contained a general list of occupations. The options presented in the second dropdown were dependent on the code selected in the first. Some selections from the second dropdown required coders to make a selection from a third even more detailed dropdown menu. Interviewers were trained to use probing techniques to assist in the coding process via the instrument-provided coding tool. Self-administered web respondents were provided supporting text on screen. If the respondent or interviewer was unable to find an appropriate SOC code for the occupation, they could proceed with the interview without selecting a code. In this case, the text string and any selections from the dropdown menus were retained to assist with coding during data processing.

RTI's coding experts attempted to code all occupations that were not coded in the web interview. This "upcoding" was completed using an application that used the same search function as the application in the instrument. The coding expert could assign an O*NET code or assign a value of 999999 to indicate that the text string was too vague to code.

[22] http://www.bls.gov/soc/2000/socstruc.pdf
[23] http://www.onetcenter.org/overview.html

5.4.2.2 Occupation Coding Quality Control Procedures and Results

Coding experts evaluated the quality of coding that was completed during the interview by recoding a random sample of approximately 10 percent of the occupation text strings. To recode the selected occupations, RTI staff members worked with a coding application which used the same search function as the application in the instruments. These coding experts evaluated text strings and assigned codes without knowledge of the codes that were selected during the interview. If the code selected differed from the code assigned during the interview, the coding expert was then shown both codes. The coding expert was instructed to only override the code selected during the interview if it was clearly incorrect. When the expert coder did not agree with the 6-digit code selected during the interview, the new code was included on the data file in place of the original code. Text strings were designated "too vague to code" when they lacked sufficient clarity or specificity.

The expert coders agreed with the 6-digit code selected during the interview for 95 percent of the text strings reviewed and agreed with the 2-digit code (but not the 6-digit code) for less than 1 percent of the text strings reviewed, for a total of approximately 96 percent agreement at the 2-digit level. The expert coder disagreed with the code selected during the interview for approximately 4 percent of the occupations. The results are shown in table 18.

Table 18. Match/disagree results of quality control recoding and upcoding of occupation: 2012

Results for sample of strings coded during interview	Percent
Match at 6-digit and 2-digit	94.7
Match at 2-digit, but not 6-digit	0.9
Disagree	4.5

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

5.4.3 Postsecondary Institution (Integrated Postsecondary Education Data System [IPEDS]) Coding

Respondents were asked to identify each postsecondary institution attended since leaving high school. The postsecondary institution IDs are available only on the restricted-use third follow-up student-institution data file:

- F3IIPED—IPEDS code of attended postsecondary institution

5.4.3.1 Postsecondary Institution Coding Methods and Results

Respondents were asked to identify the postsecondary institutions attended using a look-up tool. After respondents (or the interviewer) entered the institution's name, city, and state into the web survey, they could search an instrument-provided look-up tool containing institutions from the 2010–11 IPEDS for the appropriate match. When a match was not found, the respondent was asked to provide the institution's level (i.e., 4-year, 2-year, less-than-2-year) and

control (i.e., public, private not-for-profit, private-for-profit). This information was later used to assist RTI staff in finding a match in IPEDS as part of data processing.

Text strings not coded by respondents through the instrument-provided look-up tool were provided to coding experts to be upcoded in the following manner. First, cases were compared against the 2002–11 IPEDS database for matching. Any case with school name, city, and state that exactly matched an IPEDS record was assigned the corresponding IPEDS ID. Then, any text strings that remained uncoded were loaded into the coding application for an RTI coding expert to assign IDs. As shown in table 19, 89 percent of all text strings were coded during the interview and 11 percent were coded by expert coders at RTI.

Table 19. Postsecondary institution names by IPEDS coding method: 2012

Results	Number	Percent
Total	9,424	100.0
Coded during interview	8.373	88.8
Coded by expert coders	1,044	11.1

NOTE: Detail may not sum to totals because of rounding. IPEDS = Integrated Postsecondary Education Data System.
SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

After all coding was complete, 95 percent of the institutions had been assigned an IPEDS ID. Less than 1 percent of institutions were foreign, and 4 percent were uncodeable, which usually meant the string was not a postsecondary institution.

5.5 Construction of Scales

Certain sets of items that appear in the survey were designed to be analyzed as social-cognitive career theory-based scales. Scales need to be unidimensional in terms of their factor structure, need to be reliable, and need to increase the reliability above that which could be obtained through use of a single item for measurement purposes. The survey includes, for example, questions related to job satisfaction and the nature of the individuals the respondent works with.

Prior to constructing the scales, questionnaire responses were subjected to data cleaning procedures discussed previously; in addition, as an interim step in scale construction, some questionnaire items were temporarily reverse coded (that is, positively and negatively worded items were coded to reflect the same direction on the construct) to equate larger scale values with positive attributes (e.g., higher levels of job satisfaction). Once the data were finalized, the (weighted) reliability of the scale items was evaluated using Cronbach's alpha. Weighted scales were then created if the associated items had a minimum alpha level between 0.8 and 0.9 (depending on the variable) with SAS® *Proc Factor* and standardized to have mean zero and (weighted) standard deviation of one. Scales were set to missing if any of the scale items were missing. The individual item-level data are also available on the data file. Researchers are encouraged to further examine the psychometric properties of the scales using the item-level

data. The scales presented on the data file are just one way to combine the information. Individual researchers are able to recreate these or similar scales.

Three scales were created at the individual respondent level. These included a work support index/scale score (F3JOBSUPP); job satisfaction index/scale score (F3JOBSATIS); and an index/scale score for job persistence intentions (F3JOBPERSIST). The aforementioned scales are included in table 20. The scales were first developed in the third follow-up field test. More information about these scales and scale and construct development may be found in the ELS:2002 Third Follow-up Field Test Report (Ingels et al. 2012, NCES 2012-03).

Table 20. Summary information for scales: 2012

Student scale	Variable name	Cronbach's alpha
F3JOBSUPP: Work Support		
	F3B34A people supportive	0.80
	F3B34B learn from them	
	F3B34C people helpful	
F3JOBSATIS: Job Satisfaction	F3B34D well satisfied	0.90
	F3B34E enthusiastic	
	F3B34F enjoy work	
F3JOBPERSIST: Job Persistence Intentions	F3B34G plans to stay	0.89
	F3B34H not leaving	
	F3B34I committed to job	

SOURCE: U.S. Department of Education, National Center for Education Statistics. Education Longitudinal Study of 2002 (ELS:2002) Third Follow-up.

Chapter 6. Weighting, Imputation, Bias Assessment, and Design Effects

6.1 Overview of Weighting, Imputation, Bias Assessment, and Design Effects

Implicitly building on the sample design discussion in chapter 3, chapter 6 describes the study populations of the Education Longitudinal Study of 2002 (ELS:2002) and describes the statistical activities designed to support analysis of the study populations. In particular, the weighting, imputation, and bias assessment procedures and the design effects for the third follow-up are described in detail. Information about these activities in prior rounds may be found in the corresponding prior-round documentation: the base-year data file user's manual (NCES 2004-405), the first follow-up data file documentation (NCES 2006-344), and the base-year to second follow-up data file documentation (NCES 2008-347).

The general purpose of ELS:2002 weighting was to compensate for unequal probabilities of selection and to adjust for the fact that not all individuals selected into the sample actually participated. Chapter 6 describes the weights developed for the third follow-up and documents the statistical properties of the weights. The third follow-up sample weights and the details of their construction are described in section 6.2. The design effect is a measure of sample efficiency. More specifically, the design effect is the ratio of the true variance of a statistic (taking the complex sample design into account) to the variance of that statistic for a simple random sample with the same number of cases. Design effects for the third follow-up are explored in section 6.3. Because no single design effect is universally applicable to any given survey or analysis, it also reports design effects for different subgroups and statistics. Imputation attempts to address the issue of item nonresponse by providing a procedure that uses available information and some assumptions to derive substitute values for the missing values in a data file. The chapter provides further information on the key items that were subject to imputation, the imputation procedures, and the results of imputation. The imputation of third follow-up variables is explained in section 6.4. Methods used to address potential disclosure issues are summarized in section 6.5. Bias assessment measures the degree to which unit and item nonresponse introduce bias in estimates and the degree to which observed bias is reduced as a result of weighting adjustments or responsive design. Bias assessment is covered in two sections; unit and item nonresponse are discussed in section 6.6 and responsive design results are discussed in section 6.7.

6.2 Calculation of Third Follow-up Weights and Results of Weighting

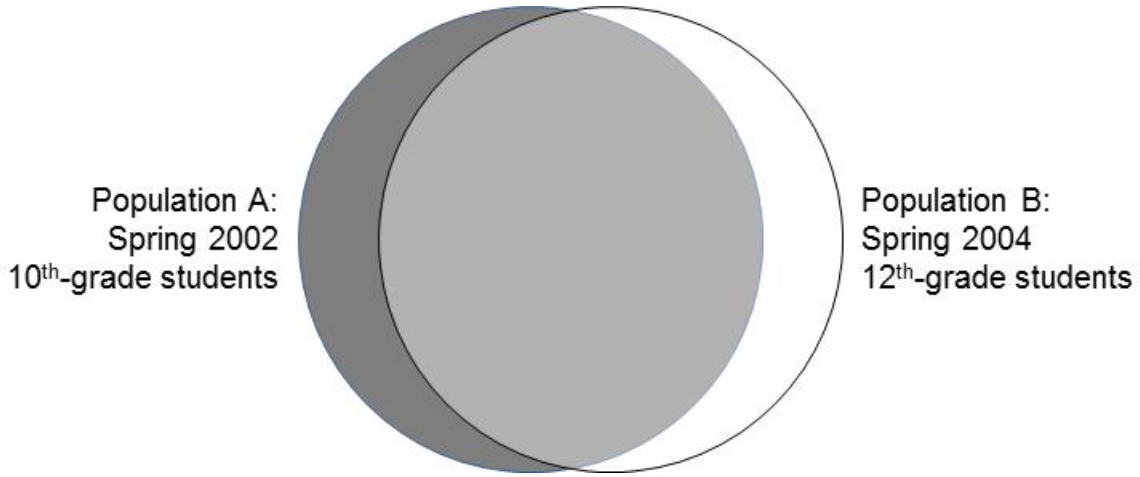
A variety of topics are discussed in the following subsections. Sections 6.2.1 and 6.2.2 provide a high-level overview of the ELS:2002 target populations, potential domains of analysis for those populations, and a description of the analysis weights created for the third follow-up. The model-based approach for weight adjustment is discussed in section 6.2.3 and details of the weight adjustment factors used to create the third follow-up analysis weights are given in sections 6.2.4 and 6.2.5. A discussion of the Balanced Repeated Replicate (BRR) weights produced for the third follow-up occurs in section 6.2.6 and a brief discussion of quality control methods used to produce the third follow-up weights may be found in section 6.2.7.

6.2.1 Target Populations and Analysis Domains

The sample design for ELS:2002 supports a number of analyses, which in turn permit accurate inferences to be made to three major groups or target populations: (1) Population A: Spring 2002 high school sophomores; (2) Population B: Spring 2004 high school seniors; and (3) Population C: Spring 2002 10th-grade schools.

Figure 7 illustrates that whereas some students are in only population A or population B, many students are in both populations—that is, both a Spring 2002 sophomore and a Spring 2004 senior.

Figure 7. Student analysis populations, by year: 2004



SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), First Follow-up, 2004.

Within these three target populations are a variety of important subpopulations. Although these subpopulations are subsets of the three target populations, the ELS:2002 sample design does not guarantee that the ELS:2002 sample will be representative of all subsets of the three primary target populations. The following lists give examples of subpopulations as subsets of the three target populations.

Population A: Spring 2002 10th-grade students:

- Subpopulations:[24]
  - Spring 2002 10th-grade students capable of completing the student questionnaire
  - Spring 2002 10th-grade students in base-year school in Spring 2004
  - Spring 2002 10th-grade students in a different school in Spring 2004 (transfers)
  - Spring 2002 10th-grade students who were dropouts in Spring 2004
  - Spring 2002 10th-grade students who graduated or achieved equivalency early (i.e., prior to March 15, 2004)
  - Spring 2002 10th-grade students who graduated by August 31, 2004
  - Spring 2002 10th-grade students who were home-schooled in Spring 2004[25]
  - Spring 2002 White 10th-grade students
  - Spring 2002 Black 10th-grade students
  - Spring 2002 Hispanic 10th-grade students
  - Spring 2002 Asian 10th-grade students
  - Spring 2002 public school 10th-grade students
  - Spring 2002 private school 10th-grade students

Population B: Spring 2004 12th-grade students:

- Subpopulations:
  - Spring 2004 12th-grade students capable of completing the student questionnaire
  - Spring 2004 12th-grade students who were graduating high school seniors in Spring 2004
  - Spring 2004 12th-grade students who graduated by August 31, 2004
  - Spring 2004 White 12th-grade students
  - Spring 2004 Black 12th-grade students
  - Spring 2004 Hispanic 12th-grade students
  - Spring 2004 Asian 12th-grade students

[24] The subpopulations listed are important but are not the only possible subpopulations.

[25] Although conceptually Spring 2002 sophomores who were homeschooled in 2004 may be thought of as an analysis population, they were not designed to be so and were therefore not subject to minimum sample size requirements. The group is of limited analytic utility owing both to the low sample size and to the narrowness of the population definition. The compelling practical reason for distinguishing this group was so that they could be administered only those items consonant with their unique situation as out-of-school students.

  - Spring 2004 public school 12th-grade students
  - Spring 2004 private school 12th-grade students

  Population C: Spring 2002 10th-grade schools:

- Subpopulations:
  - School type: public, Catholic, and other private
  - Urbanicity: urban, suburban, and rural
  - Region: Northwest, Midwest, South, West

ELS:2002 student sample members were interviewed as part of third follow-up activities. Sample members who completed a certain prespecified proportion[26] of the third follow-up questionnaire were considered to be third follow-up respondents. ELS:2002 third follow-up respondents may be in either population A (10th-grade cohort), or population B (12th-grade cohort), or in both. To identify those respondents belonging to a particular target population, two flag variables are provided. The flag variable G10COHRT denotes membership in the Spring 2002 10th-grade population and the flag variable G12COHRT[27] denotes membership in the Spring 2004 12th-grade population.

Analytic uses of these three populations, and the weighting required to support the analyses, are discussed in section 6.2.2.

6.2.2 Overview of Third Follow-up Analysis Weights

Six sets of weights were computed for the third follow-up. These weights and the types of analyses that may be conducted using these weights are described in more detail below in sections 6.2.2.1 through 6.2.2.3. Although third follow-up student weights were created, no third follow-up school weights were created. Discussion of school weights in the context of the ELS:2002 third follow-up may be found in section 6.2.2.4.

The six sets of weights were conceptualized to support three basic kinds of analysis:

(1) Estimates based on third follow-up data that include either students enrolled in 10th grade in the spring of 2002 (population A) or students enrolled in 12th grade in the spring of 2004 (population B). These weights are: F3QWT and F3QTSCWT. They are described in more detail in section 6.2.2.1.

[26] In the base year and first follow-up of ELS:2002, sample members are considered respondents if they complete at least a certain proportion of the round-appropriate questionnaire or if they are "questionnaire incapable" for that round (although eligible for contextual data and transcripts). (Again, questionnaire-incapable students were those who could not be validly assessed or surveyed owing to severe disability or language barrier.) Sample members are considered respondents in the third follow-up if they complete at least a certain proportion of the third follow-up questionnaire.

[27] G12COHRT includes members of the senior cohort determined in the first follow-up (G12COHRT = 1) as well as those whose membership status was determined in the second follow-up (G12COHRT = 2).

(2) Estimates based on third follow-up data in combination with base-year data (or other prior rounds of data) that represent students enrolled in 10th grade in the spring of 2002 (population A). These weights are F3BYPNLWT and F3BYTSCWT. They are described in more detail in section 6.2.2.2.

(3) Estimates based on third follow-up data in combination with first follow-up data (or second follow-up data) where the estimates are meant to represent students enrolled in 10th grade in the spring of 2002 (population A) or students enrolled in 12th grade in the spring of 2004 (population B). These weights are F3F1PNLWT and F3F1TSCWT. They are described in more detail in section 6.2.2.3.

These weights and the types of analyses that may be conducted using these weights are described below. Although third follow-up student weights were created, no third follow-up school weights were created. Discussion of school weights in the context of the ELS:2002 third follow-up may be found in section 6.2.2.4.

6.2.2.1 F3QWT AND F3QTSCWT Analytic Weights

F3QWT and F3QTSCWT were constructed to support analysis of third follow-up data alone (F3QWT) or in conjunction with high school (first follow-up) transcript data (F3QTSCWT). As noted in section 6.2.1 (figure 7), third follow-up respondents may be in the population of Spring 2002 10th-graders, may be in the population of Spring 2004 12th-graders, or may be in both populations. Analyses designed to assess characteristics of one of the populations must take care to restrict analyses to those third follow-up respondents in the population of interest. To identify those third follow-up respondents who are members of the two student populations, two flag variables, G10COHRT and G12COHRT, are available. Those third follow-up respondents with a value of 1 for G10COHRT are members of the population of Spring 2002 10th-graders. Those third follow-up respondents with a value of 1 (determined in the first follow-up) or a value of 2 (determined in the second follow-up) for G12COHRT are members of the population of Spring 2004 12th-graders.

- F3QWT when used in conjunction with G10COHRT supports estimates from third follow-up survey data representative of students enrolled in 10th grade in Spring 2002.
- F3QWT when used in conjunction with G12COHRT supports estimates from third follow-up survey data representative of students enrolled in 12th grade in Spring 2002.
- F3QTSCWT when used in conjunction with G10COHRT supports estimates from third follow-up survey data in combination with high school transcript data representative of students enrolled in 10th grade in Spring 2002.
- F3QTSCWT when used in conjunction with G12COHRT supports estimates from third follow-up survey data in combination with high school transcript data representative of students enrolled in 12th grade in Spring 2004.

If the analysis includes third follow-up data in combination with prior-round survey or assessment data (other than simply high school transcript data), researchers should consult sections 6.2.2.2, 6.2.2.3, and 7.4 to guide selection of an appropriate weight.

6.2.2.2 F3BYPNLWT and F3BYTSCWT Analytic Weights

F3BYPNLWTand F3BYTSCWT were constructed to support estimates of students enrolled in 10th grade in Spring 2002. F3BYPNLWT was produced for all ELS:2002 sample members who responded[28] in the base year and in the third follow-up. F3BYTSCWT was produced for cases who responded in the base year and in the third follow-up and have high school (first follow-up) transcript data on the file. It is not necessary[29] to use the flag variable G10COHRT in conjunction with F3BYPNLWTor F3BYTSCWT; by definition, only third follow-up respondents who are members of the Spring 2002 10th-grade population will have a non-zero value for these weights.

As longitudinal studies progress, the set of possible weights dramatically expands. Analytic weights produce estimates representative of specific populations and also adjust for patterns of potential differential nonresponse to survey components. F3BYPNLWT and F3BYTSCWT are intended to support analysis of third follow-up data in combination with base-year data (F3BYNLWT) and high school transcript data (F3BYTSCWT). For analysis with data from the aforementioned components and any other combination of first follow-up and second follow-up data, selection of an appropriate analysis weight requires careful consideration of the analyses to be conducted, the data to be used, and the pattern of item nonresponse. For additional information on weight selection, researchers should also review section 7.4 of this documentation.

6.2.2.3 F3F1PNLWT and F3F1TSCWT Analytic Weights

Largely, F3F1PNLWT and F3F1TSCWT were constructed to support estimates of Spring 2004 12th-graders. However, these weights may also be used to support estimates of Spring 2002 10th-graders, depending on the data in the analysis and the researcher question. F3F1PNLWT was produced for all ELS:2002 sample members who responded in the first follow-up and in the third follow-up. F3F1TSCWT was produced for cases who responded in the first follow-up and in the third follow-up and have high school (first follow-up) transcript data on the file.

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[28] Sample members who did not respond in the base year but did respond in the first follow-up were given a new participant supplement questionnaire to gather some of the same information that was collected on base-year respondents. Consequently, these base-year nonrespondents who responded in the first follow-up were treated as base-year respondents in the construction of first and second follow-up longitudinal weights. These sample members were treated as base-year respondents in the construction of third follow-up longitudinal weights.

[29] It is possible that statistical software not designed for the analysis of sample survey data may fail to exclude records that have analysis weights of zero. The G10COHRT flag may be used to specifically restrict analyses to members of the 10th-grade cohort to avoid such a situation from arising.

As with F3QWT and F3QTSCWT these weights need to be used in concert with a cohort flag. Again, to identify those third follow-up respondents who are members of the two student populations, two flag variables, G10COHRT and G12COHRT, are available. Those third follow-up respondents with a value of 1 for G10COHRT are members of the population of Spring 2002 10th-graders. Those third follow-up respondents with a value of 1 (determined in the first follow-up) or a value of 2 (determined in the second follow-up) for G12COHRT are members of the population of Spring 2004 12th-graders. In other words, third follow-up weights for the 12th-grade cohort are constructed for all sample members where G12COHRT equals 1 or 2, whereas first follow-up weights are constructed for all sample members where G12COHRT equals 1. Consequently, the 12th-grade cohort is identified by restricting sample members to those individuals with a value of 1 or 2 for G12COHORT when using third follow-up weights. The 12th-grade cohort is identified by restricting sample members to those individuals with a value of 1 for G12COHRT when using first follow-up weights.

- F3F1PNLWT when used in conjunction with G10COHRT supports estimates from the third follow-up survey in combination with first follow-up data representative of students enrolled in 10th grade in Spring 2002.[30]
- F3F1PNLWT when used in conjunction with G12COHRT supports estimates from the third follow-up survey in combination with first follow-up data representative of students enrolled in 12th grade in Spring 2004.
- F3F1TSCWT when used in conjunction with G10COHRT supports estimates from the third follow-up survey data in combination with first follow-up data and high school transcript data representative of students enrolled in 10th grade in Spring 2002.
- F3F1TSCWT when used in conjunction with G12COHRT supports estimates from the third follow-up survey data in combination with first follow-up data and high school transcript data representative of students enrolled in 12th grade in Spring 2004.

Note that these two weights are designed to support analyses that incorporate data from the third follow-up, first follow-up, and high school transcript data collection. If an analysis also incorporates data from the base year or the second follow-up then these weights may not be preferred. For example, F3BYPNLWT and F3BYTSCWT may be preferred when base-year data are included in an analysis. Additional guidance on weight selection is provided in section 7.4.

Again, as longitudinal studies progress, the set of possible weights dramatically expands. Analytic weights produce estimates representative of specific populations and also adjust for patterns of potential differential nonresponse to survey components. F3F1PNLWT and F3F1TSCWT are intended to support analysis of third follow-up data in combination with first follow-up data (F3F1PNLWT) and high school transcript data (F3F1TSCWT). For analysis with

[30] Please note that the use of multiple student questionnaires in the first follow-up gives rise to component skips that could result in a particular analysis excluding members of the 10th-grade cohort. For example, analysis of dropouts as of the first follow-up necessarily excludes other members of the 10th-grade cohort.

data from the aforementioned components and in combination with second follow-up data or base-year data, selection of an appropriate analysis weight requires careful consideration of the analyses to be conducted, the data to be used, and the pattern of item nonresponse. For additional information on weight selection, researchers should also review section 7.4 of this documentation.

6.2.2.4 School Weights and the Third Follow-up

Although there are multiple data points for analysis in ELS:2002, the base-year school weight maintains generalizability only vis-à-vis the nation's schools that contained 10th and 12th grades in Spring 2002. No additional school weight has been produced. Although additional information was collected from most of the base-year schools in the first follow-up, these data were intended to be largely contextual, an extension of the student record, and by no means are the first follow-up school data generalizable to the nation's schools in 2004. Nevertheless, one can look at the ELS:2002 base-year high schools 2 years later, using the base-year school weight as an anchor point from which to analyze change, or use student data collected in the first, second, or third follow-ups, in conjunction with analysis of the base-year schools, for which a proper weight has been provided.

6.2.2.5 Third Follow-up Weights and Prior-round Weights

In both the base year and first follow-up of ELS:2002, some sample members were not able to complete the sample member questionnaires because of limited English proficiency or because of physical or mental limitations. However, information was collected from individuals, such as school administrators and teachers, associated with these sample members. In the base year and first follow-up, the set of respondents in each round combined with the set of sample members who were questionnaire-incapable in that round was referred to as the expanded sample for that round. Analysis weights were created just for those sample members who were respondents and were created for the expanded sample. Expanded sample weights are only included in restricted-use files.

In the second and third follow-ups, however, questionnaire-incapable sample members participating in the respective follow-up were considered out of scope for constructing weights associated with that follow-up. For example, all questionnaire-incapable sample members in the third follow-up were excluded from the third follow-up weights. Third follow-up respondents who were questionnaire-incapable in prior rounds are included in third follow-up weights as long as they responded in the third follow-up.

Table 21 summarizes the ELS:2002 analysis weights and associated universe flags, populations (described in section 6.2.1), and respondents. Additional guidance on selecting weights for analysis purposes is provided in section 7.4.

Table 21. Relationship among weights, universe flags, populations, and respondents: 2002–2012

Weight	Universe flag	Population	Respondent
BYSTUWT	G10COHRT	A—Spring 2002 10th-grader	Fully or partially completed questionnaire in 2002
BYEXPWT	G10COHRT	A—Spring 2002 10th-grader	Fully or partially completed questionnaire in 2002 or were incapable of completing a questionnaire
F1PNLWT	G10COHRT	A—Spring 2002 10th-grader	Fully or partially completed questionnaire in 2002 and 2004 (base-year data may be from the new participant supplement[1] or imputed)
F1XPNLWT	G10COHRT	A—Spring 2002 10th-grader	Fully or partially completed questionnaire in 2002 and 2004 (base-year data may be from the new participant supplement or imputed) or were incapable of completing a questionnaire in 2002 or 2004
F1QWT	G10COHRT[1] G12COHRT	A—Spring 2002 10th-grader B—Spring 2004 12th-grader	Fully or partially completed questionnaire in 2004
F1EXPWT	G10COHRT G12COHRT	A—Spring 2002 10th-grader B—Spring 2004 12th-grader	Fully or partially completed questionnaire in 2004 or were incapable of completing a questionnaire in 2004
F1TRSCWT	G10COHRT G12COHRT	A—Spring 2002 10th-grader B—Spring 2004 12th-grader	Fully or partially complete high school transcript data and fully or partially completed first follow-up or base-year questionnaire or were members of the expanded sample
F2QWT	G10COHRT G12COHRT	A—Spring 2002 10th-grader B—Spring 2004 12th-grader	Fully or partially completed questionnaire in 2006
F2QTSCWT	G10COHRT G12COHRT	A—Spring 2002 10th-grader B—Spring 2004 12th-grader	Fully or partially completed questionnaire in 2006 and fully or partially complete high school transcript data
F2F1WT	G10COHRT G12COHRT	A—Spring 2002 10th-grader B—Spring 2004 12th-grader	Fully or partially completed questionnaire in 2004 and 2006 or were incapable of completing a questionnaire in 2004 and fully or partially completed questionnaire in 2006
F2BYWT	G10COHRT	A—Spring 2002 10th-grader	Fully or partially completed questionnaire in 2002 and 2006 or were incapable of completing a questionnaire in 2002 and fully or partially completed questionnaire in 2006
F3QWT	G10COHRT G12COHRT	A—Spring 2002 10th-grader B—Spring 2004 12th-grader	Fully or partially completed questionnaire in 2012
F3QTSCWT	G10COHRT G12COHRT	A—Spring 2002 10th-grader B—Spring 2004 12th-grader	Fully or partially completed questionnaire in 2012 and fully or partially complete high school transcript data
F3BYPNLWT	G10COHRT	A—Spring 2002 10th-grader	Fully or partially completed questionnaire in 2002 and 2012 or were incapable of completing a questionnaire in 2002 and fully or partially completed questionnaire in 2012

See notes at end of table.

Table 21. Relationship among weights, universe flags, populations, and respondents: 2002–2012—Continued

Weight	Universe flag	Population	Respondent
F3BYPNLWT	G10COHRT	A—Spring 2002 10th-grader	Fully or partially completed questionnaire in 2002 and 2012 or were incapable of completing a questionnaire in 2002 and fully or partially completed questionnaire in 2012
F3BYTSCWT	G10COHRT	A—Spring 2002 10th-grader	Fully or partially completed questionnaire in 2002 and 2012 or were incapable of completing a questionnaire in 2002 and fully or partially completed questionnaire in 2012 and fully or partially complete high school transcript data
F3F1PNLWT	G10COHRT G12COHRT	A—Spring 2002 10th-grader B—Spring 2004 12th-grader	Fully or partially completed questionnaire in 2004 and 2012 or were incapable of completing a questionnaire in 2004 and fully or partially completed questionnaire in 2012
F3F1TSCWT	G10COHRT G12COHRT	A—Spring 2002 10th-grader B—Spring 2004 12th-grader	Fully or partially completed questionnaire in 2004 and 2012 or were incapable of completing a questionnaire in 2004 and fully or partially completed questionnaire in 2012 and fully or partially complete high school transcript data

[1] As noted in the ELS:2002 base-year to first follow-up data file documentation, base-year nonrespondents who responded in the first follow-up are considered to be members of the Spring 2002 10th-grade population, but there is no base-year weight (BYSTUWT or BYEXPWT) for them. The new participant supplement employed in the first follow-up ensured that the standard classification variables collected in the base year were also available for this group. However, key variables were imputed for base-year nonrespondents who were first follow-up respondents, so that these students could be analyzed as part of the sophomore cohort using F1PNLWT or F1XPNLWT. These students who are third follow-up respondents may also be analyzed as part of the sophomore cohort using F3F1PNLWT.

NOTE: First follow-up sample freshening resulted in the inclusion of students who were members of the 12th-grade cohort but not the 10th-grade cohort so the G10COHRT flag is required to restrict analyses to those first follow-up respondents who are members of the 10th-grade cohort. Similarly, the G12COHRT flag is required to restrict analyses to those first follow-up respondents who are members of the 12th-grade cohort.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Base Year to Third Follow-up, 2012.

6.2.3 Overview of Nonresponse and Calibration Methodology

All third follow-up analysis weights were created by applying a variety of weight adjustments to the third follow-up base weight (discussed in section 6.2.4). These weight adjustments were designed to account for three issues:

- Some ELS:2002 sample members were not fielded for the third follow-up.
- Some of the ELS:2002 sample members fielded for the third follow-up did not respond.
- Application of weight adjustments to account for the first two issues resulted in weight sums for key analysis domains that differed from prior-round weight sums.

The weight adjustments associated with the first and second issue are known as nonresponse adjustments. Two types of nonresponse occurring during third follow-up data collection were considered: nonresponse arising from the inability to locate or contact a sample member and nonresponse arising from sample member refusal to participate once contacted. After examining the number of nonresponse cases occurring because of refusal and the number

occurring because of inability to locate or contact, a determination was made to treat all nonrespondents as one group because the predominant reason for nonresponse was refusal.

The weight adjustments associated with the third issue are known as poststratification or calibration[31] adjustments. Because the ELS:2002 third follow-up sample weights are not adjusted to sum to population totals, the adjustments associated with the third issue are referred to as calibration adjustments.

In addition to the nonresponse and calibration adjustments described above, the third follow-up high school transcript weights (F3QTSCWT, F3BYTSCWT, and F3F1TSCWT) included a nonresponse adjustments followed by a subsequent calibration adjustment; the first adjustment accounted for nonresponse arising from the student's school refusing to provide a transcript or the student refusal to allow the transcript information to be included with the ELS:2002 data, and the second adjustment calibrated weight sums to prior-round totals.

Although there are several methods that may be used to adjust sampling weights to account for nonresponse and to calibrate weight sums, the method used to create the ELS:2002 third follow-up analysis weights follows a model-based approach. An overview of this model-based approach is given below. Specific details of the nonresponse and calibration adjustments applied to produce the third follow-up analysis weights may be found in sections 6.2.5 and 6.2.6.

6.2.3.1 Generalized Exponential Model

All nonresponse and calibration adjustments were calculated using RTI's proprietary generalized exponential modeling procedure (GEM) (Folsom and Singh 2000), which is similar to logistic modeling with bounds for adjustment factors.

The GEM approach is a general version of weighting adjustments and was based on a generalization of Deville and Särndal's (1992) logit model. GEM is not a competing method to weighting classes or logistic regression; rather, it is a method of creating weight adjustments that provides a wide variety of features and options that may be employed. It is a formalization of weighting procedures such as nonresponse adjustment, poststratification, and weight trimming.

For nonresponse adjustments, GEM controls at the margins as opposed to controlling at the cell level, as weighting class adjustments. This approach allows more variables to be considered. GEM is designed so that the sum of the unadjusted weights for all eligible units equals the sum of the adjusted weights for respondents.

Extreme weights occur in the ELS:2002 data because of small probabilities of sample selection or because of weight adjustments. These extreme weights (either very small or very large) can significantly increase the variance of estimates. One way to account for this and

[31] Poststratification typically refers to the process of adjusting sample weights so that the weights sum to population totals derived from sources external to the sample of interest. Calibration is used to denote adjusting weight sums to sum to prior-round totals.

decrease the variance is to trim and smooth extreme weights within prespecified domains. Note that trimming weights has the potential to increase bias. However, the increase in bias is often offset by the decrease in variance because of weight trimming. As a result, this reduces the mean square error (MSE) of an estimate, defined as variance plus bias squared.

The innovation introduced in GEM is the ability to incorporate specific lower and upper bounds. An important application of this feature is to identify at each adjustment step an initial set of cases with extreme weights and to use specific bounds to exercise control over the final adjusted weights. Thus, there is built-in control for extreme weights in GEM.

GEM uses the median +/– X * IQR to identify extreme weights, where X is any number, typically between 2 and 3, and IQR is the interquartile range. There are also different points in the weight adjustment process during which weight trimming can occur. GEM has options to make adjustments for extreme weights as part of the nonresponse adjustment process and as part of the poststratification process. GEM adjusted for ELS:2002 third follow-up extreme weights during both nonresponse adjustment and during calibration For GEM, a variable or set of variables is selected to be used to identify extreme weights within each level of the variable(s), and the variables race and school type were chosen. Prior to running GEM, the unweighted and weighted percentage of extreme weights was examined for all four levels of race crossed with the three levels of school type using various multiples of the IQR (2.0, 2.1, 2.2,…4.0) and IQR multipliers were selected for use in the subsequent weight trimming processes.

6.2.3.2 Predictor Variables for Nonresponse Models

To create weight adjustments that account for nonresponse, predictor variables must be incorporated into the modeling process. Because the modeling process uses both respondents and nonrespondents, the information included in the nonresponse models must be known for both respondents and nonrespondents.

The third follow-up respondents include individuals who were base-year nonrespondents, individuals who were first follow-up nonrespondents, and individuals who were second follow-up nonrespondents. Consequently, most information collected as part of the base-year, first follow-up, and second follow-up surveys could not be used in the nonresponse adjustments. The variables used in the nonresponse models primarily consisted of sampling frame information, base-year sample school information, and some demographic characteristics. Table 22 lists all information used in at least one of the nonresponse models created for the third follow-up.

All school-level information was included in every nonresponse model and was only removed, where necessary, from those models to ensure model convergence required because of the iterative nature of the model-fitting process. Because the student-level information was not available for all third follow-up sample members, some information was used in some models but not in others. Details of the student-level information used in the various nonresponse models may be found in sections 6.2.5 and 6.2.6.

Table 22. Information used in third follow-up nonresponse models

School-level information	Student-level information
School type	Student race/ethnicity
Metropolitan status	Student sex
Region	Student's native language
10th-grade enrollment	Family composition
Total enrollment	Parents' highest level of education
Number of minutes per class	Mother/female guardian's occupation
Number of class periods	Father/male guardian's occupation
Number of school days	Total family income from all sources
Percent of students receiving free or reduced-price lunch	Socioeconomic status (SES)
Number of full-time teachers	G10COHRT—member of the sophomore cohort
Percent of full-time teachers certified	G12COHRT—member of the senior cohort
Number of part-time teachers	Enrollment status
Number of grades taught at the school	
School level	
Coeducational status	
Percent of students with an IEP	
Percent of students with an LEP	
Percent Hispanic 10th-grade students	
Percent Asian 10th-grade students	
Percent Black 10th-grade students	

NOTE: School-level information is from the base year (2002). IEP = individualized education program. LEP = limited English proficiency.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Base Year, 2002, First Follow-up, 2004, Second Follow-up, 2006, and Third Follow-up, 2012.

6.2.3.3 Chi-squared Automatic Interaction Detection for Nonresponse Models

For those nonresponse adjustments that included interactions of the items listed in table 22, Chi-squared automatic interaction detection analysis (CHAID) was performed on the predictor variables to detect important interactions for the logistic models used to produce nonresponse weight adjustment factors. The CHAID analysis divided the data into segments that differed with respect to the response variable (fielded, did not refuse, or respondent, depending on the model). The segmentation process first divided the sample into groups based on categories of the most significant predictor of response. It then split each of these groups into smaller subgroups based on other predictor variables. It also merged categories of a variable that were found to be insignificant. The splitting and merging process continued until no more statistically significant predictors were found or until some other stopping rule was met. The interactions from the final CHAID segments were then defined.

The interaction segments and all main effects were subjected to variable screening in the GEM logistic procedure. The initial model for a given adjustment step included all of the variables listed in table 22 that were available for respondents and nonrespondents and, where interaction terms were used, included the segments identified via CHAID. The most insignificant variables were deleted sequentially until the deletion of additional variables did not appreciably improve the unequal weight effect (UWE). Different bounds on the weight adjustments,

depending on whether the weights were classified as extreme, were used to implement nonresponse adjustment, truncation, and smoothing in one step.

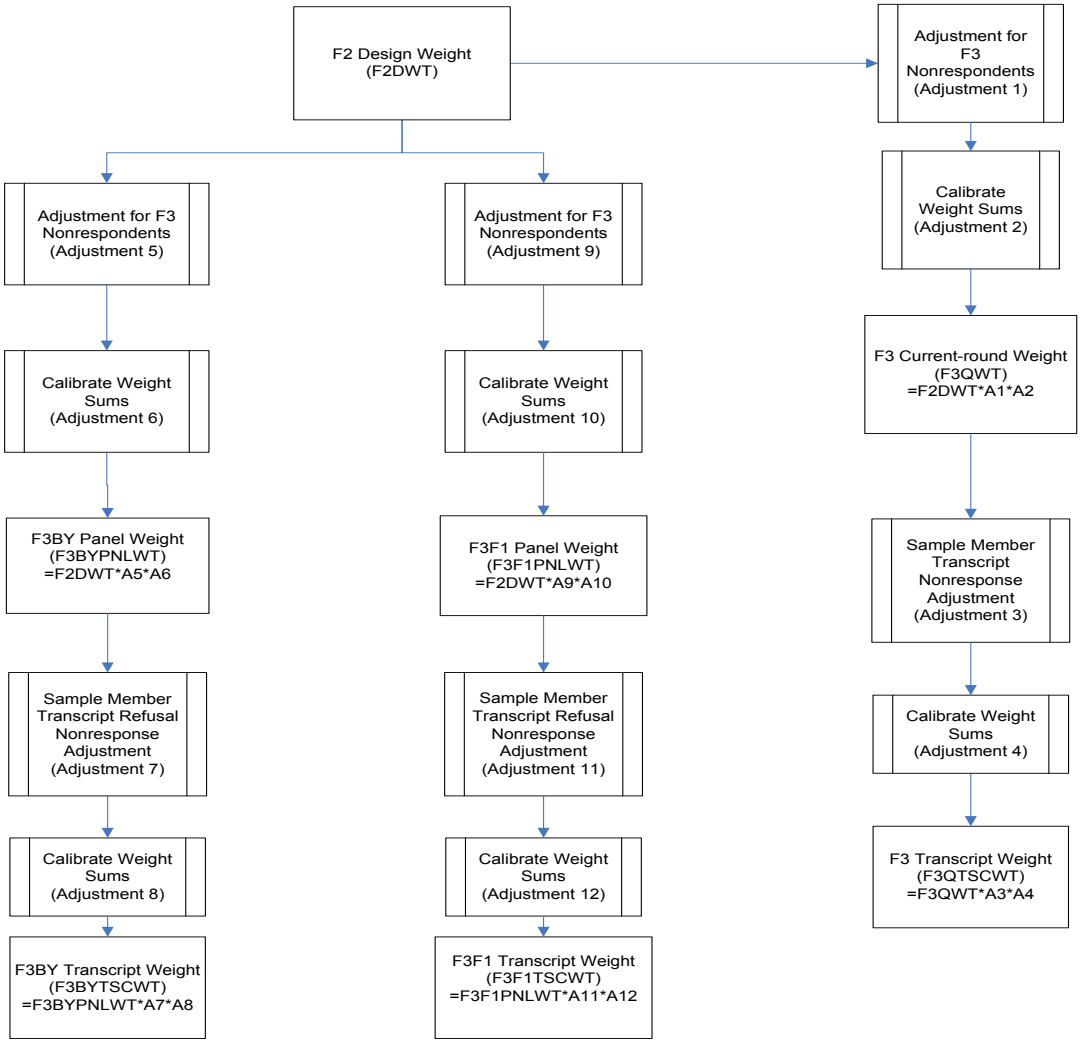
6.2.4 Base Weight

The base weight used to produce each of the third follow-up analysis weights was the second follow-up design weight, F2DWT.[32] The second follow-up design weight incorporates a simple ratio adjustment to account for unknown eligibility of some ELS:2002 sample members. Additional information about the adjustment for unknown eligibility may be found in the ELS:2002 Base-Year to Second Follow-up Data File Documentation (NCES 2008-347). All third follow-up analysis weights were produced by applying a series of nonresponse and calibration adjustments to F2DWT.

Subsequent adjustments to F2DWT varied by third follow-up analysis weight. The nonresponse and calibration adjustments applied to F2DWT to produce the third follow-up weights are described in section 6.2.5. Figure 8 summarizes the weight adjustments applied to the second follow-up design weight to produce the six third follow-up analysis weights.

[32] F2DWT is not provided in the third follow-up data files; it is referenced here to facilitate discussion of the weighting adjustments used to produce the third follow-up weights.

Figure 8. Third follow-up weight adjustments



SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Base Year, 2002, First Follow-up, 2004, Second Follow-up, 2006, and Third Follow-up, 2012.

6.2.5 Details of Weight Adjustments

The nonresponse and calibration adjustments used to produce the F3QWT and F3QTSCWT are described in section 6.2.5.1 and the corresponding adjustments for F3BYPNLWT, F3BYTSCWT, F3F1PNLWT, and F3F1TSCWT are discussed in section 6.2.5.2.

6.2.5.1 Weight Adjustments for F3QWT and F3QTSCWT

The third follow-up weight (F3QWT) was computed for those sample members who fully or partially completed the third follow-up questionnaire. As was the case in the second follow-up, prior-round questionnaire-incapable sample members who did not respond in the third follow-up were considered to be out of scope.

With a few exceptions, second follow-up eligible sample students remained eligible for the third follow-up sample. Deceased students were out of scope for the third follow-up. Students

who left the country, were unavailable for the duration of the study (e.g., in military boot camp), or were institutionalized were also out of scope for the third follow-up.

The third follow-up high school transcript weight (F3QTSCWT) was created by adjusting the third follow-up weight F3QWT. Two adjustments were applied to F3QWT. The first adjustment was a nonresponse adjustment used to account for those ELS:2002 sample members who did not have a high school transcript. The second adjustment was used to calibrate weight sums of the high school transcript weight to ensure agreement with weight sums generated with F3QWT.

The tables in appendix F summarize the nonresponse and calibration models used to produce the third follow-up weights. There are two types of tables provided in appendix F:

- nonresponse tables that list variables used in nonresponse models and indicate the number of respondents, the weighted response rate, and the average weight adjustment by each level of each predictor variable; and
- calibration tables that list variables used in calibration models and indicate the control total and average weight adjustment by each level of each variable used in the calibration model.

The list of variables (main effects and interactions) used in the student nonresponse adjustment for F3QWT may be found in table F-1 (appendix F) while the variables used in the subsequent calibration model are listed in table F-2. The nonresponse model applied to F3QWT as part of the process to produce F3QTSCWT is summarized in table F-3 and the subsequent calibration model is summarized in table F-4.

Table 23 shows various statistical properties of the final third follow-up weights F3QWT and F3QTSCWT.

Table 23. Statistical properties of F3QWT and F3TSCWT weights: 2012

Weight	F3QWT	F3QWT 10th-grade cohort	F3QWT 12th-grade cohort	F3QTSCWT	F3QTSCWT 10th-grade cohort	F3QTSCWT 12th-grade cohort
Mean	248.1	247.4	244.1	276.7	276.0	267.7
Variance	27,829.4	27,642.3	28,130.6	41,050.9	40,864.1	38,317.6
Standard deviation	166.8	166.3	167.7	202.6	202.1	195.7
Coefficient of variation (x 100)	67.2	67.2	68.7	73.2	73.2	73.1
Minimum	5.2	5.2	5.2	5.3	5.3	5.3
Maximum	903.0	861.5	903.0	2,290.0	2290.0	2290.0
Skewness	0.9	0.9	0.9	1.5	1.5	1.4
Kurtosis	0.4	0.4	0.5	4.1	4.2	3.4
Sum	3,287,051	3,248,820	2,844,923[1]	3,287,051	3,248,820	2,844,241
Number of cases	13,250	13,133	11,656	11,881	11,770	10,624

[1] Control totals and cohort status used to construct third follow-up weights match corresponding second follow-up values while the cohort status used to produce this table incorporates changes for a handful of cases, that result in a slight increase in the sum of the weights.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Base Year, 2002, First Follow-up, 2004, Second Follow-up, 2006, and Third Follow-up, 2012.

6.2.5.2 Weight Adjustments for F3BYPNLWT, F3BYTSCWT, F3F1PNLWT, and F3F1TSCWT

F3BYPNLWT was calculated for all sample members who:

- fully or partially completed a third follow-up questionnaire and fully or partially completed a base-year questionnaire; or
- fully or partially completed a third follow-up questionnaire and were questionnaire-incapable in the base year.

Sample members who were questionnaire-incapable in the base year were treated as base-year respondents for the purposes of constructing F3BYPNLWT. Questionnaire-incapable sample members who did not respond in the third follow-up were considered to be out of scope.

The nonresponse adjustments used to create F3BYPNLWT accounted for the same two nonresponse mechanisms used in the adjustment process used to create F3QWT as described in section 6.2.5.1. The list of variables (main effects and interactions) used in the student nonresponse adjustment for F3BYPNLWT may be found in table F-5 (appendix F) while the variables used in the subsequent calibration model are listed in table F-6.

F3BYTSCWT was calculated for all sample members who:

- fully or partially completed a third follow-up questionnaire and fully or partially completed a base-year questionnaire and have fully or partially complete high school transcript data; or
- fully or partially completed a third follow-up questionnaire and were questionnaire-incapable in the base year and have fully or partially complete high school transcript data.

The third follow-up high school transcript weight (F3BYTSCWT) was created by adjusting the third follow-up weight F3BYPNLWT. Two adjustments were applied to F3BYPNLWT. The first adjustment was a nonresponse adjustment used to account for those ELS:2002 sample members who did not have a high school transcript because a school refused to provide the transcript or those sample members who refused to allow their transcript to be collected. The second adjustment was used to calibrate weight sums of the transcript weight to ensure agreement with weight sums generated with F3QWT for the 10th-grade cohort. The nonresponse model applied to F3BYPNLWT as part of the process to produce F3BYTSCWT is summarized in table F-7 and the subsequent calibration model is summarized in table F-8.

F3F1PNLWT was calculated for all sample members who:

- fully or partially completed a third follow-up questionnaire and fully or partially completed a first follow-up questionnaire; or
- fully or partially completed a third follow-up questionnaire and were questionnaire incapable in the first follow-up.

Sample members who were questionnaire-incapable in the first follow-up were treated as first follow-up respondents for the purposes of constructing F3F1PNLWT. Questionnaire-incapable sample members who did not respond in the third follow-up were considered to be out of scope.

The nonresponse adjustments used to create F3F1PNLWT accounted for the same nonresponse mechanisms used in the adjustment process to create F3QWT as described in section 6.2.5.1. The list of variables (main effects and interactions) used in the student nonresponse adjustment for F3F1PNLWT may be found in table F-9 (appendix F) while the variables used in the subsequent calibration model are listed in table F-10.

F3F1TSCWT was calculated for all sample members who:

- fully or partially completed a third follow-up questionnaire and fully or partially completed a first follow-up questionnaire and have full or partial high school transcript data; or
- fully or partially completed a third follow-up questionnaire and were questionnaire incapable in the first follow-up and have full or partial high school transcript data.

The third follow-up high school transcript weight (F3F1TSCWT) was created by adjusting the third follow-up weight F3F1PNLWT. Two adjustments were applied to F3F1PNLWT. The first adjustment was a nonresponse adjustment used to account for those ELS:2002 sample members who did not have a high school transcript because a school refused to provide the transcript or those sample members who refused to allow their transcript to be collected. The second adjustment was used to calibrate weight sums of the transcript weight to ensure agreement with weight sums generated with F3QWT. The nonresponse model applied to F3F1PNLWT as part of the process to produce F3F1TSCWT is summarized in table F-11 and the subsequent calibration

model is summarized in table F-12. Table 24 shows various statistical properties of the final third follow-up weights.

Table 24. Statistical properties of F3BYPNLWT, F3BYTSCWT, F3F1PNLWT, and F3F1TSCWT weights: 2012

Weight	F3BYPNLWT	F3BYTSCWT	F3F1PNLWT	F3F1PNLWT 10th-grade cohort	F3F1PNLWT 12th-grade cohort	F3F1TSCWT	F3F1TSCWT 10th-grade cohort	F3F1TSCWT 12th-grade cohort
Mean	247.4	276.0	264.1	263.6	254.2	291.6	291.0	277.0
Variance	27,591.5	41,469.1	33,789.4	33,659.2	31,565.9	49,220.5	49,098.9	43,383.2
Standard deviation	166.1	203.6	183.8	183.5	177.7	221.9	221.6	208.3
Coefficient of variation (x 100)	67.1	73.8	69.6	69.6	69.9	76.1	76.1	75.2
Minimum	5.2	5.2	5.2	5.2	5.3	5.4	5.4	5.4
Maximum	837.8	2,163.2	3,073.6	3,073.6	959.0	2,509.0	2,509.0	2,509.0
Skewness	0.9	1.4	1.2	1.2	1.0	1.7	1.7	1.6
Kurtosis	0.3	3.8	4.7	4.8	0.7	5.4	5.4	4.9
Sum	3,248,820	3,248,820	3,287,051	3,248,820	2,844,241	3,287,051	3,248,820	2,844,241
Number of cases	13,132	11,769	12,444	12,327	11,188	11,274	11,163	10,268

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Base Year, 2002, First Follow-up, 2004, Second Follow-up, 2006, and Third Follow-up, 2012.

6.2.6 BRR Weights

Six sets of 200 BRR replicate weights were computed to support a variance estimation procedure in addition to Taylor series variance estimation supported by the weights described in section 6.2.2. The six sets correspond to the six weights described in section 6.2.2:

- F3Q001—F3Q200; corresponds to F3QWT
- F3TRS001—F3TRS200; corresponds to F3QTSCWT
- F3BYP001—F3BYP200; corresponds to F3BYNPLWT
- F3BYT001—F3BYT200; corresponds to F3BYTSCWT
- F3F1P001—F3F1P200; corresponds to F3F1PNLWT
- F3F1T001—F3F1T200; corresponds to F3F1TSCWT

The third follow-up replicate weights were computed in a similar manner to those computed for the base year, first, and second follow-up.

The BRR procedure is a variance estimation procedure that computes the variance based on a balanced set of pseudoreplicates. The BRR variance estimation process involves modeling the design as if it were a two primary sampling unit (PSU) per stratum design. Variances were calculated using a replication variance estimation procedure, with a balanced set of 200 replicates as the groups. Balancing was done by using an orthogonal matrix (200 x 200 Hadamard matrix) and allows the use of less than the full set of 2^L possible replicates, where L is the number of analysis strata. To achieve full orthogonal balance, the number of BRR strata needs to be less than the number of replicates. Therefore, 200 replicates were created in 199 strata. Section 6.2.6.1 describes the strata and PSUs (replicates) that were created for the base-year replicate weights and used again in the first, second, and third follow-ups. Section 6.2.6.2 describes the weight adjustments made for the third follow-up.

6.2.6.1 Strata and Primary Sampling Units for Balanced Repeated Replicate Weights

For Taylor series variance estimation, 361 analysis strata containing responding schools were created from the 96 sampling strata based on the sample design. To replicate the school weight, it is necessary for the BRR strata to contain all sample schools (respondents and nonrespondents). For the base year, 594 analysis strata were formed for the purpose of computing school-level Taylor series variance estimates. These 594 analysis strata were collapsed into 199 BRR strata. The base-year expected sample size for each sample school in the 594 strata was estimated, and then strata were collapsed randomly across size groups (small, medium, large) so that the 199 strata have approximately equal sizes. Collapsing randomly allows schools of different types, regions, or urbanicities to be together in a stratum. This provides more degrees of freedom for variance estimation for domains and helps obtain more accurate variance estimates within domains. Within each of the 199 BRR strata, there are two PSUs. Each school in a stratum was randomly assigned to one of the two PSUs. The strata were

randomly assigned to the rows of the Hadamard matrix. The 200 columns of the matrix are the replicates. Within each stratum, the matrix contains values of +1 and -1; one PSU was randomly assigned +1 and the other was assigned -1. For PSUs with a value of +1, the school base (sampling) weight was multiplied by 2 to create the initial BRR weight; otherwise the school base weight was multiplied by zero. Approximately half of the schools in each of the 200 replicates have initial BRR weights of zero and the other half have initial BRR weights double the initial base weight.

6.2.6.2 Balanced Repeated Replicate Weight Adjustments

Although both Taylor series and BRR variance estimation methods reflect the increase in variance because of unequal weighting, the BRR weights can also be designed to reflect the variance impact (increase or decrease) of the weight adjustment process. The impact of the weight adjustment process is captured by repeating nonresponse adjustment and calibration processes on each BRR half-sample.

The third follow-up replication process mirrored the third follow-up analysis weight construction, and the design weight was the second follow-up replicate design weight. All third follow-up weight adjustments were replicated, including nonresponse adjustments, and calibration. The original third follow-up nonresponse and calibration models were used initially for each of the 200 replicates. However, some of the models did not converge for some replicates, so variables were deleted one by one from the models until convergence was achieved. The variables deleted were those that seemed to be causing the convergence problems, as long as they were not key design variables. The weight distribution was calibrated to the third follow-up F3QWT weight sums. Because the third follow-up weights were not poststratified to external (known) totals, the estimates could legitimately reflect some variation in base-year totals because of sampling variability. To recognize the calibration to the third follow-up, each half-sample was calibrated to the third follow-up half-sample replicate weight sums rather than calibrated to the third follow-up full sample analysis weight sums.

6.2.7 Quality Control

Quality control was emphasized on all activities, including weighting. Because of the central importance of the analysis weights to population estimation, each set of weights was thoroughly checked. The most fundamental type of check was the verification of totals that are algebraically equivalent (e.g., marginal totals of the weights of eligible students prior to nonresponse adjustment and of respondents after nonresponse adjustment). In addition, various analytic properties of the initial weights, the weight adjustment factors, and the final weights were examined, both overall and within sampling strata, including

- distribution of the weights;
- ratio of the maximum weight divided by the minimum weight; and
- unequal weighting design effect, or variance inflation effect ($1 + CV^2$).

Additionally, two-dimensional tables of before and after weight adjustments were reviewed to ensure that the weight distribution was not distorted.

6.3 Standard Errors and Design Effects

6.3.1 Standard Errors

For probability-based sample surveys, most estimates are nonlinear statistics. For example, a mean or proportion, which is expressed as $\Sigma wy/\Sigma w$,[33] is nonlinear because the denominator is a survey estimate of the (unknown) population total. In this situation, the variances of the estimates cannot be expressed in closed form. One common procedure for estimating variances of survey statistics is the Taylor series linearization procedure. This procedure takes the first-order Taylor series approximation of the nonlinear statistic and then substitutes the linear representation into the appropriate variance formula based on the sample design. Woodruff (1971) presented the mathematical formulation of this procedure. The variance estimation must also take into account stratification and clustering. There are other variance estimation procedures, such as jackknife and BRR. Taylor series and BRR estimation were supported for the base year, first follow-up, and second follow-up and is also supported for the third follow-up.

Variance estimation procedures assumed a with-replacement design at the first stage of sampling. Because school sampling rates were moderately low, this assumption yields estimates that are only slightly biased in the positive direction. For stratified multistage surveys and a with-replacement sample design, the Taylor series procedure requires the specification of analysis strata and analysis PSUs. In the base year, 361 analysis strata were formed from the sampling strata used in the first stage of sampling, and the analysis PSUs were the individual schools. Given that the school sample was selected using probability with minimum replacement (pmr), for variance estimation in the base year, variance estimation strata were formed consisting of two PSUs per stratum (Chromy 1981). However, when there were an odd number of schools in a sampling stratum, one of the analysis strata formed had three PSUs. The same analysis strata and PSUs as in the base year were used in the first follow-up, in the second follow-up, and in the third follow-up.

As described in chapter 3, the ELS:2002 base-year sampling design was a stratified two-stage design. A stratified sample of schools was selected with probabilities proportional to a composite measure of size at the first stage, and a stratified systematic sample of students was selected from sample schools at the second stage. At the first stage, the school sampling rates

[33] Σw is the estimated population and y is the corresponding value of the variable for which a mean or proportion is calculated. In the case of estimation of a proportion, y is a 0/1 variable indicating whether a certain characteristic is present for the sample member. In the case of estimation of a mean, y is either a continuous or ordinal value reported by or associated with the sample member.

varied considerably by school sampling strata. At the second stage, Asian and Hispanic students were sampled at higher rates than other students. Because of this complex sampling design, statistical analyses should be conducted using software that properly accounts for the complex survey design.

Many commonly used statistical computing packages assume that the data were obtained from a simple random sample; that is, they assume that the observations are independent and identically distributed. When the data have been collected using a complex sampling design, the simple random sampling assumption usually leads to an underestimate of the sampling variance, which would lead to artificially small confidence intervals and liberal hypothesis test results (i.e., rejecting the null hypothesis when it is in fact true more often than indicated by the nominal Type I error level) (Carlson, Johnson, and Cohen 1993).

Statistical strategies that have been developed to address this issue include first-order Taylor series expansion of the variance equation, BRR, and the jackknife approach (Wolter 2007). Special-purpose software packages that have been developed for analysis of complex sample survey data include SUDAAN, WesVar, Stata, SPSS, SAS, R, and AM. Evaluations of the relative performances of these packages are reported by Cohen (1997).

- SUDAAN is a commercial product developed by RTI; information regarding the features of this package and its lease terms is available from the website http://www.rti.org/sudaan.
- WesVar is a product of Westat, Inc.; information regarding the features of this package and its lease terms is available from the website http://www.westat.com/westat/expertise/information_systems/wesvar/index.cfm.
- Information regarding the features of Stata and its lease terms is available from the website http://www.stata.com.

  SPSS is a product of IBM; information regarding the features of this package may be found on the website http://www-01.ibm.com/software/analytics/spss/products/statistics.
- SAS information (SAS-STAT User's Guide) can be found at http://support.sas.com/documentation/.
- R information is available at http://www.r-project.org.
- AM software, a product developed by the American Institutes for Research (AIR), can be downloaded for free from the website http://am.air.org/.

The following pseudo code is an example of generic SUDAAN code used to produce estimates and standard errors using Taylor series. The symbols /* and */ in the code indicate the beginning and end of a comment. Note that the dataset must be sorted by analysis strata and analysis PSUs before analyzing the data in SUDAAN.

```
proc descript data=/* insert filename[34]*/ design=wr;
nest analstr analpsu; /* these variables are the analysis strata and analysis PSUs,
respectively */
weight F3QWT;
var /*insert variables*/;
subpopn /* insert domain of interest if domain is a subset of students*/;
print nsum mean semean ;
run;
```

Corresponding Stata version 9 code is:

```
drop _all
set memory 18000
use "/* insert filename */", clear
sort analstr analpsu /* these variables are the analysis strata and analysis PSUs,
respectively */
svyset analpsu [pweight=f3qwt], strata(analstr)
svy: tab /*insert variables*/, subpop (name of domain) row se
Earlier versions of Stata require the following syntax:
svyset [pweight=f3qwt], strata(analstr) psu(analpsu)
svytab /*insert variables*/, subpop (name of domain) row se
```

6.3.2 Design Effects

The impact of the departures of the ELS:2002 complex sample design from a simple random sample design on the precision of sample estimates can be measured by the design effect. The design effect is the ratio of the actual variance of the statistic to the variance that would have been obtained had the sample been a simple random sample. The design standard errors will be different from the standard errors that are based on the assumption that the data are from a simple random sample. The ELS:2002 sample departs from the assumption of simple random sampling in three major respects: student samples were stratified by student characteristics, students were selected with unequal probabilities of selection, and the sample of students was clustered by school. A simple random sample is, by contrast, unclustered and not stratified. Additionally, in a simple random sample, all members of the population have the same probability of selection. Generally, clustering and unequal probabilities of selection increase the variance of sample estimates relative to a simple random sample, and stratification decreases the variance of estimates.

Standard errors and design effects were computed for all respondents. Standard errors and design effects were computed for 29 means and proportions overall for all respondents and for subgroups of all respondents. The subgroups are similar to those used in National Education Longitudinal Study of 1988 (NELS:88) and prior rounds of ELS:2002.

[34] All ELS:2002 sample members should be included in the file used with SUDAAN and all other software packages so that variance estimates are calculated correctly.

- sex (male and female);
- race/ethnicity (Asian/Pacific Islander, Black, Hispanic, White/other, multiracial);
- school type (public, Catholic, other private); and
- socioeconomic status (SES) (lowest quarter, middle two quarters, and highest quarter).

For purposes of trend comparisons, it is valuable to compare design effects across cohorts (e.g., ELS:2002 versus NELS:88), so the NELS:88 Base-Year to Fourth Follow-Up User's Manual (NCES 2002-323) was initially used to help guide the items picked. However, the available ELS:2002 items differ substantially from the items used in constructing design effects for NELS:88 because there were substantial differences in the types and composition of variables produced in each study. Nonetheless, the items chosen are a good representation of the different items in the ELS:2002 third follow-up survey questionnaire. These items should provide a range of design effects that will give a reasonable average for both the entire sample and for analytically important subgroups. However, because item matching with NELS:88 was difficult, the ELS:2002 design effects may not be comparable with the NELS:88 repeated design effects. Ideally, one would like to compare exact items between surveys. Table 25 lists the 29 items chosen for computing design effects for all respondents and subgroups. For categorical variables, the item value corresponding to the category of interest is listed.

For all respondents, the standard errors and design effects were calculated using all six third follow-up weights.

Table 25. Items chosen for computing design effects for all respondents and subgroups

Survey item	Variable name	Item value[1]
First job is working for an employer	F3A01A	1
Working for pay 35 or >35 hours per week	F3A03A	1
Extent to which postsecondary education prepared for life: Work and career	F3A15A	1
Postsecondary education paid with grants/scholarships	F3A23	1
Respondent served in military	F3B01	1
Current employer offers health insurance	F3B24	1
College degree but not advanced degree needed for job at age 30	F3C14	6
Number of friends or roommates living with respondent	F3D15A	Continuous
Number of siblings living with respondent	F3D15B	Continuous
Voted in 2008 presidential election	F3D38	1
Respondent performed community service in past 2 years	F3D40	1
Volunteered with church-related group	F3D41D	1
Volunteered with school/community organizations	F3D41E	1
Respondent's parent/guardian divorced in last 2 years	F3D44A	1
Respondent's parent/guardian lost job in last 2 years	F3D44B	1
Ever attended a postsecondary school	F3EVERATT	1
Ever dropped out	F3EVERDO	1
Ever held a job since leaving high school	F3EVRJOB	1
Fall 2003—Summer 2004 high school graduate	F3HSSTAT	1
Received GED or other equivalency	F3HSSTAT	6
Respondent's current marital status is single	F3MARRSTATUS	3
Respondent's current marital status is married	F3MARRSTATUS	1
At age 30 expects to have a job as a laborer	F3ONET2AGE30	37
At age 30 expects to have a job as a manager	F3ONET2AGE30	11
At age 30 expects to have a job in the military	F3ONET2AGE30	55
At age 30 expects to have a professional job (group a) Business and Financial	F3ONET2AGE30	13
At age 30 expects to have a sales job	F3ONET2AGE30	45
At age 30 expects to have a job as a school teacher	F3ONET2AGE30	25
Expect to finish college, but not advance degree	F3STEXP	6

[1] For categorical variables, the item value corresponds to the category of interest, and for continuous variables, the item value is indicated as continuous.

NOTE: GED = General Educational Development credential.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

Appendix G contains tables of design effects for all respondents. Each table includes the survey item (or composite variable), variable name and value, percent estimate, design standard error, simple random sample standard error, sample size (n), design effect (DEFF), and square root of the design effect (DEFT). Tables 26 to 31 summarize the average DEFFs and DEFTs for the full sample, panel samples, and high school transcript samples respectively, for all respondents, dropouts, and each subgroup. The reader should note that the mean DEFTs reported in tables 26 to 31 were not calculated directly from the mean DEFF but, rather, are based on the summary statistics from the tables in appendix G.

Table 26. Mean design effects (DEFFs) and root design effects (DEFTs) for F3QWT, by selected characteristics: 2012

Characteristic	Mean design effect	Mean root design effect
Total	1.7	1.3
Sex		
Male	1.5	1.2
Female	1.6	1.3
Race/ethnicity		
American Indian or Alaska Native	1.3	1.1
Asian or Pacific Islander	1.5	1.2
Black or African American	1.5	1.2
Hispanic or Latino	1.4	1.2
White	1.6	1.3
More than one race	1.6	1.3
School type		
Public	1.5	1.2
Catholic	1.4	1.2
Other private	2.3	1.5
Socioeconomic status (SES)		
Low SES	1.4	1.2
Middle SES	1.5	1.2
High SES	1.6	1.2

NOTE: The mean DEFT was not calculated directly from the mean DEFF but, rather, is the average DEFT over selected items. See appendix G of this document for more information.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

Table 27. Mean design effects (DEFFs) and root design effects (DEFTs) for F3BYPNLWT, by selected characteristics: 2012

Characteristic	Mean design effect	Mean root design effect
Total	1.7	1.3
Sex		
Male	1.5	1.2
Female	1.6	1.3
Race/ethnicity		
American Indian or Alaska Native	1.3	1.1
Asian or Pacific Islander	1.5	1.2
Black or African American	1.5	1.2
Hispanic or Latino	1.4	1.2
White	1.6	1.3
More than one race	1.6	1.3
School type		
Public	1.5	1.2
Catholic	1.4	1.2
Other private	2.3	1.5
Socioeconomic status (SES)		
Low SES	1.4	1.2
Middle SES	1.5	1.2
High SES	1.6	1.2

NOTE: The mean DEFT was not calculated directly from the mean DEFF but, rather, is the average DEFT over selected items. See appendix G of this document for more information.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

Table 28. Mean design effects (DEFFs) and root design effects (DEFTs) for F3F1PNLWT, by selected characteristics: 2012

Characteristic	Mean design effect	Mean root design effect
Total	1.8	1.3
Sex		
Male	1.6	1.3
Female	1.6	1.3
Race/ethnicity		
American Indian or Alaska Native	1.3	1.1
Asian or Pacific Islander	1.5	1.2
Black or African American	1.5	1.2
Hispanic or Latino	1.5	1.2
White	1.6	1.3
More than one race	1.7	1.3
School type		
Public	1.5	1.2
Catholic	1.4	1.2
Other private	4.3	1.9
Socioeconomic status (SES)		
Low SES	1.4	1.2
Middle SES	1.6	1.3
High SES	1.6	1.2

NOTE: The mean DEFT was not calculated directly from the mean DEFF but, rather, is the average DEFT over selected items. See appendix G of this document for more information.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

Table 29. Mean design effects (DEFFs) and root design effects (DEFTs) for F3QTSCWT, by selected characteristics: 2012

Characteristic	Mean design effect	Mean root design effect
Total	1.9	1.4
Sex		
Male	1.7	1.3
Female	1.8	1.3
Race/ethnicity		
American Indian or Alaska Native	1.4	1.2
Asian or Pacific Islander	1.7	1.3
Black or African American	1.6	1.3
Hispanic or Latino	1.6	1.3
White	1.7	1.3
More than one race	1.7	1.3
School type		
Public	1.6	1.3
Catholic	1.5	1.2
Other private	2.7	1.6
Socioeconomic status (SES)		
Low SES	1.5	1.2
Middle SES	1.6	1.3
High SES	1.8	1.3

NOTE: The mean DEFT was not calculated directly from the mean DEFF but, rather, is the average DEFT over selected items. See appendix G of this document for more information.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

Table 30. Mean design effects (DEFFs) and root design effects (DEFTs) for F3BYPNLWT, by selected characteristics: 2012

Characteristic	Mean design effect	Mean root design effect
Total	1.9	1.4
Sex		
Male	1.7	1.3
Female	1.8	1.3
Race/ethnicity		
American Indian or Alaska Native	1.4	1.2
Asian or Pacific Islander	1.7	1.3
Black or African American	1.7	1.3
Hispanic or Latino	1.6	1.3
White	1.7	1.3
More than one race	1.7	1.3
School type		
Public	1.6	1.3
Catholic	1.5	1.2
Other private	2.7	1.6
Socioeconomic status (SES)		
Low SES	1.5	1.2
Middle SES	1.7	1.3
High SES	1.8	1.3

NOTE: The mean DEFT was not calculated directly from the mean DEFF but, rather, is the average DEFT over selected items. See appendix G of this document for more information.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

Table 31. Mean design effects (DEFFs) and root design effects (DEFTs) for F3F1TSCWT, by selected characteristics: 2012

Characteristic	Mean design effect	Mean root design effect
Total	2.0	1.4
Sex		
Male	1.8	1.3
Female	1.8	1.3
Race/ethnicity		
American Indian or Alaska Native	1.5	1.2
Asian or Pacific Islander	1.7	1.3
Black or African American	1.7	1.3
Hispanic or Latino	1.7	1.3
White	1.7	1.3
More than one race	1.8	1.3
School type		
Public	1.7	1.3
Catholic	1.5	1.2
Other private	2.6	1.6
Socioeconomic status (SES)		
Low SES	1.5	1.2
Middle SES	1.7	1.3
High SES	1.8	1.3

NOTE: The mean DEFT was not calculated directly from the mean DEFF but, rather, is the average DEFT over selected items. See appendix G of this document for more information.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

As discussed in section 6.2, trimming weights reduces the variance, which reduces the design effect. Additionally, the items used to compute the mean design effects were different in the third follow-up than in prior rounds because the design effects were not expected to change much across the four rounds of the study. For purpose of trend comparisons, it is valuable to compare design effects across cohorts, as described below, so the items were chosen to be as comparable to NELS:88 fourth follow-up items as possible.

The smaller design effects in ELS:2002 compared with those for the NELS:88 and High School and Beyond (HS&B) sophomore cohorts are probably substantially a result of smaller degree of subsampling in ELS:2002. Although no subsampling was used for the ELS:2002 third follow-up, sample base-year nonrespondents were subsampled for inclusion in the first follow-up. In NELS:88, subsampling was performed in the first, third, and fourth follow-ups. See Curtin et al. (2002) for more details. In HS&B, sophomore cohort members were subsampled for inclusion in the HS&B high school transcript study and this subsample was the basis for the HS&B second follow-up study. See Zahs et al. (1995) for more details. As mentioned above, the general tendency in longitudinal studies is for design effects to lessen over time, because

dispersion reduces the original clustering. Subsampling increases design effects because it introduces additional variability into the weights with an attendant loss in sample efficiency.

The smaller design effects in ELS:2002 compared with those for the HS&B sophomore cohort also may reflect the somewhat smaller cluster size used in the latter survey in the base year. Although the clusters were reduced somewhat in the first follow-up for both studies, a number of students remained in the base-year school. The HS&B base-year sample design called for 36 sophomores selected from each school. The ELS:2002 sample design called for about 26 sophomores selected from each school. Clustering tends to increase the variance of survey estimates because the observations within a cluster are similar and therefore add less information than independently selected observations. The impact of clustering depends mainly on two factors: the number of observations within each cluster and the degree of within-cluster homogeneity. When cluster sizes vary, the impact of clustering (DEFFc) can be estimated by

$$\text{DEFFc} = 1 + \left(\bar{b} - 1\right) \text{rho},$$

where $\bar{b}$ refers to the average cluster size (the average number of students selected from each school) and rho refers to the intraclass correlation coefficient, a measure of the degree of within-cluster homogeneity. If the value of rho (which varies from one variable to the next) averaged about 0.05 in both studies, then the reduced cluster size in ELS:2002 would almost exactly account for the reduction in the design effects relative to HS&B.

If one must perform a quick analysis of ELS:2002 data without using one of the software packages for analysis of complex survey data, the design effects tables in appendix G can be used to make approximate adjustments to the standard errors of survey statistics computed using the standard software packages that assume simple random sampling designs. One cannot be confident regarding the actual design-based standard error without performing the analysis using one of the software packages specifically designed for analysis of data from complex sample surveys.

Standard errors for a proportion can be estimated from the standard error computed using the formula for the standard error of a proportion based on a simple random sample and the appropriate DEFT:

$$\text{SE} = \text{DEFT} * (p(1-p)/n)^{1/2}.$$

Similarly, the standard error of a mean can be estimated from the weighted variance of the individual scores and the appropriate mean DEFT:

$$\text{SE} = \text{DEFT} * (\text{Var}/n)^{1/2}.$$

Tables 26 to 31 make it clear that the DEFFs and DEFTs vary by subgroup, with the largest values appearing among other private schools. It is therefore important to use the mean DEFT for the relevant subgroup in calculating approximate standard errors for subgroup statistics.

Standard error estimates may be needed for subgroups that are not shown in appendix G. One rule of thumb may be useful in such situations. The general rule states that design effects will generally be smaller for groups that are formed by subdividing the subgroups listed in the tables. (Smaller subgroups will be affected less by clustering than larger subgroups; in terms of the equation for DEFFc, $\bar{b}$ will be reduced.) Estimates for Hispanic males, for example, will generally have smaller design effects than the corresponding estimates for all Hispanics or all males. For this reason, it will usually be conservative to use the subgroup mean DEFT to approximate standard errors for estimates concerning a portion of the subgroup. This rule only applies when the variable used to subdivide a subgroup crosscuts schools. Sex is one such variable because most schools include students of both sexes. It will not reduce the average cluster size to form groups that are based on subsets of schools.

Standard errors may also be needed for other types of estimates than the simple means and proportions that are the basis for the results presented in the above tables. A second method can be used to estimate approximate standard errors for comparisons between subgroups. If the subgroups crosscut schools, then the design effect for the difference between the subgroup means will be somewhat smaller than the design effect for the individual means; consequently, the variance of the difference estimate will be less than the sum of the variances of the two subgroup means from which it is derived:

$$\text{Var}(b\text{-}a) = \text{Var}(b) + \text{Var}(a)$$

where Var(b-a) refers to the variance of the estimated difference between the subgroup means, and Var(a) and Var(b) refer to the variances of the two subgroup means. This equation assumes that the covariance of the subgroup means is negligible. It follows from this equation that Var(a) + Var(b) can be used in place of Var(b-a) with conservative results.

A final rule of thumb is that many complex estimators show smaller design effects than simple estimators (Kish and Frankel 1974). This principle implies that it will often be conservative to use the DEFTs in the above tables in calculating approximate standard errors for complex statistics, such as multiple regression coefficients. The procedure for calculating such approximate standard errors is the same as with simpler estimates: first, a standard error is calculated using the formula for data from a simple random sample; then the standard error is multiplied by the appropriate DEFT.

One analytic strategy for accommodating complex survey designs is to use the mean design effect to adjust for the effective sample size resulting from the design. For example, one could create a weight that is the multiplicative inverse of the design effect and use that weight (in conjunction with sampling weights) to deflate the obtained sample size to take into account the inefficiencies resulting from a sample design that is a departure from a simple random sample. Using this procedure, statistics calculated by a statistical program such as SAS or SPSS will reflect the reduction in sample size in the calculation of standard errors and degrees of freedom. Such techniques capture the effect of the sample design on sample statistics only approximately.

However, although it does not provide a full accounting of the sample design, this procedure does provide some adjustment for the sample design and is probably better than conducting analysis that assumes the data were collected from a simple random sample. The analyst applying this correction procedure should carefully examine the statistical software being used and assess whether the program treats weights in such a way as to produce the effect described above.

6.4 Third Follow-up Imputation

6.4.1 Imputation Variables

A set of 14 key analytic variables was identified for item imputation on data obtained from the ELS:2002 third follow-up member interview. These 14 variables include indicators of whether the respondent ever applied to or attended a postsecondary institution, highest level of education attained, and various employment indicators such as whether the respondent has held a job for pay since high school, as well as total job earnings. Additional variables were considered for this list but were excluded because they were deemed to be of little analytic importance. Note that some variables with high item response rates were imputed because the variables were considered to be key analytic variables. Table 32 lists the selected variables in the order in which they were imputed. Note that some of the imputed variables are inputs to other imputed variables. For example, if F3STLOANEVR was imputed as a "No" then the value of F3STLOANAMT was set to 0. Sets of logical constraints, specific to each imputed variable, were used to ensure that imputed values for any given imputed variable are consistent with values for all other imputed variables.

6.4.2 Imputation Methodology

Stochastic methods were used to impute the missing values for the ELS:2002 third follow-up data. Specifically, a weighted sequential hot-deck (WSHD) statistical imputation procedure (Cox 1980; Iannacchione 1982) using the final analysis weight (F3QWT) was applied to the missing values for the variables in table 12 in the order in which they are listed. The WSHD procedure replaces missing data with valid data from a donor record within an imputation class. In general, variables with lower item nonresponse rates were imputed earlier in the process.

Table 32. ELS:2002 third follow-up imputation variables, by number and weighted proportion imputed

Variable name	Description	Number of cases imputed	Weighted percent imputed
F3EVRJOB	Ever held a job for pay since high school	3	0.03
F3EVRATT	Ever attended a postsecondary institution	4	0.04
F3EDSTAT	Education status	6	0.06
F3STEXP	Highest level of education expected to complete	23	0.18
F3ATTAINMENT	Highest level of education attained	183	1.40
F3ERN2011	Total job earnings in 2011 calendar year	612	4.63
F3ONET6AGE30	Occupation at age 30	862	6.69
F3EMPSTAT	Employment status	1,125	8.90
F3STLOANEVR	Whether respondent took out any student/postsecondary education loans	1,032	7.87
F3STLOANAMT	Total amount borrowed in student loans	1,183	9.00
F3SPERN2011	2011 employment income: spouse/partner only	1,184	9.52
F3STLOANPAY	Amount currently paid monthly toward student loan balance	1,092	8.29
F3HS2BA	Number of months between high school completion and bachelor's completion	880	5.57
F3PS2BA	Number of months between postsecondary entry and bachelor's completion	995	6.36

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

Imputation classes were constructed for each imputed variable. Some imputation classes were constructed directly while others were identified using a recursive partitioning function created in R®.[35] With recursive partitioning (also known as a nonparametric classification tree or classification and regression tree [CART] analysis), the association of a set of items and the variable requiring imputation are statistically tested (Breiman et al. 1984). The result is a set of imputation classes formed by the cross-classification of the items that are most predictive of the variable in question. The pattern of missing items within the imputation classes is expected to occur randomly so that the WSHD procedure can be used. Table 33 lists the initial group of potential classification variables used during the imputation procedure. In each step of the imputation procedure, previously imputed variables also added to the potential classification group to identify associations among the imputation variables themselves.

[35] See www.r-project.org.

Table 33. Initial group of potential classification variables for ELS:2002 third follow-up imputation

Variable Name	Description
BYREGION	Geographic region of school
BYSCTRL	School control
BYURBAN	School urbanicity
F1RACE	First follow-up student's race/ethnicity-composite
F1SES1QR	First follow-up quartile coding of SES1 variable (restricted)
F1SEX	First follow-up sex-composite
F3HSSTAT	High school completion status (updated version of F2HSSTAT)
F2EVRJOB	Ever held a job since leaving high school—composite
F2EVRATT	Whether has ever attended a postsecondary institution—composite
F2STEXP	Highest level of education respondent expects to complete—composite

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Base Year (2002) to Third Follow-up, 2012.

In addition to questionnaire items used to form the imputation classes, sorting variables were used within each class to increase the chance of obtaining a close match between donor and recipient. If more than one sorting variable was chosen, a serpentine sort was performed where the direction of the sort (ascending or descending) changed each time the value of a variable changed. The serpentine sort minimized the change in the student characteristics every time one of the variables changed its value. Table 34 shows the method of imputation used, variables used to construct the classification, as well as sorting variables for each step of the imputation process.

Table 34. Details of imputation procedures for ELS:2002 third follow-up imputation variables

Imputation variable[1]	Method of Classification[2,3]	Imputation class variables	Sort variables within class
Ever held a job for pay since high school (F3EVRJOB)	Static	F2EVRJOB	BYREGION BYSCTRL BYURBAN
Ever attended a postsecondary institution (F3EVRATT)	Static	F2EVRATT	BYREGION BYSCTRL BYURBAN
Education status (F3EDSTAT)	CART	F3EVRATT F2STEXP	BYREGION BYSCTRL BYURBAN
Highest level of education expected to complete (F3STEXP)	Static	F2STEXP	BYREGION BYSCTRL BYURBAN
Highest level of education attained (F3ATTAINMENT)	CART	F3EDSTAT F3EVRATT F3STEXP	BYREGION BYSCTRL BYURBAN
Total job earnings in 2011 calendar year (F3ERN2011)	CART	F3ATTAINMENT	BYREGION BYSCTRL BYURBAN
Occupation at age 30 (F3ONET6AGE30)	CART	F3STEXP F3ATTAINMENT	BYREGION BYSCTRL BYURBAN
Employment status (F3EMPSTAT)	CART	F3ERN2011	BYREGION BYSCTRL BYURBAN
Whether respondent took out any student/postsecondary loans (F3STLOANEVR)	CART	F3EVRATT	BYREGION BYSCTRL BYURBAN
Total amount borrowed in student loans (F3STLOANAMT)	CART	F3STLOANEVR F3STEXP F3ATTAINMENT F3EMPSTAT	BYREGION BYSCTRL BYURBAN

See notes at end of table.

Table 34. Details of imputation procedures for ELS:2002 third follow-up imputation variables—Continued

Imputation variable[1]	Method of Classification[2,3]	Imputation class variables	Sort variables within class
2011 employment income: spouse/partner only (F3SPERN2011)	CART	F1SEX F1RACE	BYREGION BYSCTRL BYURBAN
Amount currently paid monthly toward student loan balance (F3STLOANPAY)	CART	F3STLOANAMT F3EDSTAT F3ERN2011	BYREGION BYSCTRL BYURBAN
Number of months between high school completion and bachelor's completion (F3HS2BA)	Static	F3ATTAINMENT	BYREGION BYSCTRL BYURBAN
Number of months between postsecondary entry and bachelor's completion (F3PS2BA)	Static	F3ATTAINMENT	BYREGION BYSCTRL BYURBAN

[1] The variables are listed in the order in which the missing values were imputed.
[2] CART signifies that WSHD imputation was performed with the assistance of a nonparametric classification and regression tree (CART) procedure for classification.
[3] Static signifies that WSHD imputation was performed with a pre-determined group of classification variables.
NOTE: WSHD = weighted sequential hot deck.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

6.4.3 Imputation Results

After the variables were imputed, a set of quality control checks was implemented to ensure the highest quality. For example, the number of times a donor was used in the WSHD was tracked. If it was determined that a single donor was used too often (e.g., the donor value was used in place of three or more missing values) in a single imputation pass, then the classification process was altered to ensure a realistic level of variation in the imputed responses. The weighted percent distribution of the values before and after the imputation procedure was also compared, both within and across the imputation classes, to identify large areas of change. Differences greater than 5 percent were flagged and examined to determine whether changes should be made to the imputation sort or class variables.

Multivariate consistency checks ensured that relationships between the imputation variables were maintained and that any special instructions for the imputation were implemented properly. For these checks, it was important to ensure that the imputation process did not create any new relationships that did not already exist in the item respondent data. For variables that had multiple consistency checks to track, it was necessary to evaluate all checks after the imputations were complete and reimpute a small number of cases that were inconsistent. These cases were originally imputed inconsistently because it was not possible to include all necessary variables in the classification for the imputation because it resulted in imputation classes that contained no donor records. Once the cases for reimputation were identified, they were reimputed (stochastically) using the same classes as their original pass but the donor pool was restricted to maintain consistency.

6.5 Data Security; Third Follow-up Disclosure Risk Analysis and Protections

Data security was a pervasive concern for the third follow-up. Extensive confidentiality and data security procedures were employed for ELS:2002 data collection and data processing activities; some of those procedures are summarized briefly here. All project staff members signed confidentiality agreements and affidavits of nondisclosure and are prohibited by law from using the obtained information for any purposes other than this research study. The third follow-up interview data were collected via the Web on a server protected with a Secure Sockets Layer encryption policy, which forces all data transferred to or from the website to be encrypted and transmitted only via secure (HTTPS) connection to conforming web browsers. Sample members received an e-mail and a lead letter that described the purpose of the study, and contained the URL to the ELS:2002 secure website and a user ID number and strong randomly generated credential which allowed them access to the web-based interview. The only mechanism of access to the self-administered web-based interview was through this ID number and credential. Sample members could only access their individual case using their ID number and credential; they could not access data or information about anyone else. The ID numbers provided to sample members were completely different from the data IDs included on the restricted- and public-use data files. Data were prepared in accordance with NCES-approved disclosure avoidance plans. The data disclosure guidelines are designed to minimize the possibility of a data user being able to identify individuals on the file by matching outliers or other unique data to external data sources.

Because of the paramount importance of protecting the confidentiality of NCES data that contain information about specific individuals, ELS:2002 third follow-up data files were subject to various procedures to minimize disclosure risk. The ELS:2002 third follow-up data products and the disclosure treatment methods employed to produce them are described in the following sections.

6.5.1 Third Follow-up Data Products

The set of data products produced for the ELS:2002 third follow-up are similar to the set of data products produced in the base year and first and second follow-ups in that a public-use and a restricted-use data file were created.

The disclosure treatment developed for the ELS:2002 third follow-up is composed of several steps:

- Review the collected data and identify items that may increase risk of disclosure.
- Apply disclosure treatment[36] to these risky items to lower risk of disclosure.
- Produce a restricted-use data file that incorporates the disclosure-treated data.
- Produce a public-use data file that incorporates the disclosure-treated data.

The disclosure treatment methods used to produce the ELS:2002 third follow-up data files include variable recoding, variable suppression, and swapping. These methods are described below.

6.5.2 Recoding, Suppression, and Swapping

Some of the data used during data collection activities were deemed to be too identifying and were not included in either the restricted-use or the public-use data file. Some restricted-use data were deemed to be too identifying for inclusion in the public-use file and these data were not included in the public-use file.

For items in the restricted-use file, recoding was used to produce more analytically useful variables. Some restricted-use variables were recoded for inclusion in the public-use data file. The recoding for the public-use file was necessary because some items had values that occurred with extremely low frequencies in the restricted-use data file and the items were therefore recoded to ensure that all values of all items occurred with a reasonable frequency in the public-use file.

Swapping was applied to ELS:2002 data items determined to potentially increase risk of disclosure. Respondents were randomly selected for swapping to achieve a specific, but undisclosed, swapping rate. In data swapping, the values of the variables being swapped are exchanged between carefully selected pairs of records: a target record and a donor record. By so doing, even if a tentative identification of an individual is made, because every case in the file has some undisclosed probability of having been swapped, uncertainty remains about the accuracy and interpretation of the match. The third follow-up swapping was done independently of the swapping conducted in the base year, the first follow-up, and the second follow-up.

Because perturbation (swapping) of the ELS:2002 data may change the relationships between data items, an extensive data quality check was carried out to limit the impact of swapping on relationships. Before-and-after weighted distributions and correlations for swapped variables show that, after applying the disclosure limitation techniques, the analytic utility of the data files was not compromised.

[36] The NCES Statistical Standards (Seastrom 2003) (http://nces.ed.gov/statprog/2002/std4_2.asp), specifically NCES Standard 4-2, provide information both about the legislative background and legal requirements of maintaining confidentiality, and definitions of key terms (perturbation, coarsening, disclosure risk analysis, data swapping, and so forth).

6.6 Third Follow-up Unit and Item Nonresponse Bias Analysis

6.6.1 Unit Nonresponse Bias Analysis

Unit nonresponse causes bias in survey estimates when the outcomes of respondents and nonrespondents are different. For the ELS:2002 third follow-up, student response is defined as the sample member completing at least a specified portion of the questionnaire. The weighted response rate was 77.8 percent overall. The domains selected for the unit nonresponse bias analysis were derived from the subpopulations listed in section 6.2. Examples of subpopulations used in the nonresponse bias analysis are given below:

- Spring 2002 Black 10th-grade students
- Spring 2002 Hispanic 10th-grade students
- Spring 2002 Asian 10th-grade students
- Spring 2002 White/other 10th-grade students
- Spring 2002 public school 10th-grade students
- Spring 2002 Catholic school 10th-grade students
- Spring 2002 other private school 10th-grade students
- Spring 2002 10th-grade students who graduated by August 31, 2004
- Spring 2004 Black 12th-grade students
- Spring 2004 Hispanic 12th-grade students
- Spring 2004 Asian 12th-grade students
- Spring 2004 White/other 12th-grade students
- Spring 2004 public school 12th-grade students
- Spring 2004 Catholic school 12th-grade students
- Spring 2004 other private school 12th-grade students
- Spring 2004 12th-grade students who graduated by August 31, 2004

Because the overall response rate was below 85 percent, nonresponse bias analyses were conducted as required under NCES standards. All third follow-up weights described in section 6.2 were used in the nonresponse bias analyses.

The nonresponse bias was estimated for variables known for both respondents and nonrespondents. Because the sample for the third follow-up consists of respondents from the base year, the first follow-up, and the second follow-up, sample member data used in the

nonresponse bias analysis were available, although some of the available data may have been imputed.[37] The sample member data that were used include:

- Student race/ethnicity
- Student sex
- Student's native language
- Family composition
- Parents' highest level of education
- Mother/female guardian's occupation
- Father/male guardian's occupation
- Total family income from all sources
- Socioeconomic status (SES)

The sample member's Spring 2004 enrollment status was also used and defined as follows:

- in school, in grade (in grade 12);
- in school, out of grade (in grade 10 or 11, ungraded, or graduated early); and
- out of school (dropout or homeschooled).

The sample member cohort flags were also used:

- G10COHRT—indicates a member of the sophomore cohort (i.e., Spring 2002 10th-grader)
- G12COHRT—indicates a member of the senior cohort (i.e., Spring 2004 12th-grader)

There were also extensive data available for schools from the base-year school administrator questionnaire, so these data were used to help reduce potential nonresponse bias. Students were linked to the base-year school from which they were sampled. The school sampling frame constructed from the Common Core of Data and Private School Universe Survey also contains data for all base-year schools. School data used included the following:

- school sector;
- urbanicity;
- region;
- sophomore enrollment;

[37] For example, some base-year nonrespondents were sampled for inclusion in the first follow-up study. Some of these base-year nonrespondents responded in the first follow-up and some base-year data were collected on these individuals. If these individuals did not provide these base-year data in the first follow-up questionnaires then some of their base-year data were imputed.

- total enrollment;
- number of minutes per class;
- number of class periods;
- number of school days;
- number of students receiving free or reduced-price lunch;
- number of full-time teachers;
- percentage of full-time teachers certified;
- number of part-time teachers;
- number of grades taught at the school;
- school level;
- coeducational status;
- percentage of students with an individualized education program;
- percentage of students with limited English proficiency;
- percentage of Hispanic or Latino sophomores;
- percentage of Asian sophomores;
- percentage of Black or African American sophomores; and
- percentage of all other race sophomores (includes White).

The procedures used for the nonresponse bias analysis were similar to those used in the base year, first follow-up, and second follow-up. First, sample member data known for both respondents and nonrespondents were identified. Second, because the set of data known for both respondents and nonrespondents was limited, all of these data were incorporated into nonresponse models used for the third follow-up. The nonresponse adjustments described in section 6.2 were designed to significantly reduce or eliminate nonresponse bias for variables included in the models. Variables not known for most respondents and nonrespondents could not be included in the nonresponse adjustments, and therefore nonresponse bias could not explicitly be reduced for these variables. However, many of the variables in the nonresponse models are correlated with many of the other variables.

Third, after the sample member weights were computed, remaining bias for data known for most respondents and nonrespondents was estimated and statistically tested to check if there was any remaining significant nonresponse bias. Fourth, the remaining bias after student weight adjustments was divided by the standard error, that is, bias/standard error.

The bias in an estimated mean based on respondents, $\overline{y}_R$, is the difference between this mean and the target parameter, π (i.e., the mean that would be estimated if a complete census of the target population was conducted). This bias can be expressed as follows:

$$B(\bar{y}_R) = \bar{y}_r - \pi$$

The estimated mean based on nonrespondents, $\bar{y}_{NR}$, can be computed if data for the particular variable for most of the nonrespondents are available. The estimation of π is as follows:

$$\hat{\pi} = (1-\eta)\bar{y}_R + \eta\bar{y}_{NR}$$

where η is the weighted unit nonresponse rate. For the variables that are from the frame rather than from the sample, π can be estimated without sampling error. Therefore, the bias can be estimated as follows:

$$\hat{B}(\bar{y}_R) = \bar{y}_R - \hat{\pi}$$

or, equivalently,

$$\hat{B}(\bar{y}_R) = \eta(\bar{y}_R - \bar{y}_{NR})$$

This formula shows that the estimate of the nonresponse bias is the difference between the mean for respondents and the mean for nonrespondents multiplied by the weighted nonresponse rate. The variance of the bias was computed using Taylor series estimation in RTI's software package SUDAAN.

In addition to calculating and assessing bias, relative bias estimates were also calculated and are provided so that bias estimates may be compared across the variables for which bias estimates were generated. The estimated relative bias formula, as per Biemer and Lyberg (2003), is:

$$\hat{R}(\hat{B}) = \frac{\hat{B}(\bar{y}_R)}{\hat{\pi}}$$

Tables H-1a through H-6a in appendix H show the nonresponse bias before and after weight adjustments for selected variables for sample members where F3QWT is used in table H-1a, F3QTSCWT is used in table H-2a, F3BYPNLWT is used in table H-3a, F3BYTSCWT is used in table H-4a, F3F1PNLWT is used in table H-5a, and F3F1TSCWT is used in table H-6a. The tables show estimated bias before nonresponse adjustment for the variables available for most responding and nonresponding students. Statistical tests (*t* tests) were used to test each level of the variables for significance of the bias at the 0.05/(c-1) significance level, where c is the number of categories (levels) within the primary variable. Tables 35 to 40 provide a summary of the before- and after-adjustment significant bias derived from tables H-1a to H-6a, respectively, in appendix H.

Table 35. Summary of student bias analysis for F3QWT

Nonresponse bias statistics[1]	Overall
Before weight adjustments—study member	
Mean percent relative bias across characteristics	2.67
Median percent relative bias across characteristics	1.52
Percent of characteristics with significant bias	40.43
After nonresponse weight adjustments—study member	
Mean percent relative bias across characteristics	0.06
Median percent relative bias across characteristics	0.04
Percent of characteristics with significant bias	#

Rounds to zero.
[1]Relative bias and significance calculated on respondents versus full sample.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

Table 36. Summary of student bias analysis for F3QTSCWT

Nonresponse bias statistics[1]	Overall
Before weight adjustments—study member	
Mean percent relative bias across characteristics	2.01
Median percent relative bias across characteristics	1.71
Percent of characteristics with significant bias	22.14
After nonresponse weight adjustments—study member	
Mean percent relative bias across characteristics	0.04
Median percent relative bias across characteristics	0.03
Percent of characteristics with significant bias	#

Rounds to zero.
[1]Relative bias and significance calculated on respondents versus full sample.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

Table 37. Summary of student bias analysis for F3BYPNLWT

Nonresponse bias statistics[1]	Overall
Before weight adjustments—study member	
Mean percent relative bias across characteristics	2.65
Median percent relative bias across characteristics	1.53
Percent of characteristics with significant bias	42.45
After nonresponse weight adjustments—study member	
Mean percent relative bias across characteristics	0.07
Median percent relative bias across characteristics	0.04
Percent of characteristics with significant bias	#

Rounds to zero.
[1]Relative bias and significance calculated on respondents versus full sample.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

Table 38. Summary of student bias analysis for F3BYTSCWT

Nonresponse bias statistics[1]	Overall
Before weight adjustments—study member	
Mean percent relative bias across characteristics	2.04
Median percent relative bias across characteristics	1.71
Percent of characteristics with significant bias	22.31
After nonresponse weight adjustments—study member	
Mean percent relative bias across characteristics	0.04
Median percent relative bias across characteristics	0.03
Percent of characteristics with significant bias	#

Rounds to zero.
[1]Relative bias and significance calculated on respondents versus full sample.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

Table 39. Summary of student bias analysis for F3F1PNLWT

Nonresponse bias statistics[1]	Overall
Before weight adjustments—study member	
Mean percent relative bias across characteristics	3.60
Median percent relative bias across characteristics	2.16
Percent of characteristics with significant bias	45.07
After nonresponse weight adjustments—study member	
Mean percent relative bias across characteristics	0.10
Median percent relative bias across characteristics	0.04
Percent of characteristics with significant bias	#

Rounds to zero.
[1]Relative bias and significance calculated on respondents versus full sample.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

Table 40. Summary of student bias analysis for F3F1TSCWT

Nonresponse bias statistics[1]	Overall
Before weight adjustments—study member	
Mean percent relative bias across characteristics	2.18
Median percent relative bias across characteristics	1.90
Percent of characteristics with significant bias	29.69
After nonresponse weight adjustments—study member	
Mean percent relative bias across characteristics	0.04
Median percent relative bias across characteristics	0.03
Percent of characteristics with significant bias	#

Rounds to zero.
[1]Relative bias and significance calculated on respondents versus full sample.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

Tables H-1b through H-6b in appendix H show the estimated bias after weight adjustments (using F3QWT table H-1b, F3QTSCWT in table H-2b, F3BYPNLWT in table H-3b, F3BYTSCWT in table H-4b, F3F1PNLWT in table H-5b, and F3F1TSCWT in table H-6b) for the variables available for most responding and nonresponding students. The bias after weight adjustments was computed as the difference between the estimate using nonresponse-adjusted and calibrated (final) weights and the estimate using the design (base) weights prior to nonresponse and calibration adjustment. This latter estimate is an estimate of π, the population parameter of interest, because it is the estimate of the target population using the design weights. Similar to the testing of before-adjustment bias, *t* tests were performed to test the significance of the bias for each level of the variables. In tables H-1b through H-6b, the estimated bias usually decreased after weight adjustments. Therefore, the number of significantly biased levels of variables decreased from 58 *before* adjustment to 1 *after* adjustment in table H-1, from 30 *before* adjustment to 0 *after* adjustment in table H-2, from 60 *before* adjustment to 0 *after* adjustment in table H-3, from 31 *before* adjustment to 0 *after* adjustment in table H-4, from 65 *before* adjustment to 1 *after* adjustment in table H-5, and from 39 *before* adjustment to 0 *after* adjustment in table H-6.

6.6.2 Item Nonresponse Bias Analysis

Because the overall weighted unit response rate (77.8 percent) was less than 85 percent, an item nonresponse bias analysis was carried out as required under NCES statistical standards. The first step in the item-level nonresponse bias analysis was to calculate the weighted[38] item-level response rate for every questionnaire item included in the ELS:2002 third follow-up. Twenty-nine items were found to have response rates lower than 85 percent. Table 41 shows the item-level response rates for the 29 items.

[38] Weighted item-level response rates used to identify items for which nonresponse bias analysis were required were calculated using the third follow-up current-round weight, F3QWT.

Table 41. Student-level questionnaire items with a weighted item response rate below 85 percent using F3QWT

Variable name	Variable label	Weighted item response rate
F3MOBILITYF1F2	RESIDENTIAL MOBILITY: F1-V.-F2	84.8
F3A19	TOTAL AMOUNT BORROWED IN STUDENT LOANS	83.8
F3STLOANAMT	TOTAL AMOUNT BORROWED IN STUDENT LOANS	83.8
F3ALLINC2011	2011 INCOME FROM ALL SOURCES	82.8
F3PARAGE	AGE AT WHICH RESPONDENT FIRST HAD A CHILD	82.6
F3A07	PROGRAM THROUGH WHICH GED/EQUIVALENCY WAS EARNED	82.2
F3A09B	COMPLETED GED TO TRAIN FOR A NEW JOB/CAREER	82.2
F3A09D	COMPLETED GED TO MEET REQUIREMENTS FOR ADDITIONAL STUDY	82.2
F3D22	SPOUSE/PARTNERS 2011 EMPLOYMENT EARNINGS	82.0
F3SPERN2011	2011 EMPLOYMENT INCOME: SPOUSE/PARTNER ONLY	82.0
F3A10	WHETHER CURRENTLY WORKING TOWARDS A GED/EQUIVALENT);	82.0
F3A08	STATE IN WHICH GED/EQUIVALENCY WAS EARNED	81.8
F3A09A	COMPLETED GED TO IMPROVE/ADVANCE/KEEP UP TO DATE ON CURRENT JOB	81.8
F3A09E	COMPLETED GED B/C REQUIRED OR ENCOURAGED BY EMPLOYER	81.8
F3A09F	COMPLETED GED FOR PERSONAL OR FAMILY OR SOCIAL REASONS	81.8
F3OCC30F1VF3	CHANGE/STABILITY IN OCCUPATIONAL EXPECTATIONS: F1-V.-F3	81.5
F3A09C	COMPLETED GED TO IMPROVE BASIC READING/WRITING/MATH SKILLS	81.4
F3DEBTALL2011	DEBT/INCOME RATIO: CURRENT DEBT TO 2011 INCOME FROM ALL SOURCES	81.2
F3OCC302	WHAT JOB FOR PAY OR OCCUPATION DO YOU PLAN TO HAVE WHEN YOU ARE AGE 30?—2 DIGIT CODE	78.4
F3OCC306	WHAT JOB FOR PAY OR OCCUPATION DO YOU PLAN TO HAVE WHEN YOU ARE AGE 30?—6 DIGIT CODE	78.3
F3D42	FREQUENCY OF VOLUNTEER SERVICE	77.7
F3OCC30BYVF3	CHANGE/STABILITY IN OCCUPATIONAL EXPECTATIONS: BY-V.-F3	77.6
F3ONET2AGE30	2-DIGIT ONET CODE FOR EXPECTED AGE-30 OCCUPATION	77.4
F3ONET6AGE30	6-DIGIT ONET CODE FOR EXPECTED AGE-30 OCCUPATION	77.3
F3A21	AMOUNT CURRENTLY PAID MONTHLY TOWARD STUDENT LOAN BALANCE	74.7
F3STLOANPAY	AMOUNT CURRENTLY PAID MONTHLY TOWARD STUDENT LOAN BALANCE	74.7
F3D16	WHETHER RESPONDENT LIVES IN PARENT(S) HOME OR PARENTS LIVE IN RESPONDENTS HOME	66.0
F3SEIAGE30	SEI-BASED CODE FOR EXPECTED AGE-30 OCCUPATION	65.4
F3B22	HOURS CURRENTLY WORKING PER WEEK ACROSS ALL JOBS	52.2

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

Tables I-1 through I-29 in appendix I compare item respondents and nonrespondents on these 29 items by using four characteristics known for all item respondents and item nonrespondents. Weighted distributions of the values of these four characteristics were generated using both respondents and nonrespondents, using respondents only, and using nonrespondents only and these distributions are presented in tables I-1 through I-29.

Twenty-eight of the variables had a least one statistically significant bias. The only variable that did not have any statistically significant bias was F3A08 (STATE IN WHICH GED/EQUIVALENCY WAS EARNED). There were 201 significant bias tests out of the 406 tests that were conducted.

6.7 Assessment of Responsive Design for ELS:2002 Third Follow-up

6.7.1 Responsive Design Setting

As discussed in section 4.3, the goal of responsive design was to identify and target, via new protocols or interventions, the nonresponding cases that are different from the respondent set at any one point. Although numerous approaches are available to identify target cases (e.g., critical subgroups, propensity to respond), the ELS:2002 third follow-up used a Mahalanobis distance function to identify nonrespondent cases most unlike the existing respondent set. A large number of survey variables, paradata, and sampling frame variables were incorporated into the distance function calculation providing an opportunity to target the cases most unlike respondents and therefore, if completed, most likely to reduce nonresponse bias. In this section, the bias results are discussed.

6.7.2 Responsive Design Results

Responsive design was integrated into the ELS:2002 third follow-up data collection and the responsive design is discussed in section 4.3. The analysis of the responsive design implementation is presented in this section. Cases that were selected at each of the phases had different levels of response. Those selected in phase 1 had an unweighted response rate of 72.9 percent. The cases selected in phase 2 had an unweighted response rate of 68.5 percent. The phase 3 cases had an unweighted response rate of 71.5 percent.

The primary question is whether data collection outcomes (i.e., bias in key survey estimates) were improved by identifying and prioritizing cases using a Mahalanobis distance score. To answer this question, 12 key frame and survey variables (the same variables used in the distance function calculation) were examined for evidence of bias at multiple points in data collection. The 12 variables included a total of 57 levels and therefore 57 bias estimates are presented. There were 4,683 cases that responded just before phase 1 case selection. Cumulatively, 7,805 cases had responded before phase 2 case selection. Although there were 3,122 additional respondents between phase 1 case selection and phase 2 case selection, only 322 were phase 1 selected cases.

Table J-1 in appendix J lists the variables used to construct bias estimates and Table J-2 shows the categorization of those variables used in the bias assessment. Table J-3 shows the bias estimates for all respondents, untreated respondents, and untreated plus phase 1 respondents. At the conclusion of data collection, 35 of the 57 pre *weight adjustment* estimates are biased or have values statistically different from zero. If all respondents who received no treatment or were not

targeted are considered, 41 of the 57 estimates are significantly different from zero, or biased. Finally, if the untreated plus phase 1 respondents are considered, 33 of 57 estimates are significantly biased. The number of biased estimates goes down slightly if respondents selected in phase 1 are included with the untreated respondents.

Chapter 7. Data File Contents

This chapter describes the Education Longitudinal Study of 2002 (ELS:2002) base-year to third follow-up longitudinal data file contents. It addresses the general structure of the data files included as well as the nature of the data access and analysis tools available to users which currently include the electronic codebook (ECB) system and the Education Data Analysis Tool (EDAT). The chapter also provides details associated with several key data file characteristics such as data reserve codes, variable naming conventions, and the nature of composite variables. In addition, the chapter provides information regarding how best to analyze ELS:2002 data, including guidance on cohort flag and weight selection.

7.1 Data File Structure

This section describes the general structure of the ELS:2002 data files and the individual file components.

7.1.1 Base-year to Third Follow-up Longitudinal Data File Structure

The base-year to third follow-up longitudinal data file combines the full complement of base-year to third follow-up data (including high school transcript data). A summary of the comprehensive set of files that comprise the base-year to third follow-up data file is provided at the end of this sub-section in table 42.

Because the school and student files include data from multiple sources, they are considered to be "megafiles." The pair includes one megafile at the student level (with other data sources supplying contextual data for analysis of the student) and one at the high school level.

The student-level megafile encompasses the following: base-year student data (student, parent, and teacher questionnaires and student tests); base-year school-level data merged to the appropriate student case (administrator, library, facilities); first follow-up student data (student, transfer, dropout, early graduate, and homeschool questionnaires, student tests and transcripts); first follow-up school administrator data merged to the appropriate student case; first follow-up high school transcript composites[39] merged to the appropriate student case; second follow-up questionnaire and composite data; and third follow-up questionnaire and composite data. Additional details regarding the student megafile are provided in section 7.1.2.

The megafile at the school level encompasses base-year data (collected via the facilities checklist, school administrator questionnaire, and library media center questionnaire), first

[39] The content and organization of the high school transcript and course offerings data (course-level file, student-level file, school-level file, and course offerings file) are further described in Bozick et al. (2006).

follow-up school administrator questionnaire data, high school transcript data (including course offerings composite data), and data drawn from the Common Core of Data and the Private School Universe Survey. Analysts should be aware that the base-year school data may be used as a standalone, nationally representative sample of 2001–02 schools with 10th grades, but that the school data for the 2003–04 school year are not precisely generalizable to the nation's 2003–04 high schools with 12th grades. Additional details regarding the school megafile are provided in section 7.1.3.

In addition to the student and high school–level megafiles, the data file includes a pair of postsecondary student-institution files. The first, referred to as the second follow-up postsecondary student-institution file, links students to postsecondary institutions applied to or attended as of the second follow-up interview. The second, referred to as the third follow-up postsecondary student-institution attendance file, links students to postsecondary institutions for which attendance was reported in either the second or third follow-up. It should be noted that the third follow-up student-institution file only includes records associated with third follow-up respondents. Additional details regarding the postsecondary student-institution files are provided in sections 7.1.4 and 7.1.5.

The base-year to third follow-up longitudinal data file also includes a collection of extant data files containing data imported from external administrative records. Specifics regarding which extant sources were drawn upon are provided in section 7.1.6.

Table 42. Summary of files included within the base-year to third follow-up data file

File name	Accessibility	Level	Record count	Longitudinal composition
Student file (BYF3STU)	Public and restricted use	Student level	16,197	BY, F1, F2 and F3 student interview, BY parent interview, BY teacher interview, school-level (BY and F1) administrator and staff interviews, school-level composites), HS transcript composites (F1), postsecondary educational transcript composites (F3), extant sources
School file (BYF1TSCH)	Public and restricted use	School level	1,954	BY and F1 administrator interview, BY facilities checklist, HS transcript (F1), extant sources
HS student transcript file (HSTRNSTU)	Restricted use	Student-course level	638,967	HS student transcripts (F1)
HS school transcript file (HSTRNSCH)	Restricted use	School-course level	117,151	HS course catalog (F1)
F2 student-institution file (F2INST)	Public and restricted use	Student-institution level	33,495	F2 interview, IPEDS
F3 student-institution file (F3INST)	Public and restricted use	Student-institution level	20,951	F2 and F3 interview, IPEDS

See notes at end of table.

Table 42. Summary of files included within the base-year to third follow-up data file—Continued

File name	Accessibility	Level	Record count	Longitudinal composition
CPS 2004-05 file (CPS0405)	Restricted use	Student level	6,484	CPS, academic year 2004–05
CPS 2005-06 file (CPS0506)	Restricted use	Student level	5,261	CPS, academic year 2005–06
CPS 2006-07 file (CPS0607)	Restricted use	Student level	4,343	CPS, academic year 2006–07
CPS 2009-10 file (CPS0910)	Restricted use	Student level	3,296	CPS, academic year 2009–10
CPS 2010-11 file (CPS1011)	Restricted use	Student level	3,143	CPS, academic year 2010–11
CPS 2011-12 file (CPS1112)	Restricted use	Student level	2,408	CPS, academic year 2011–12
CPS 2012-13 file (CPS1213)	Restricted use	Student level	2,721	CPS, academic year 2012–13
CPS 2013-14 file (CPS1314)	Restricted use	Student level	1,074	CPS, academic year 2013–14
NSLDS Pell file[1] (NSLDSPL)	Restricted use	Student level	18,277	NSLDS
NSLDS Loan file[2] (NSLDSLN)	Restricted use	Student level	52,665	NSLDS
GED file GED)	Restricted use	Student level	496	GED
Student BRR weight file (BRRSTU)	Public and restricted use	Student level	16,197	BY, F1, F2 and F3 replicate weights
School BRR weight file (BRRSCH)	Public and restricted use	School level	751	BY and F1 replicate weights

[1] The NSLDS Pell file contains all Pell records available as of the third follow-up. Additional notes related to the cumulative nature of this file are provided in section 7.1.6.
[2] The NSLDS loan file contains all loan records available as of the third follow-up. Additional notes related to the cumulative nature of this file are provided in section 7.1.6.
NOTE: BRR = balanced repeated replicate. BY = base year. CPS = Central Processing System. F1 = first follow-up. F2 = second follow-up. F3 = third follow-up. GED = General Educational Development credential. HS = high school. IPEDS = Integrated Postsecondary Education Data System. NSLDS = National Student Loan Data System.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

7.1.2 Student Megafile

The student file contains all prior-round data,[40] retaining the basic structure as in the base-year to second follow-up longitudinal data file. Variables introduced as of the third follow-up were typically added to new sections and then inserted into a logical grouping of sections (i.e., composites, sample member response data, school replicated data). The section titled "ID and Universe Variables" is an exception in spanning rounds of data collection.

[40] Although all data elements have been retained, not all base-year, first follow-up, and second follow-up data have been carried over. Specifically, in two rare instances data have been expunged: past data for deceased sample members, and data for sample members who withdrew their participation with instructions that past data be dropped.

Sections of the student file (BYF3STU) are as follows:

- ID and Universe Variables;
- Base-year (BY) Weights and Composites;
- First follow-up (F1) Weights and Composites;
- High School Transcript Composites;
- Second follow-up (F2) Weights and Composites;
- F2 Extant Data Source Composites;
- Third follow-up (F3) Weights and Composites;
- F3 Extant Data Source Composites;
- BY Student Questionnaire;
- F1 Student Questionnaire;
- F1 Dropout Questionnaire;
- F1 Transfer Questionnaire;
- F1 Early Graduate Questionnaire;
- F1 New Participant Supplement;
- F2 Survey;
- F3 Survey;
- BY Parent Questionnaire;
- BY Teacher Questionnaire (English);
- BY Teacher Questionnaire (Math);
- BY School Composites;
- F1 School Composites;
- BY Administrator Questionnaire;
- F1 Administrator Questionnaire;
- BY Library Questionnaire; and
- BY Facilities Checklist.

7.1.3 High School Megafile

The school file reflects data for the base-year survey, first follow-up survey, and first follow-up high school transcript (course offerings) data composites. The first follow-up was the final round for collection of school-level data directly from high schools. Common Core of Data and Private School Universe Survey data were added to the restricted-use ECB as a convenience to the ECB user. The School ID (Sch_ID) is the unique key identifier on the file and is

constructed such that student data file records can be merged with the high school data. It should be noted that the student data file includes two high school linkage IDs; one associated with the student's base-year school (Sch_ID) and the other associated with the school the student was attending (if still enrolled) as of the first follow-up (F1Sch_ID). Analysts can merge the student and school files on either school ID, depending on the time frame of interest.

7.1.4 Second Follow-up Postsecondary Student-Institution File

The postsecondary student-institution file is a student-level file that links students to postsecondary institutions applied to or attended as of the second follow-up interview. The key on the file is Stu_ID, order number, and Integrated Postsecondary Education Data System ID. Data for the institutions were obtained in the second follow-up interview, and collected by looping over each institution for a series of questions about application and attendance, among others. The looped iterations were normalized (one record for each unique postsecondary student-institution pair) and placed into the student-institution file structure. The order number enables researchers to associate information for a given institution from the student-level file with information about the given institution. An order number helps researchers determine a uniquely identifiable key and to allow users to easily link institution-based items from the student file to the institution file.

If the respondent reported attending one postsecondary institution, this institution is listed first for that student. If the respondent indicated attending more than one postsecondary institution, the one the respondent attended first would be listed first and so on. Institutions that respondents applied to but did not attend follow in the order they were named in the interview.

7.1.5 Third Follow-up Postsecondary Student-Institution Attendance File

The postsecondary student-institution attendance file is a student-level file that links students to postsecondary institutions for which attendance was reported as of the third follow-up interview. The key on the file is Stu_ID, order number, and Integrated Postsecondary Education Data System ID. Data for institutions reported via the third follow-up interview were collected by looping over each institution for a series of questions about attendance as well as questions regarding the nature of any credentials earned. The file contains one record for each unique postsecondary student-institution pair.

The ordering of the third follow-up student-institution file is consistent with that of the second follow-up student-institution file. If a given respondent reported attending a single postsecondary institution, this institution is the only one listed for that student. If the respondent indicated attending more than one postsecondary institution, the one the respondent attended first would be listed first and so on.

Data associated with credentials earned for any given institution are presented in two "blocks," meaning two subsets of variables that follow a specific naming convention. There are four basic data patterns regarding data stored in credential block #1 (variables following the

naming convention F3ICREDxxxx_1) and credential block #2 (variables following the naming convention F3ICREDxxxx_2):

- The respondent has not earned a credential from the associated postsecondary institution (F3ICREDNUM = 0): both credential block #1 and credential block #2 will be empty (i.e., legitimate skips).
- The respondent has earned a single credential from the associated postsecondary institution (F3ICREDNUM = 1): credential block #1 will store information about the highest/only credential the respondent earned from that postsecondary institution, and credential block #2 will be empty (i.e., legitimate skips).
- The respondent has earned more than one credential from the associated postsecondary institution (F3ICREDNUM = 2), and the first credential earned from that institution is not the same as the highest credential earned from that institution: credential block #1 will store information about the highest credential the respondent has earned from that institution, and credential block #2 will store information about the first credential earned from that institution.
- The respondent has earned more than one credential from the associated postsecondary institution (F3ICREDNUM = 2), and the first credential earned from that institution *is* the highest credential earned from that institution: credential block #1 will store information about the highest/first credential the respondent has earned from that institution, and credential block #2 will store information about an additional credential earned from that institution (this data pattern is less common than that described in #3 above).

It should be noted that the third follow-up student-institution file only includes data associated with third follow-up respondents. Postsecondary institutions reported to have been attended during the second follow-up interview were referenced in the third follow-up interview, and the associated data were carried forward to the third follow-up student-institution file. Records associated with second follow-up reported attendance for third follow-up nonrespondents were excluded from the third follow-up student-institution file. Such records are still available on the second follow-up postsecondary institution file.

7.1.6 Extant Data Source Files: Ancillary Data Links in the ELS:2002 Base-year to Third Follow-up Electronic Codebook

Rather than merge data from extant data sources on the student file, separate files were constructed that can be linked to the student file using Stu_ID as the key. Sample members will have one record on the Central Processing System (CPS), Scholastic Aptitude Test (SAT), ACT, and General Educational Development (GED) data source files, and one or more records on the National Student Loan Data System (NSLDS) data source files when data are available. If information is not available for that data source, then the student record will be excluded from that data source file. The following data source files were used:

- the Central Processing System[41];
- the National Student Loan Data System[42];
- the Scholastic Aptitude Test;
- the ACT; and
- the General Educational Development.

Variables representing the extant sources data imported into the second and third follow-up rounds are described in appendix K and listed in appendix L of this document. Some composite variables have been constructed and included on the student megafile to facilitate use of data associated with each extant data source.

It should be noted that the NSLDS loan and Pell grant data files are cumulative as of the third follow-up and may differ slightly in records and content from the versions delivered as part of the ELS:2002 second follow-up release. Furthermore, users should note that student-level composite variables specific to the second follow-up release (F2PELLCUM for example) were constructed using records available as of the second follow-up, whereas third-follow-up-specific composites (F3PELLCUM for example) were constructed using the cumulative set of records available as of the third follow-up.

7.2 Data Access and Analysis Tools

ELS:2002 data have been made available in public-use form via the web-based EDAT and PowerStats applications and (for licensed users) in restricted-use form[43] via ECB format. The restricted-use ECB is installed from a DVD and is designed to be run in a Windows environment. ECB software packages are available at no cost from the National Center for Education Statistics (NCES). A summary of all data access and analysis tools is provided in table 43 below.

[41] The CPS contains Free Application for Federal Student Aid data.

[42] The NSLDS database contains records of all federal loans, and Pell grant information, for anyone who has such a loan or grant. The NSLDS loan and Pell grant data source files are cumulative as of the third follow-up.

[43] A license is required to access the restricted-use ECB (http://nces.ed.gov/statprog/confid.asp).

Table 43. Summary of ELS:2002 data access and analysis tools

ELS:2002 Base-year to Third Follow-Up		
Detail	Public use	Restricted use
Longitudinal composition	BY, F1, F2, and F3	BY, F1, F2, F3, high school transcripts
Data file and documentation publication number	NCES 2014-362	NCES 2014-365
Access point	EDAT, PowerStats	Request DVD under license
Data file format	EDAT: One of six programming languages (SAS, Stata, SPSS, Sudaan, R, S-Plus) (or ASCII or CSV) PowerStats: Does not allow extraction of raw data	One of three programming languages (SAS, SPSS, and Stata)
Data file variable selection	EDAT: Tag Files PowerStats: Does not provide access to micro data	Electronic codebook
Analysis capability	EDAT: Does not support interactive analysis; provides access to micro data PowerStats: General statistics (percentages, means, etc.), data tables, table regressions	Does not support interactive analysis; provides access to micro data

ELS:2002 Base-year to Third Follow-up Data Availability						
	Base year	First follow-up	High school transcripts	Second follow-up	Third follow-up	Postsecondary transcripts
Year conducted	2002	2004	2005	2006	2012	2013-2014
Date available	Now	Now	Now	Now	January 2014	Spring 2015
Restricted-use (DVD) NCES 2014-362	✔	✔	✔	✔	✔	Released as separate file
Public-use (EDAT) NCES 2014-365	✔	✔		✔	✔	

NOTE: BY = base year. EDAT = Educational Data Analysis Tool. F1 = first follow-up. F2 = second follow-up. F3 = third follow-up.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

7.2.1 Electronic Codebook

The ECB system serves as an electronic version of a fully documented survey codebook. It allows the data user to browse through all ELS:2002 variables contained on the data files, search variable and value names for keywords related to particular research questions, review the wording of these items along with notes and other pertinent information related to them, examine the definitions and programs used to develop composite and classification variables, and export SAS, SPSS, or Stata syntax programs for statistical analysis. The ECB also provides an electronic display of the distribution of counts and percentages for each variable in the dataset. Analysts can use the ECB to select or "tag" variables of interest, export codebooks that display the distributions of the tagged variables, and generate SAS, SPSS, and Stata program code (including variable and value labels) that can be used with the analyst's own statistical software.

A guide for using the ECB is accessible via the "View Help" option of the "Help" tab in the ECB's main menu.

7.2.2 Education Data Analysis Tool

The EDAT web application, available via the NCES website (http://nces.ed.gov/EDAT), allows users to download public-use data files in formats compatible with one of six statistical programming languages (SAS, SPSS, S-Plus, Stata, R, and SUDAAN). The contents of downloaded files can be customized via the application's "tag" functionality by which users can select variables pertaining to their specific research interests. Additional information regarding the EDAT application is available via the NCES website.

7.2.3 PowerStats Data Analysis Tool

The PowerStats web application, available via the NCES website, allows users to generate simple statistics such as data tables and regressions via an interactive interface. The application also allows users to store work associated with their analyses or import (via external files) previously generated analyses. Additional information regarding the PowerStats application is available via the NCES website.

7.3 Data File Details

This section provides an overview of several key data file characteristics. An understanding of these characteristics will prove useful with respect to locating variables of specific interest and in understanding the nature of the underlying data.

7.3.1 Reserve Codes

There are a number of reasons for data to be missing for given variables. We account for these situations by filling items with reserve codes. The following reserve code scheme was used:

- -1 "Don't know." This reserve code was not used in the third follow-up but is retained for prior-round data.
- -2, "Refused." This reserve code was not used in the third follow-up but is retained for prior-round data.
- -3 "Item legitimate skip/NA." Filled for questions that are not answered because prior answers route the respondent elsewhere.
- -4 "Nonrespondent." Filled for all variables across the entire instrument when a sample member did not respond to the instrument.
- -5 "Suppressed" or "Out of Range." Used to identify third follow-up restricted-use variables appearing on public-use data products as a means of indicating the suppression of restricted-use values. (The label for values of -5 in such instances reads "Suppressed.")

This reserve code was also used in the base year and first follow-up (when hardcopy surveys were employed) for the purpose of identifying out-of-range responses.

- -6 "Multiple Response." This reserve code was not used in the third follow-up and is retained for prior-round data.
- -7 "Not administered, abbreviated interview or breakoff." Filled for abbreviated interview respondents for questions not included in the abbreviated questionnaire or for questions that are not answered because the respondent has broken off the interview without completing it.
- -8 "Survey component legitimate skip/NA." Filled for all variables across the entire instrument when a sample member does not apply to a particular instrument or round. It is similar to -4 in that it applies to all variables across an entire instrument; however, the reason is different in that the sample member never had the chance to respond.
- -9 "Missing." Filled for questions that are not answered when the routing suggests that respondents should have responded.

It should be noted that, to better distinguish reserve codes from valid (negative) scale values, the reserve codes used for three third follow-up index/scale score variables (F3JOBSUPP, F3JOBSATIS, and F3JOBPERSIST) are slightly different than those normally used in other ELS:2002 variables. Specifically, -33 is used instead of -3 to denote "item legitimate skip"; -44 is used instead of -4 to denote "nonrespondent"; -88 is used instead of -8 to denote "survey component legitimate skip/NA"; and -99 is used instead of -9 to denote "missing."

7.3.2 Variable Naming Conventions

Data users should find naming conventions for variables, flags, and weights intuitive. Most variables begin with an indicator of the round (i.e., base-year variables begin with BY, first follow-up with F1, second follow-up with F2, and third follow-up with F3). Weights follow the same round-naming convention and also contain the suffix WT (e.g., BYSTUWT is the name for the final student weight for base-year questionnaire completion, F3QWT is the equivalent third follow-up questionnaire completion weight, F2QWT is the equivalent second follow-up questionnaire completion weight, and BYSCHWT is the name for the base-year final school weight).

In the base year and first follow-up (but not the second and third follow-ups), variable names also distinguish (in their third character) between components and questionnaire types. F1S, for example, indicates a first follow-up student questionnaire variable, whereas F1A stands for administrator questionnaire items, and F1D refers to the "out of school" (dropout) questionnaire.

Variables that reflect specific items in the questionnaire carry the question number in the variable name, immediately after the component indicator. Hence, F1S58 would be item 58 from the first follow-up student questionnaire, and F1D19 would be item 19 in the dropout instrument.

The round-specific constructed variables are typically not anchored in a single questionnaire item and may sometimes reflect nonquestionnaire sources of information, such as the assessments. First follow-up test scores carry the prefix F1TX. F1TXMQU, for example, indicates the quartile score for the first follow-up mathematics test. Flags are indicated by the suffix FLG or FG. Variable names also distinguish between the public (P) and restricted (R) use forms, where variables differ between them (the base-year, first follow-up, and second follow-up public-use variables are a subset of the restricted-use superset). It should be noted that variables new to the third follow-up do not have independent restricted-use and public-use versions, rather restricted-use data are suppressed or recoded as needed for inclusion on public-use data products; these third follow-up variables have the same variable names on the restricted-use and public-use data files.

Finally, some slightly different information is included in second and third follow-up variable names. In the base year and first follow-up, variable names contain a letter to reference a questionnaire (e.g., S = Student) in addition to the round prefix (BY or F1) and frequently reference the question number (composite and transcript variables do not link to specific questionnaire items so they contain a descriptive reference). The second and third follow-up instruments are electronic questionnaires with many pathways; there is no fixed hardcopy questionnaire nor question numbers. However, a sequential number within each section or thematic area has been assigned to each item from the interview. Whenever possible, second and third follow-up variable names were constructed as (using third follow-up as an example) F3{Section Letter}{Sequential Number}{sub-item letter if applicable}.The applicable section letters for the second follow-up round are as follows:

- A—High school section;
- B—Postsecondary section;
- C—Employment section; and
- D—Community section.

The applicable section letters for the third follow-up round are as follows:

- A—Current Activities and Education section;
- B—Current Employment section;
- C—Employment History and Future section; and
- D—Family and Community section.

Variables that do not follow the sequential numbering naming convention are:

- Postsecondary student-institution variables—These variables were obtained at the respondent level and contain information associated with each respondent-identified institution. The final file contains one record for each of the institutions that the respondent identified in the interview. The variables are named with a descriptive reference, where the prefix “F2I” is applied to variables belonging to the second follow-

up student-institution file and "F3I" is applied to third follow-up student-institution file variables.

- Composites—These variables were given terse, descriptive names (with similar descriptive names used across rounds as applicable), prefixed with the round indicator (i.e., BY, F1, F2, F3).
- Extant data file variables:
  - CPS data, *academic years 2004–05 to 2006–07*—For the CPS files that were introduced in the base-year to second follow-up data files (academic years 2004–05, 2005–06, and 2006–07), variables were assigned a prefix beginning with "C" (taken from the acronym "CPS") followed by 2 digits consistent with the latter year of the applicable academic year span. For example, the name of a variable belonging to the CPS 2004–05 file would begin with the prefix "C05." The remainder of the variable name comprises a 3-digit number that is consistent with the file position of that particular field on the raw source file it was imported from. For example, if the 21st variable on the raw CPS 2004–05 source file was selected for inclusion in the data file, the resulting variable name would be "C05021" (C {2-digit academic year}{3-digit file position}).
  - CPS data, *academic years 2009–10 to 2012–13*—The naming convention for variables belonging to CPS files introduced in the third follow-up (academic years 2009–10 through 2012–13) have a slightly different naming convention than the one applied to CPS variables imported as of the second follow-up. The variable prefix is consistent with previously imported variables, where the prefix comprises a leading "C" (taken from the acronym "CPS") followed by 2 digits consistent with the latter year of the applicable academic year span. The remaining portion of the variable name is descriptive in nature. For example, the field associated with the student's state of legal residence, imported from the raw CPS 2010–11 source file, is named C11STATE (C {2-digit academic year}{descriptive string}).
  - NSLDS Pell data—The variables belonging to the NSLDS Pell file do not abide by a formal naming convention. The names are purely descriptive in nature. For example, the variable pertaining to "Highest cost of attendance" is named HICOA.
  - NSLDS Loan data—The variables belonging to the NSLDS Loan file do not abide by a formal naming convention. The names are purely descriptive in nature. For example, the variable pertaining to "Current loan status date" is named LNSTDATE.
  - Blended Test scores/ACT-SAT Concordance—The naming convention for the test score variables comprises two portions, the first of which is a variable prefix. The prefix begins with "TX" (representing "test") followed by a string that is descriptive in nature. For example, the variable associated with the "Most recent ACT composite score" is named TXACTC (TX {descriptive string}).

- GED data—The naming convention for variables imported from GED comprise two portions, the first of which is a variable prefix. The prefix begins with "GED," consistent with the source acronym, followed by a string that is descriptive in nature. For example, the field associated with the "Date passed GED test" is named GEDPASDT (GED {descriptive string}).

7.3.3 Composite Variables

Composite variables—also called constructed, derived, or created variables—are usually generated using responses from two or more questionnaire items or from recoding of a variable (typically for disclosure avoidance reasons). Some are copied from another source (e.g., a variable supplied in sampling or imported from an external database). Examples of composite variables include school variables (school sector, urbanicity, region of the country), math assessment scores (achievement quintile in math), and demographic variables (sex, race, Hispanic ethnicity, and month and year of birth).

The base-year to third follow-up data file includes many composite variables for the convenience of data users. Composite variables combine or reorganize data, whereas survey variables (that is, using the third follow-up survey as an example, variables named with an "F3A," "F3B," "F3C," or "F3D" prefix) represent the data as they were collected in the interview. Most of the composite variables can be used as classification variables or independent variables in data analysis. For better estimation in analysis, many of the composites have undergone imputation procedures for missing data (all imputed versions of variables have been flagged and are available in composite variables that are named with an "IM" suffix).

7.4 Analyzing ELS:2002 Data

ELS:2002 is designed to produce accurate inference for three populations; 10th-grade students as of Spring 2002, 12th-grade students as of Spring 2004, and Spring 2002 10th-grade schools.

To analyze these populations, one must select one of the populations to analyze, identify the time periods over which to analyze that population, and identify an appropriate analysis weight.

7.4.1 Analyzing Spring 2002 10th-Grade Schools

There is only one analysis weight appropriate for analyzing the Spring 2002 10th-grade school population, the school weight (BYSCHWT) constructed in the base year. Longitudinal analyses (the base-year school 2 years later) of this school population may be carried out using this base-year weight, and associated base-year school-level data, combined with administrator responses and school-level transcript information collected in the first follow-up. As noted in chapter 6, analysis of base-year schools that incorporates data from the first, second, or third follow-up will support inference to a subpopulation of the base-year population of schools in 2002 containing a sophomore grade. In particular, the ELS:2002 sample of schools is not

representative of schools as of 2004 or any other year aside from 2002. Furthermore, the base-year school weight is not adjusted for school nonresponse in the first, second, or third follow-up nor is the weight adjusted for school closings.

7.4.2 Analyzing Spring 2002 10th-grade Students

Because the third follow-up student-level file contains records for individuals who were not in the 10th grade in Spring 2002 but were in the 12th grade in Spring 2004, analysts should first use the variable G10COHRT to restrict analysis to individuals who are in the population of Spring 2002 10th-grade students. The variable G10COHRT equals 1 if a student was in the 10th grade in Spring 2002 and equals 0 if a student was not in the 10th grade in Spring 2002.

In addition to using G10COHRT = 1 to restrict analysis to appropriate individuals, analysts should identify the time period(s) for which analysis will be conducted. A variety of analysis weights have been constructed that support analyzing the 10th-grade cohort over various time periods. The possible time periods and the appropriate analysis weights are shown in table 44. Note that no specific analysis weight was constructed to analyze the Spring 2002 10th-grade population for some particular combinations of response across the rounds of ELS:2002.

Table 44. Selecting weights to analyze Spring 2002 10th-grade population

BY	F1	F2	F3	TR	Available analysis weight(s)	Optional weights*
No response data used, only whole population composites						
0	0	0	0	1	F1TRSCWT(#)	
Response data from single wave						
1	0	0	0	0	BYSTUWT, BYEXPWT	
0	1	0	0	0	F1QWT, F1EXPWT	
0	0	1	0	0	F2QWT	
0	0	1	0	1	F2QTSCWT	
0	0	0	1	0	F3QWT	
0	0	0	1	1	F3QTSCWT	
Response data from multiple waves						
1	1	0	0	0	F1PNLWT, F1XPNLWT	
1	1	0	0	1	No specific analysis weight	F1TRSCWT(*), F1PNLWT, F1XPNLWT
1	0	1	0	0	F2BYWT	
1	0	1	0	1	No specific analysis weight	F2QTRSCWT(*), F2BYWT
1	0	0	1	0	F3BYPNLWT	
1	0	0	1	1	F3BYTSCWT	
1	1	1	0	0	No specific analysis weight	F2F1WT(*), F2BYWT
1	1	1	0	1	No specific analysis weight	F2QTRSCWT(*), F2F1WT, F2BYWT
1	1	0	1	0	No specific analysis weight	F3BYPNLWT(*), F3F1PNLWT
1	1	0	1	1	No specific analysis weight	F3QTRSCWT(*), F3BYPNLWT(*), F3F1PNLWT
1	0	1	1	0	No specific analysis weight	F3BYPNLWT(*)
1	0	1	1	1	No specific analysis weight	F3BYTSCWT(*), F3BYPNLWT
1	1	1	1	0	No specific analysis weight	F3BYPNLWT(*), F3F1PNLWT
1	1	1	1	1	No specific analysis weight	F3BYTSCWT(*), F3BYPNLWT, F3F1PNLWT
0	1	1	0	0	F2F1WT	
0	1	1	0	1	No specific analysis weight	F3QTSCWT(*), F2F1WT
0	1	0	1	0	F3F1PNLWT	
0	1	0	1	1	F3F1TSCWT	
0	0	1	1	0	No specific analysis weight	F3QWT(*)
0	0	1	1	1	No specific analysis weight	F3QTSCWT(*), F3QWT
0	1	1	1	0	No specific analysis weight	F3F1PNLWT(*)
0	1	1	1	1	No specific analysis weight	F3F1TSCWT(*), F3F1PNLWT(*)

* Denotes weight that maximizes number of records.
# F1TRSCWT is defined for base-year or first follow-up respondents as well as first follow-up questionnaire-incapable sample members who have high school transcript data collected during the first follow-up so some sample members who have a nonmissing value for this weight would not be included in analyses that incorporate first follow-up interview data.
NOTE: BY = base year. F1 = first follow-up. F2 = second follow-up. F3 = third follow-up. TR = transcript.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

For any given response pattern across the four ELS:2002 study rounds, the analysis weights that were specifically constructed to be representative of the Spring 2002 10th-grade cohort using individuals who exhibited that particular response are listed in the column labeled "Available analysis weights." There are two reasons multiple weights may be available. One weight was constructed to account for student nonresponse at various rounds and another weight was constructed to account for schools that did not participate in providing student transcript information. Additional weights were also constructed to allow analysts to include or exclude questionnaire-incapable students. Where no specific analysis weights were constructed, such as for individuals who responded in all four rounds, the set of potential weights that could be used with these individuals is given in the column labeled "Optional weights." The weight marked with an asterisk, in any given row, denotes the weight that provides the most records to use in an analysis that incorporates data from the rounds identified in the first five columns of that row.

7.4.3 Analyzing Spring 2004 12th-grade Students

Because the third follow-up student-level file contains records for individuals who were not in the 12th grade in Spring 2004 but were in the 10th grade in Spring 2002, analysts should first use the variable G12COHRT to restrict analysis to individuals who are in the population of Spring 2004 12th-grade students. Note that some individuals were not classified as members of the 12th grade in Spring 2004 as of the first follow-up but were determined to be members of that population during the second follow-up. Because analysis of the 12th-grade population using first follow-up weights is intrinsically tied to the identification of members of the 12th-grade population as of the first follow-up, the value of G12COHRT was changed from 0 to 2 for individuals not classified as part of the 12th-grade population during the first follow-up but who were subsequently classified as part of the 12th-grade population for the second follow-up. When using first follow-up weights to analyze the 12th-grade population, records should be restricted to those where G12COHRT = 1 but, when using second or third follow-up weights, records should also include those records where G12COHRT = 2.

In addition to using G12COHRT to restrict analysis to appropriate individuals, analysts should identify the time period(s) for which analysis will be conducted. A variety of analysis weights have been constructed that support analyzing the 12th-grade cohort over various time periods. The possible time periods and the appropriate analysis weight are shown in table 45.

Table 45. Selecting weights to analyze Spring 2004 12th-grade population

BY	F1	F2	F3	TR	Available analysis weight(s)	Optional weights*
No response data used, only whole population composites						
0	0	0	0	1	F1TRSCWT(#)	
Response data from single wave						
1	0	0	0	0	Not applicable	
0	1	0	0	0	F1QWT, F1EXPWT	
0	0	1	0	0	F2QWT	
0	0	1	0	1	F2QTSCWT	
0	0	0	1	0	F3QWT	
0	0	0	1	1	F3QTSCWT	
Response data from multiple waves						
1	1	0	0	0	Not applicable	
1	1	0	0	1	Not applicable	
1	0	1	0	0	Not applicable	
1	0	1	0	1	Not applicable	
1	0	0	1	0	Not applicable	
1	0	0	1	1	Not applicable	
1	1	1	0	0	Not applicable	
1	1	1	0	1	Not applicable	
1	1	0	1	0	Not applicable	
1	1	0	1	1	Not applicable	
1	0	1	1	0	Not applicable	
1	0	1	1	1	Not applicable	
1	1	1	1	0	Not applicable	
1	1	1	1	1	Not applicable	
0	1	1	0	0	F2F1WT	
0	1	1	0	1	No specific analysis weight	F3QTSCWT(*), F2F1WT
0	1	0	1	0	F3F1PNLWT	
0	1	0	1	1	F3F1TSCWT	
0	0	1	1	0	No specific analysis weight	F3QWT(*)
0	0	1	1	1	No specific analysis weight	F3QTSCWT(*), F3QWT
0	1	1	1	0	No specific analysis weight	F3F1PNLWT(*)
0	1	1	1	1	No specific analysis weight	F3F1TSCWT(*), F3F1PNLWT(*)

* Denotes weight that maximizes number of records.

F1TRSCWT is defined for base-year or first follow-up respondents as well as first follow-up questionnaire-incapable sample members who have transcript data collected during the first follow-up so some sample members who have a nonmissing value for this weight would not be included in analyses that incorporate first follow-up interview data.

NOTE: BY = base year. F1 = first follow-up. F2 = second follow-up. F3 = third follow-up. TR = transcript.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), Third Follow-up, 2012.

For any given response pattern across the four ELS:2002 study rounds, the analysis weights that were specifically constructed to be representative of the Spring 2004 12th-grade cohort using individuals who exhibited that particular response are given in the column labeled "Available analysis weights." There are two reasons multiple weights may be available; some weights were constructed that excluded questionnaire-incapable students and some weights were

constructed to generalize to the 12th-grade cohort using only individuals with high school transcript data.

Where no specific analysis weights were constructed, such as for individuals who responded in all four rounds of ELS:2002, the set of potential weights that could be used with these individuals are given in the column labeled "Optional weights." The weight marked with an asterisk, in any given row, denotes the weight that provides the most records to use in an analysis that incorporates data from the rounds identified in the first five columns of that row.

7.4.4 Notes on Selecting Weights for Analysis

There are four general steps required to identify an appropriate weight for a particular analysis. These four steps are listed below followed by some examples of additional considerations that may be required, especially when trying to identify an appropriate weight when no specific analysis weight was constructed for a particular analysis.

- Identify the cohort of interest and refer to the appropriate tables in sections 7.4.2 and 7.4.3 to identify the subset of all possible weights that may be used to make inference about that cohort. Also ensure that the appropriate cohort flag variable is used to restrict analysis to the individuals in the cohort of interest.
- Identify the time periods that contain data that are to be used in analysis and refer to the appropriate table in sections 7.4.2 and 7.4.3 to identify the available appropriate weights.[44]
- If multiple weights are available for the given cohort and time period, select one weight for analysis by, for example, reviewing table 21 in section 6.2.2.5, which lists all weights and identifies the sample members with a non-zero value for each weight.
- Examine the potential weights and other data to be used in analysis to identify missing data patterns. Missing data patterns may lead to the rejection of some weights from consideration.

There are three topics associated with the ELS:2002 sample that warrant specific discussion because of their impact on weight construction and, therefore, on the appropriateness of weights for particular analyses. These three topics are sample freshening, expanded sample members, and high school transcript data collection.

7.4.4.1 Sample Freshening and First Follow-up New Participant Supplement

Sample freshening occurred in the ELS:2002 first follow-up supplement the existing ELS:2002 base-year sample so that the updated sample would be representative of the Spring 2004 12th-grade population as well as the original Spring 2002 10th-grade population. This freshening of the ELS:2002 base-year sample introduced some nuances that bear additional

[44] If analysis only uses data from a single time point, then a weight is available to support that analysis. As a general rule, if analyzing data from multiple time points, consider using weights constructed for the latest time point.

discussion. The individuals added to the ELS:2002 sample in the first follow-up represent that portion of the 2004 senior population who were not in the 10th grade in 2002. The freshened sample members are not part of the 10th-grade cohort but are part of the 12th-grade cohort. Because the freshened sample members did not participate in the base year, a supplemental questionnaire was used in the first follow-up to try and collect a minimum amount of information from them.

The new participant supplement was also used to collect information in the first follow-up from base-year nonrespondents. An example of the impact of the new participant supplement on weight construction arises when considering the two weights F1QWT and F1PNLWT for use in analysis of the 10th-grade cohort. The weight, F1PNLWT, will exclude first follow-up respondents who did not respond in the base year. The single round weight, F1QWT, will, however, include base-year nonrespondents who responded in the first follow-up. Both weights may be used to analyze the 10th-grade cohort but may produce different estimates for specific analyses not just because of the difference between a longitudinal and a single round weight but also because of inclusion of base-year nonrespondents in the first follow-up.

7.4.4.2 Expanded Sample Members

In each round of ELS:2002, some sample members were questionnaire-incapable; however, additional information was often collected from other sources for those sample members. To support analyses of the data that were collected on questionnaire-incapable sample members, expanded sample weights were constructed in some rounds. These expanded sample weights are non-zero for respondents as well as questionnaire-incapable sample members.

As illustration, consider two weights constructed in the first follow-up to permit analysis of the 10th- and 12th-grade cohorts as of the first follow-up: F1QWT and F1EXPWT. The two weights have non-zero values for slightly different sets of first follow-up respondents. Students who responded in the first follow-up or were questionnaire-incapable for the first follow-up have a non-zero value for F1EXPWT. Students who responded in the first follow-up have a non-zero value for F1QWT but students who were questionnaire-incapable for the first follow-up have a zero value for F1QWT.

The second and third follow-up weights are set to zero for students who were questionnaire-incapable as of the corresponding study round. For example, F2QWT is set to 0 for sample members who were questionnaire-incapable as of the second follow-up and F2QWT is designed to represent that population of capable students as of the second follow-up. Note that the questionnaire capability status of students may change over time so students may be represented in some rounds and not other rounds.

7.4.4.3 High School Transcripts

High school transcripts were collected after the first follow-up for base-year respondents as well as first follow-up respondents. A series of high school transcript weights were

constructed in the first, second, and third follow-up to support the analysis of transcript data along with interview data.

F1TRSCWT is unique among the set of high school transcript weights in that it is non-zero for first follow-up respondents with transcript data and non-zero for first follow-up nonrespondents who responded in the base year but who also have transcript data. Because of its construction, some sample members with a non-zero value of this weight will not have first follow-up interview data so these sample members would drop out of an analysis that seeks to incorporate first follow-up interview data with transcript data. Care should be taken to consider the set of data to be used with the analysis weight F1TRSCWT to ensure that not too many records with a nonmissing weight value are excluded. As a general rule of thumb, F1TRSCWT will most likely be the best available weight to use when incorporating high school transcript data in analyses. Because F1TRSCWT is not adjusted to account for incomplete transcripts, only whether a transcript was provided, some additional analysis may be necessary to account for missing data in any given analysis.

7.4.4.4 Missing Data

The three topics discussed in brief above—sample freshening, expanded sample members, and high school transcripts—are designed to illustrate three specific considerations that deal with identification of missing data patterns. The choice of appropriate analysis weight must take into account not just the available weights but the set of data to be used in a given analysis. The relationships between response status, weights, and data should be reviewed to ensure that the selected weight is appropriate for the analysis at hand. The review of missing data patterns is most important when considering analyses that incorporate data collected across multiple ELS:2002 rounds.

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