NATIONAL CENTER FOR EDUCATION STATISTICS

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Teacher Followup Survey

Modeling Teacher Supply and Demand, with Commentary

U.S. Department of Education
Office of Educational Research and Improvement NCES 93-461

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June 1993

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For sale by the U.S. Government Printing Office
Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402-9328
ISBN 0-16-041825-9

Foreword

An important purpose of the Schools and Staffing Survey (SASS) and the Teacher Followup Survey (TFS) was to provide the research community with data useful for analyzing teacher demand and supply. This report 1) summarizes the important issues related to teacher supply and demand; 2) presents descriptive statistics on those aspects of supply and demand that can be addressed with SASS and TFS; and 3) develops and tests multivariate models to identify the teacher, school, and district characteristics most closely related to staying in and leaving teaching.

This report is one of a series of Research and Development (R & D) reports that have been issued by the National Center for Education Statistics. The series was initiated:

1) To share studies and research that are developmental in nature. The results of such studies may be revised as the work continues and additional data become available.

2) To share studies which are, to some extent, on the "cutting-edge" of methodological developments. Emerging analytical approaches and new computer software development often permit new, and sometimes controversial, analysis to be done. By participating in "frontier research," we hope to contribute to the resolution of issues and improved analysis.

3) To participate in discussions of emerging issues of interest to educational researchers, statisticians, and the Federal statistical community in general. Such reports may document workshops and symposiums sponsored by NCES to address methodological and analytical issues or may share and discuss issues regarding NCES practice, procedures, and standards.

The common theme in all three goals is that these reports present results or discussion that do not reach definitive conclusions at this point in time, either because the data are tentative, the methodology is new and developing, or the topic is one on which there are divergent views. Therefore the techniques and inferences made from the data are tentative and are subject to revision. To facilitate the process of closure on the issues, we invite comment, criticism and alternatives to what we have done. Such responses should be directed to:

Roger A. Herriot
Associate Commissioner
Statistical Standards and Methodology Division
National Center for Educational Statistics
555 New Jersey Avenue NW
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Acknowledgments

The authors wish to thank all those who contributed to the production of this report. Among MPR Associates staff, special mention goes to Ellen Liebman, for her very capable programming support; Phil Kaufman, for his technical assistance; and Andrea Livingston and Brett Threlkeld, for their careful editing of the manuscript.

Paul Planchon, Dan Kasprzyk, Marilyn McMillen, Chuck Hammer, and Stephen Broughman, of the Elementary and Secondary Education Statistics Division, reviewed the manuscript through several drafts. We would also like to acknowledge the helpful comments of the following reviewers from other NCES divisions who assisted us at various stages: Susan Ahmed and Debra Gerald, Statistical Standards and Methodology Division; and Shelley Burns, Mary Rollefson, and Nabeel Alsalam, Data Development Division. Others who provided advice include Steven Barro, SMB Research, Linda Darling-Hammond, Teachers' College, Columbia University; and Trond Peterson, University of California, Berkeley.

We would particularly like to thank the four consultants whose comments are included in this report for their thoughtful reviews: Bonnie Billingsley, Virginia Tech, College of Education; Keith Rust, Westat; Stanley Lemeshow, University of Massachusetts, Amherst; and Donald Ramirez, University of Virginia.

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Chapter 1

Introduction

Determining who is teaching our nation's youth and whether or not there will be enough well-trained teachers to meet the demand during the next decade are matters of utmost importance to educators, parents, policymakers, and others interested in educational issues. During the 1980s, as more children of the "baby boom" generation entered the school system and fewer college graduates chose teaching as a career, many feared that there would not be enough teachers for these children and that those who taught would be poorly prepared for their task.[1] Moreover, many worried that students would suffer due to increased class sizes and would be taught by teachers who knew little about their subject matter or pedagogy, resulting in lower student achievement and motivation, and ultimately, in lower intellectual, vocational, and civic abilities.[2]

These concerns prompted a flurry of studies on the supply and demand of teachers confirming that fewer and less qualified college graduates were choosing to teach, and spurred new data collection efforts at the national and state level to better monitor these trends.[3] More recent state-level research by Grissmer and Kirby suggests that teacher attrition is actually at its lowest point in years due to a maturing, stable teaching force and a drop in attrition rates among new teachers and women. However, attrition rates still vary among types of teachers, and while a massive shortage may not be likely in the next 10 years, many changes in the teaching force could occur as the current cohort of teachers begins to retire.[4] Consequently, continuing efforts are needed to identify and predict changes in the components of teacher supply and demand. The 1987–88 Schools and Staffing Survey (SASS), conducted by the National Center for Education Statistics (NCES), significantly increases the data available on teacher supply and demand. In fact, an entire questionnaire (Teacher Demand and Shortage) was distributed to public districts and private schools to collect information on various aspects of teacher supply and demand. Also, the Teacher Followup Survey (TFS), conducted 1 year after the SASS, focuses on why teachers leave the profession, and permits comparisons between teachers who stay in teaching and those who leave.

The purposes of this study were to 1) summarize the important issues related to teacher supply and demand; 2) present descriptive statistics on those aspects of supply and demand that can be addressed with SASS and TFS; and 3) develop and test multivariate models to identify the teacher, school, and district characteristics most closely related to staying in and leaving teaching. The tables with descriptive statistics were designed to help identify variables for the multivariate analysis.

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[1]Linda Darling-Hammond, *Beyond the Commission Reports: The Coming Crisis in Teaching* (Santa Monica: The RAND Corporation, 1984).

[2]Carnegie Forum on Education and the Economy, *A Nation Prepared: Teachers for the 21st Century*, the report of the Task Force on Teaching as a Profession (New York: The Carnegie Corporation, 1986).

[3]Dorothy M. Gilford and Ellen Tenenbaum, eds., *Precollege Science and Mathematics Teachers: Monitoring Supply, Demand, and Quality* (Washington, D.C.: National Academy Press, 1990); Gus W. Haggstrom, Linda Darling-Hammond, and David W. Grissmer, *Assessing Teacher Supply and Demand* (Santa Monica: The RAND Corporation, 1988); and Panel on Statistics on Supply and Demand for Precollege Science and Mathematics Teachers, *Toward Understanding Teacher Supply and Demand: Priorities for Research and Development, Interim Report* (Washington, D.C.: National Academy Press, 1987).

[4]David W. Grissmer and Sheila Nataraj Kirby, *Patterns of Attrition Among Indiana Teachers, 1965-1987* (Santa Monica: The RAND Corporation, 1992).

The data for the descriptive statistics and the multivariate analysis came from the 1987–88 Schools and Staffing Survey (SASS) and the Teacher Followup Survey (TFS).[5] The SASS sample included approximately 67,800 teachers, 12,800 schools, and 5,600 public school districts. The TFS included approximately 7,500 teachers. All teachers in the original SASS sample who were reported by their schools to have left teaching between 1987–88 and 1988–89 (a total of 2,500) were automatically included in the TFS sample. The other 5,000 teachers in the TFS sample were drawn from the SASS participants who remained in teaching.

The attempts to develop a multivariate model of teacher attrition were less successful than planned, and left many unanswered questions. Among these questions were which types of leavers to group together in a model, which independent variables to include, and how to interpret the logistic regression results. To help answer these questions, NCES solicited the assistance of four outside reviewers who are acknowledged experts in the areas of teacher supply and demand, statistics, and logistic regression analysis. Chapter 5 contains their comments. It is hoped that this report and the comments it generated will stimulate further discussion of these issues, and will lead to more successful multivariate analyses of teacher attrition in the future.

Chapter 2 of this report reviews the literature on teacher supply and demand and presents data from SASS on various components of teacher supply and demand and on indicators of shortages. Chapter 3 reviews various theories related to teacher attrition and describes attrition between 1987–88 and 1988–89 using data from SASS and TFS. Next, Chapter 4 describes our attempts to develop a multivariate model of teacher attrition, and discusses the sample chosen for analysis, the specific variables selected, the alternative models specified, and the results. Chapter 6 contains the reviewers' comments. Finally, Chapter 6 presents the conclusions.

[5]The tables in this report with descriptive statistics from SASS and TFS are also published, along with their standard errors, in National Center for Education Statistics, *Selected Tables on Teacher Supply and Demand: 1987–88 and 1988–89* (Washington, D.C., 1993).

Chapter 2

Teacher Supply and Demand

Estimates of teacher supply and demand have been developed for the nation as a whole, for states, and for smaller entities,[6] using different methods, depending upon available data. However, there are overall theoretical models of teacher supply and demand that guide all studies in principle, even though it is not always possible to estimate them with existing data. The Schools and Staffing Survey was developed to collect data on many components of these models.

While supply and demand are discussed separately here, they are closely interrelated. The same demographic, policy, social, and economic trends drive not only the components of teacher demand—student enrollments, class sizes, and teacher attrition—but also the determinants of teacher supply—the number of available continuing and prospective teachers and the attractiveness of teaching jobs. In addition, even though one could theoretically be higher than the other, the numbers of teachers demanded and supplied usually appear to balance out within schools. Shortages or surpluses are not often apparent numerically, because school districts do not allow classes of students to meet without teachers, and they do not assign teachers to classes without students. Instead, accommodations are made in class sizes, offerings, or in the qualifications of teachers hired for the available jobs, which are often used as indicators of shortages or surpluses of teachers.

Teacher Supply

There are four sources of teachers in any given year:[7] 1) continuing teachers, or stayers (those who are teaching in the same school as the previous year); 2) immigrant teachers, or movers (those who have moved from outside the local hiring level, which, depending on the level of the analysis, could be an academic subject, school, district, state, or nation); 3) new, first-time teachers (new teacher education graduates or others who have never taught); and 4) re-entrants (former teachers who were not teaching in the previous year). Equation (1) expresses the supply of teachers in the year *t*.

$$T(t) = C(t) + I(t) + N(t) + R(t); \quad (1)$$

where: T (t) = Teachers this year,
C (t) = Continuing teachers (stayers),
I (t) = Immigrants (movers),
N(t) = New (first-time) teachers:
recent teacher education or other college graduates and others who have never taught, and
R(t) = Re-entrants (former teachers).

[6]This discussion is based on the following sources, which can be consulted for more detailed information: Haggstrom, Darling-Hammond, and Grissmer; and Stephen M. Barro, "Models for Projecting Teacher Supply, Demand, and Quality: An Assessment of the State of the Art," in *Teacher Supply, Demand, and Quality: Policy Issues, Models, and Data Bases* (Washington, D.C.: National Academy Press, 1992).

[7]Haggstrom, Darling-Hammond, and Grissmer, 54–55.

For this analysis, immigrants (movers) were those who were teaching in a different school the previous year. During the 1987–88 school year, 89 percent of public school teachers were continuing teachers, 6 percent were movers, 2 percent were new teachers, and 3 percent were re-entrants (table 1). Among private school teachers, 82 percent were continuing teachers, 8 percent were movers, 6 percent were new teachers, and 5 percent were re-entrants.

Continuing and immigrant teachers are drawn from a clearly designated segment of the labor force—those who are currently teaching. First-time and re-entrant teachers, on the other hand, can come from a number of different sources. For example, in 1987–88, 61 percent of the 63,000 newly hired first-time teachers in the United States attended college the year before, 20 percent worked in non-teaching jobs, and 4 percent were homemakers. The rest were unemployed or in the military or their status was unknown (table 2). Of the 65,000 newly hired re-entrant teachers, 31 percent worked in non-teaching jobs, 26 percent were homemakers, and 12 percent attended college. The rest were unemployed or in the military or their status was unknown (table 3).

First-time and re-entrant teachers come from different educational backgrounds as well as different previous activities. For example, 39 percent of re-entrant newly hired public school teachers had a master's degree as their highest degree earned, compared with 8 percent of newly hired first-time public school teachers (table 4). The corresponding percentages for private school teachers were 19 percent and 8 percent.

After determining the proportion and training of the current teachers who come from each source, the next step is to determine the proportion from each source who are likely to become teachers in the future. As Barro points out, there are several reasons why information on the source of current teachers is not a sufficient indicator of the potentially available teachers from each source. First, there may have been more applicants than hires from any one source. Second, there may have been potential teachers from each source who did not apply, but might have applied under different conditions (if salaries had been higher, for example). Estimating the number of teachers potentially available from each source requires knowing the size of the population who could teach (continuing teachers, new teacher education graduates, other qualified college graduates, former teachers, and so on.), the proportion of this population who want to teach, and the proportion who would apply for a teaching position under current conditions.[8]

SASS and TFS data can be used to estimate the proportion of current teachers who were continuing teachers (stayers) or immigrant teachers (movers) between 1987–88 and 1988–89, and what proportion left teaching (leavers) (table 5). In addition, the Recent College Graduates Study (RCG) can be used to estimate the proportions of recent teacher education and other college graduates who became first-time teachers. Among 1985–86 bachelor's degree recipients, 11 percent were newly qualified teachers, and 61 percent of them taught in 1987 (table 6). However, estimating the proportions of other first-time teachers and of re-entrants from their source populations is not currently possible.[9] The rest of this section discusses how information can be used to partially predict the future supply of teachers from the available sources, and presents the limitations of these predictions.

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[8]Stephen M. Barro, *The State of the Art in Projecting Teacher Supply and Demand,* unpublished report prepared for the NAS Panel on Supply and Demand for Precollege Science and Mathematics Teachers (Washington, D.C.: SMB Research, Inc., 1986), 46–53.

[9]Haggstrom, Darling-Hammond, and Grissmer, 55.

Table 1—Number of teachers and percentage distribution of teachers by teacher status, by sector and selected school and teacher characteristics: 1987–88

	Number of teachers	Teacher status (percent)			
		Stayers	Movers	First-time teachers	Re-entrants
Total	2,334,499*	88.3	6.2	2.7	2.8
Public	2,089,158*	89.1	6.1	2.3	2.5
Region					
Northeast	440,932	90.4	5.3	1.7	2.6
Midwest	538,119	91.1	4.9	1.9	2.0
South	754,906	87.5	7.1	2.6	2.8
West	355,200	87.8	6.5	3.2	2.5
Teaching level and field					
Elementary	930,758	88.8	6.5	2.4	2.3
Secondary					
Math/computer science	142,767	90.2	4.7	3.0	2.0
Science	115,330	90.7	4.4	2.7	2.2
Other	704,343	91.0	4.7	1.9	2.3
Special education	195,960	82.1	10.7	2.7	4.5
Private	245,342*	81.6	7.5	5.7	5.1
Region					
Northeast	71,432	80.9	7.3	6.8	5.0
Midwest	66,811	83.2	6.4	6.3	4.1
South	70,916	82.5	7.3	4.1	6.1
West	36,183	78.5	10.3	5.7	5.5
Teaching level and field					
Elementary	128,925	80.9	8.1	5.7	5.3
Secondary					
Math/computer science	16,985	80.8	6.9	7.1	5.2
Science	16,042	82.3	6.8	7.5	3.4
Other	77,160	83.5	7.0	4.6	4.9
Special education	6,229	74.7	5.2	11.0	9.1

*The total number of teachers and the numbers of public and private school teachers are less than numbers based on the Teacher Questionnaire published elsewhere (2,630,335; 2,323,204; and 307,131) because teachers missing data on teacher status due to item nonresponse were not included in this table.

NOTE: Details may not add to totals due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires).

Table 2—Number of newly hired, first-time teachers and percentage distribution of newly hired first-time teachers by previous year's main activity, by sector and selected school and teacher characteristics: 1987–88

	Number of newly hired, first-time teachers*	Main activity during 1986-87 school year (percent)					
		Working/ not teaching	Attending college/ university	Home-making	Unemployed	Retired	Military/ unknown
Total	62,558	20.1	61.0	4.0	1.4	—	13.3
Public	48,546	17.7	62.9	3.6	1.6	—	14.2
Region							
Northeast	7,368	19.8	58.4	5.5	—	0.0	15.6
Midwest	10,308	18.1	63.5	—	—	0.0	16.6
South	19,584	14.7	68.2	5.0	1.4	—	10.5
West	11,287	21.1	55.9	2.2	3.3	0.0	17.5
Teaching level and field							
Elementary	22,400	14.0	62.1	4.9	1.0	0.0	18.0
Secondary							
Math/computer science	4,276	12.5	72.0	—	3.8	0.0	8.9
Science	3,147	23.6	65.1	—	—	0.0	9.9
Other	13,514	25.1	56.1	3.2	2.2	—	13.1
Special education	5,209	15.1	74.8	—	—	0.0	7.4
Sex							
Male	12,228	26.0	55.6	—	3.6	—	13.2
Female	36,161	15.0	65.2	4.4	0.9	0.0	14.5
Race–ethnicity							
Black, non-Hispanic	—	—	—	—	—	—	—
White, non-Hispanic	42,628	15.7	63.2	3.9	1.8	0.0	15.3
All others	2,547	30.9	64.2	0.0	0.0	0.0	4.8
Age							
Under 36 years	38,899	16.7	67.6	3.0	1.3	0.0	11.5
36–50 years	8,965	22.4	42.2	6.4	3.0	—	25.5
51 years or older	—	—	—	—	—	—	—
Private	14,012	28.5	54.7	5.5	0.8	—	10.4
Region							
Northeast	4,843	33.7	49.3	4.9	—	0.0	11.1
Midwest	4,204	22.5	59.8	7.2	0.0	0.0	10.6
South	2,908	31.7	48.6	7.5	—	—	11.0
West	2,057	24.2	65.9	—	—	0.0	7.5

Table 2—Number of newly hired, first-time teachers and percentage distribution of newly hired first-time teachers by previous year's main activity, by sector and selected school and teacher characteristics: 1987–88—Continued

	Number of newly hired, first-time teachers*	Main activity during 1986–87 school year (percent)					
		Working/ not teaching	Attending college/ university	Home-making	Unemployed	Retired	Military/ unknown
Teaching level and field							
Elementary	7,337	24.7	56.2	8.0	—	0.0	9.9
Secondary							
Math/computer science	—	—	—	—	—	—	—
Science	—	—	—	—	—	—	—
Other	3,579	47.3	41.9	—	—	—	7.6
Special education	—	—	—	—	—	—	—
Sex							
Male	3,850	46.3	44.5	0.0	0.0	—	8.9
Female	10,162	21.8	58.6	7.5	1.1	0.0	11.0
Race–ethnicity							
Black, non-Hispanic	—	—	—	—	—	—	—
White, non-Hispanic	12,844	28.5	54.6	5.2	0.9	0.0	10.8
All others	—	—	—	—	—	—	—
Age							
Under 36 years	12,398	27.4	59.1	2.2	—	0.0	10.8
36–50 years	1,395	31.9	23.1	35.6	—	0.0	6.4
51 years or older	—	—	—	—	—	—	—

—Too few cases for a reliable estimate.
*Includes teachers who reported that 1987–88 was the year in which they began their first full-time teaching position at the elementary or secondary level and that teaching at the elementary or secondary level was not their main activity in 1986–87.

NOTE: Details may not add to totals due to rounding or cell suppression.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires).

Table 3—Number of newly hired, re-entrant teachers and percentage distribution of newly hired, re-entrant teachers by previous year's main activity, by sector and selected school and teacher characteristics: 1987–88

	Number of newly hired, re-entrant teachers*	Main activity during 1986–87 school year (percent)					
		Working/ not teaching	Attending college/ university	Home-making	Unemployed	Retired	Military/ unknown
Total	65,168	31.0	12.0	26.4	1.9	2.0	26.6
Public	52,589	30.0	11.4	27.0	1.8	0.5	29.3
Region							
Northeast	11,667	20.4	14.4	34.3	0.0		30.9
Midwest	10,771	26.7	10.5	27.3	3.6	—	31.8
South	21,109	39.2	6.3	25.7	2.1	—	26.3
West	9,041	24.9	20.4	20.3	1.6	—	31.1
Teaching level and field							
Elementary	21,866	23.0	7.7	38.4	1.2	0.7	28.9
Secondary							
Math/computer science	2,907	35.3	12.3	13.4	—	0.0	37.8
Science	2,531	38.7	23.3	17.1	—	0.0	18.9
Other	16,465	40.1	9.4	17.8	0.9	—	31.4
Special education	8,819	24.2	20.4	23.2	5.3	—	26.4
Sex							
Male	12,398	51.5	8.7	—	3.5	1.3	34.6
Female	39,935	23.5	12.2	34.9	1.3	—	27.8
Race–ethnicity							
Black, non-Hispanic	3,841	52.1	11.6	8.8	—	0.0	23.7
White, non-Hispanic	44,615	27.7	10.8	28.0	1.8	0.6	31.0
All others	2,327	45.2	15.8	23.0	0.0	0.0	15.9
Age							
Under 36 years	18,576	27.4	12.8	30.3	3.2	0.0	26.3
36–50 years	28,330	30.3	11.6	27.9	1.3	0.0	28.9
51 years or older	5,073	39.2	4.8	8.3	0.0	5.3	42.5
Full-time experience							
Less than 5 years	10,637	32.5	18.0	19.6	1.5	0.0	28.5
5–14 years	28,953	27.7	11.0	37.0	2.4	—	21.8
15 years or more	12,877	33.3	6.9	10.6	1.0	1.7	46.6

Table 3—Number of newly hired, re-entrant teachers and percentage distribution of newly hired, re-entrant teachers by previous year's main activity, by sector and selected school and teacher characteristics: 1987–88—Continued

	Number of newly hired, re-entrant teachers*	Main activity during 1986–87 school year (percent)					
		Working/ not teaching	Attending college/ university	Home-making	Unemployed	Retired	Military/ unknown
Private	12,579	35.3	14.8	23.6	2.4	8.4	15.5
Region							
Northeast	3,569	43.5	13.4	18.1	—	—	20.0
Midwest	2,717	22.7	15.9	37.6	2.3	0.0	21.4
South	4,319	30.2	15.3	21.7	—	—	9.3
West	1,974	48.5	14.7	18.8	—	0.0	12.7
Teaching level and field							
Elementary	6,823	24.0	13.2	35.2	2.5	—	12.3
Secondary							
Math/computer science	—	—	—	—	—	—	—
Science	—	—	—	—	—	—	—
Other	3,761	47.2	13.1	10.8	—	5.1	23.3
Special education	—	—	—	—	—	—	—
Sex							
Male	2,012	49.6	27.1	0.0	—	—	8.9
Female	10,567	32.5	12.4	28.1	1.9	—	16.8
Race–ethnicity							
Black, non-Hispanic	—	—	—	—	—	—	—
White, non-Hispanic	11,818	35.5	14.5	23.5	2.5	8.9	15.0
All others	—	—	—	—	—	—	—
Age							
Under 36 years	4,573	42.7	21.9	19.9	1.4	0.0	14.1
36–50 years	6,060	34.0	10.6	32.0	2.7	—	19.9
51 years or older	—	—	—	—	—	—	—
Full-time experience							
Less than 5 years	4,091	44.3	16.9	20.8	—	—	14.1
5–14 years	6,539	30.6	17.9	30.1	1.5	—	19.1
15 years or more	—	—	—	—	—	—	—

—Too few cases for a reliable estimate.
*Includes teachers who reported that the year in which they began their first full-time teaching position at the elementary or secondary level was prior to 1987–88 and that teaching at the elementary or secondary level was not their main activity in 1986–87.

NOTE: Details may not add to totals due to rounding or cell suppression.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires).

Table 4—Number of teachers and percentage distribution of teachers by highest degree earned, by sector and teacher status: 1987–88

	Number of teachers	Highest degree earned (percent)					
		AA/AS	BA/BS in education	BA/BS not in education	MA/MS in education	MA/MS not in education	Higher degree
Total	2,315,209*	1.0	41.9	12.4	37.6	6.2	1.0
Public	2,070,634*	0.7	41.7	11.5	39.4	5.8	0.9
Teacher status							
Newly hired, first-time	48,129	1.4	64.6	20.5	8.3	4.4	0.7
Newly hired, re-entrant	51,599	0.4	42.5	9.1	39.4	6.4	2.2
Continuing	1,948,502	0.6	41.1	11.3	40.2	5.8	0.9
Private	244,575*	3.6	43.9	19.6	21.7	9.5	1.7
Teacher status							
Newly hired, first-time	13,971	6.2	50.9	29.6	7.5	4.3	1.5
Newly hired, re-entrant	12,442	1.1	53.5	16.2	18.5	8.8	—
Continuing	214,897	3.6	42.9	19.2	22.7	9.9	1.7

*The total number of teachers and the numbers of public and private school teachers are less than numbers based on the Teacher Questionnaire published elsewhere (2,630,335; 2,323,204; and 307,131) because teachers missing data on teacher status or highest degree earned due to item nonresponse were not included in this table.
—Too few cases for a reliable estimate.

NOTE: Details may not add to totals due to rounding or cell suppression.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires).

Table 5—Percentage distribution of 1987–88 teachers by 1988–89 teacher status, by sector: 1988–89

	Stayers	Movers	Leavers
Total	86.2	7.8	5.9
Public	87.2	7.5	5.3
Private	78.4	10.2	11.4

NOTE: Details may not add to totals due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Teacher Followup Survey, 1988–89.

Table 6—Number of 1985–86 bachelor's degree recipients, percentage and number who were newly-qualified teachers, and percentage of newly-qualified teachers who were teaching in 1987: 1987

	Total number of 1985–86 college graduates	Percentage who were newly qualified teachers	Number who were newly qualified graduates	Percentage of newly qualified teachers who taught in 1987
1985-86 college graduates	987,800	11.3	112,100	61.2

SOURCE: U. S. Department of Education, National Center for Education Statistics, Survey of Recent College Graduates, as reported in *New Teachers in the Job Market, 1987 Update,* Survey Report, July 1990, NCES, U. S. Department of Education, Tables 1 and 10.

Continuing Teachers

Continuing teachers (stayers) provide most of the current teachers in any given year. Of all of the sources, their number is the easiest to predict, because the population from which the supply is drawn (the total number of those teaching in the previous year) is known.[10] The proportion of teachers who continue varies from year to year depending on the number of teachers retiring, alternative labor market opportunities for teachers, and other factors.[11] Nevertheless, TFS data on the proportion of 1987–88 teachers who continued teaching in 1988–89 could be used as a beginning estimate of the rate at which teachers might be expected to continue from year to year.

Immigrants

Nationally, the number of immigrant teachers (movers) can be predicted based on the number of teachers who change schools. The potential population for this group is the same as that for continuing teachers—the total number teaching in the previous year. The proportion of teachers who change schools each year may fluctuate based on factors that may resemble or differ from those that influence whether all teachers continue teaching. The TFS provides data on the proportion of 1987–88 teachers who continued teaching, but were in different schools in 1988–89. However, it is impossible to use this estimate to predict the number of immigrant teachers who might be available to any given school, district, or state. To know the potential supply of movers for any given school, district, or state, a more extensive analysis of the source and destination of movers would be necessary.[12]

New (First-Time) Teachers: New Teacher Education and Other College Graduates

The potential supply of teachers from the population of new teacher education and other college graduates can be predicted with about the same degree of accuracy as the number of continuing teachers. Predicting the potential number of teachers in these two groups requires knowing the number in each group and the proportion who are likely to seek and obtain teaching jobs when they graduate. These data can be obtained from the NCES surveys of recent college

[10]Ibid., 29.

[11]Stephen M. Barro, "Models for Projecting Teacher Supply, Demand, and Quality: An Assessment of the State of the Art," chapter 3, 11–12.

[12]Haggstrom, Darling-Hammond, and Grissmer, 55.

graduates, which provide information on the proportion of teacher education and other college graduates who obtained teaching jobs.[13]

New (First-Time) Teachers: Past College Graduates

Using data on only recent college graduates to predict the potential supply of new teachers would lead to an underestimate.[14] Past graduates are a source as well. However, the number of teachers that might be supplied from all past college graduates is much more difficult to predict than the potential numbers of continuing teachers, immigrant teachers, or recent teacher education or college graduates, because past graduates are not located in institutions and we do not know under what conditions they might teach. While recent college graduates are enrolled in college and universities before they graduate and can be surveyed there, the proportion of past college graduates of all ages who might decide to enter teaching are located everywhere, and therefore cannot be estimated without a detailed national survey that identifies all past college graduates and determines who might be likely to teach under what conditions. NCES' Baccalaureate and Beyond Survey will provide information on the rate at which at least a portion of past graduates enter teaching.

Re-Entrants

Similarly, it is difficult to predict the proportion of former teachers who will re-enter teaching. Unless the population of all former teachers could be identified and a sample selected, it would not be possible to determine what proportion of this group would consider returning to teaching and under what circumstances.

Demand for New Teachers

Most of the need for teachers is met by continuing teachers. Following Haggstrom, Darling-Hammond, and Grissmer, the focus here is on the demand for *new* teachers, which can be expressed as the number of open positions filled with new hires plus the number of open positions that were left unfilled, as indicated by the number of unfilled vacancies, positions filled by a substitute, and/or positions abolished because a suitable candidate could not be found.[15] Thus, the demand for new teachers at time t can be expressed by equation (2).[16]

$$D(t) = F(t) + U(t); \quad (2)$$

where: D(t) = New demand,
F(t) = Filled positions: number of new hires, and
U(t) = Unfilled positions: vacant positions, full-time substitutes, and positions abolished.

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[13]The Recent College Graduates Study (RCG) surveyed graduates every several years from 1974–75 to 1990–91, and the Baccalaureate and Beyond Longitudinal Study (B&B) will survey graduates starting in 1992–93. Even these estimates are not entirely accurate about the availability of new college graduates for teaching. More graduates may have wanted to teach than those who actually obtained jobs.

[14]Barro, *The State of the Art in Projecting Teacher Supply and Demand,* 44–47.

[15]Haggstrom, Darling-Hammond, and Grissmer, 39.

[16]Ibid., 55–56.

The number of filled positions represents the "met demand," while the number of unfilled positions is the "unmet demand." Filled positions are easy to spot, and unfilled positions can be estimated by the number of unfilled vacancies, full-time substitutes, and positions abolished; however, the unmet demand is often masked by increasing student/teacher ratios or canceling classes.[17] For these reasons, schools and districts cannot always determine the exact number of positions that they could not fill. Nonetheless, theoretically total demand for new teachers consists of both met and unmet demand.

Table 7 shows that during 1987–88, approximately 260,000 teaching positions were open in the United States. Overall, 11 percent of them were unfilled (12 percent in public districts and 8 percent in private schools).

Several factors may produce a higher or lower total demand for new teachers from one year to the next, including growth or decline in enrollments, growth or decline in student/teacher ratios due to policy changes or shifts in course or staff requirements, and the loss, or attrition, of teachers from the previous year.[18] In 1986–87 and 1987–88, the student/teacher ratio was about 17 in both public districts and private schools (table 8). The demand for new teachers at time *t* can also be expressed as shown in equation (3).[19]

$$D(t) = G(t) + L(t); \quad (3)$$

where: $D(t)$ = New demand,
$G(t)$ = Changes due to growth or decline in enrollment, the student/teacher ratio, or staff requirements, and
$L(t)$ = Loss of teachers due to attrition.

Population and Policy Changes

As Haggstrom, Darling-Hammond, and Grissmer point out, these components of demand are relatively straightforward to *measure*, although the *prediction* of demand is more difficult. Enrollment changes reflect both population and migration shifts, and can be measured within schools and districts and predicted from population censuses and surveys. (Changes in fertility and migration are hard to predict, although the impact of fertility changes can be planned for given the 5-year lag between birth and school entry.) Similarly, changes in student/teacher ratios reflect either state and local mandates of this ratio, local policy changes, or local adjustments to respond to enrollment fluctuations. While the resulting changes can be measured within schools and districts, it is not possible to tell whether changes in this ratio are adjustments to enrollment changes, changes in policy, or both. Thus, it is difficult to predict future student/teacher ratios. Other mandated changes such as increases in high school graduation requirements can also be measured, although they cannot always be directly linked to immediate increases in the demand for teachers.[20]

[17]Ibid., 44; 56.
[18]Ibid., 39; 56–57.
[19]This equation is a modification of that in Haggstrom, Darling-Hammond, and Grissmer, 56–57.
[20]Ibid., 39–43.

Table 7—Number of open teaching positions and percentage distribution of open positions by filled status, by selected public district and private school characteristics: 1987–88

	Number of open positions	Filled status of open positions (percent)	
		Filled positions	Unfilled positions
Total	259,814	89.3	10.7
Public Districts	199,914	88.5	11.5
Region			
Northeast	33,475	83.7	16.3
Midwest	42,094	87.0	13.0
South	84,098	90.3	9.7
West	40,247	90.3	9.7
Free lunch eligibility			
Less than 20%	72,170	86.9	13.1
20–49%	88,987	89.0	11.0
50% or more	35,695	90.2	9.8
Minority enrollment			
Less than 5%	49,062	87.5	12.5
5–19%	46,415	90.9	9.1
20–49%	53,991	87.2	12.8
50% or more	50,114	88.8	11.2
Private Schools	59,899	92.1	7.9
Region			
Northeast	17,549	91.9	8.1
Midwest	15,458	91.3	8.7
South	16,479	92.0	8.0
West	10,414	93.7	6.3
Free lunch eligibility			
Less than 20%	11,364	92.0	8.0
20–49%	3,972	93.0	7.0
50% or more	3,559	90.2	9.8
Minority enrollment			
Less than 5%	24,243	93.1	6.9
5–19%	17,646	91.1	8.9
20–49%	7,663	91.5	8.5
50% or more	9,237	91.9	8.1

NOTE: Details may not add to totals due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (School and Teacher Demand and Shortage Questionnaires).

Table 8—Total number of students and full-time-equivalent (FTE) teachers, student/teacher ratio in 1986–87 and 1987–88, and percentage change between 1986–87 and 1987–88, by sector, region, and grade level: 1987–88

	Number				Ratio		Percent change	
	1986–87 students	1986–87 FTE teachers	1987–88 students	1987–88 FTE teachers	1986–87 students/ teacher	1987–88 students/ teacher	Change in number of students	Change in number of teachers
Total	45,156,131	2,590,806	45,411,325	2,638,931	17.4	17.2	0.6	1.9
Public districts	39,711,745	2,271,533	40,003,907	2,316,942	17.5	17.3	0.7	2.0
Region								
Northeast	7,506,182	495,318	7,471,702	504,973	15.2	14.8	–0.5	1.9
Midwest	9,902,433	579,680	9,903,336	583,141	17.1	17.0	0.0	0.6
South	14,047,961	802,577	14,206,503	824,531	17.5	17.2	1.1	2.7
West	8,255,169	393,978	8,422,366	404,296	21.0	20.8	2.0	2.6
Private schools	5,444,386	319,274	5,407,418	321,989	17.1	16.8	–0.7	0.9
Region								
Northeast	1,587,947	93,609	1,573,969	93,377	17.0	16.9	–0.9	–0.2
Midwest	1,551,901	85,579	1,535,368	86,492	18.1	17.8	–1.1	1.1
South	1,388,234	89,359	1,387,947	90,635	15.5	15.3	0.0	1.4
West	916,304	50,727	910,134	51,485	18.1	17.7	0.7	1.5
Grades K–6	24,825,174	1,315,494	25,319,370	1,353,119	18.9	18.7	2.0	2.9
Sector								
Public districts	21,506,954	1,143,722	21,977,234	1,177,869	18.8	18.7	2.2	3.0
Private schools	3,318,221	171,772	3,342,135	175,250	19.3	19.1	0.7	2.0
Grades 7–12	20,330,956	1,275,313	20,091,955	1,285,458	15.9	15.6	–1.2	0.8
Sector								
Public districts	18,204,791	1,127,811	18,026,672	1,138,720	16.1	15.8	–1.0	1.0
Private schools	2,126,165	147,502	2,065,283	146,737	14.4	14.1	–2.9	–0.5

NOTE: The number of full-time-equivalent teachers in this table was estimated using data from the Teacher Demand and Shortage Questionnaires and therefore differs from the number in table 1, which was estimated using data from the Teacher Questionnaires.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Demand and Shortage Questionnaires).

Teacher Attrition

A major determinant of new demand is the turnover, or attrition, of teachers. The attrition rate is defined as "the fraction or percentage of teachers employed in one period who are not employed as teachers in a subsequent period."[21] This attrition can be caused by teachers leaving teaching altogether (leavers) and by teachers leaving to teach in other schools (movers). The inclusion of movers in the attrition rate depends upon the unit of analysis. For instance, if the analysis is at the state level, movers who just change schools within the state can be seen as continuing teachers and do not count in the state attrition rate. On the other hand, if the analysis is at the school level, movers who leave to teach in other schools count as part of the school-level attrition rate. However, at every analysis level, it is best to examine the attrition of leavers and movers separately, because movers have different reasons for leaving their schools than do those who are leaving teaching altogether.[22] For that reason, movers are sometimes considered continuing teachers.

Teacher attrition can be involuntary, such as leaving due to layoffs or death, or voluntary, such as leaving for a different type of job or activity.[23] Reasons for voluntary attrition among leavers include going to school, working in another job, raising children, or retiring before the mandatory retirement age. Attrition due to retirement, disability, and death is relatively easy to predict if the ages of current teachers are known, although economic conditions can alter retirement patterns. Attrition due to layoffs and firings is more difficult to predict. Voluntary attrition is particularly difficult to predict, because it depends on a variety of factors such as teachers' personal situations, their working conditions, the economy, and the attractiveness and availability of alternatives to teaching. Moreover, these factors interact. For example, teachers who give birth may not leave at a consistently predictable rate. Whether they continue or leave teaching may depend on their working conditions, their need for income, and the availability of alternative jobs at the time they give birth. By 1988–89, 6 percent of those who were teaching in 1987–88 had left teaching (table 9).

Indicators of Shortages and Surpluses

Unfilled or abolished positions and the use of substitutes may indicate shortages in the number of available teachers with the desired qualifications, while layoffs may indicate overall surpluses (if they have been precipitated by enrollment declines). However, these measures are not reliable indicators, because unfilled or abolished positions as well as layoffs could be due to budget cuts rather than shortages or surpluses.[24] In addition, schools and districts do not always allow vacancies or layoffs to occur, even if there are shortages or surpluses.[25] If well-qualified teachers cannot be found to fill certain positions, schools and districts might prefer hiring teachers with less preparation or switching teachers from other fields, rather than leaving the positions unfilled. Thus, the qualifications of teachers for their assignments can be more reliable indicators of shortages or surpluses, and the differences between the qualifications of new hires and other teachers can highlight changes.[26]

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[21]Barro, *Models for Projecting Teacher Supply, Demand, and Quality,* 3-3.
[22]Ibid., 3-3–3-4.
[23]Ibid., 3-5–3-7.
[24]Haggstrom, Darling-Hammond, and Grissmer, 45–47.
[25]Barro, *The State of the Art in Projecting Teacher Supply and Demand,* 20–22; Haggstrom, Darling-Hammond, and Grissmer, 44.
[26]Haggstrom, Darling-Hammond, and Grissmer, 47–52; 71–72.

Table 9—Number of 1987–88 teachers and percentage distribution of 1987–88 teachers by 1988–89 teaching status and percentage distribution of those still teaching in 1988–89 by stayer/mover status, by sector and selected school and teacher characteristics: 1987–88 and 1988–89

	Number of 1987–88 teachers	1987–88 teachers		1987–88 teachers still teaching	
		Percent who left	Percent who still taught	Percent who stayed	Percent who moved
Total	2,406,193*	5.9	94.1	91.7	8.3
Public	2,151,619*	5.3	94.7	92.0	8.0
Region					
Northeast	458,728	4.4	95.6	94.6	5.4
Midwest	571,627	5.5	94.5	92.5	7.5
South	763,799	5.6	94.4	90.1	9.9
West	357,464	5.5	94.5	92.0	8.0
School level					
Elementary	1,136,413	5.0	95.0	91.2	8.8
Secondary	743,805	4.9	95.1	93.4	6.6
Combined/other	105,389	6.5	93.5	95.1	4.9
Community type					
Rural/farming	505,276	4.9	95.1	91.2	8.8
Small city	443,961	5.0	95.0	93.8	6.2
Suburban	527,705	4.7	95.3	91.9	8.1
Urban	508,665	5.5	94.5	92.3	7.7
Free lunch eligibility					
Less than 20%	836,187	5.1	94.9	93.3	6.7
20–49%	693,961	4.8	95.2	91.3	8.7
50% or more	414,150	5.5	94.5	91.3	8.7
Minority enrollment					
Less than 5%	644,058	4.9	95.1	92.7	7.3
5–19%	485,462	5.2	94.8	92.4	7.6
20–49%	441,002	4.5	95.5	92.6	7.4
50% or more	415,085	5.4	94.6	91.0	9.0

Table 9—Number of 1987–88 teachers and percentage distribution of 1987–88 teachers by 1988–89 teaching status and percentage distribution of those still teaching in 1988–89 by stayer/mover status, by sector and selected school and teacher characteristics: 1987–88 and 1988–89—Continued

	Number of 1987–88 teachers	1987–88 teachers		1987–88 teachers still teaching	
		Percent who left	Percent who still taught	Percent who stayed	Percent who moved
Teaching level and field					
Elementary	958,603	5.3	94.7	91.0	9.0
Secondary					
Math/computer science	140,044	5.2	94.8	95.0	5.0
Science	120,410	5.6	94.4	95.1	4.9
Other	726,844	5.1	94.9	93.8	6.2
Special education	204,399	5.8	94.2	86.7	13.3
Sex					
Male	644,885	4.7	95.3	92.7	7.3
Female	1,498,981	5.5	94.5	91.8	8.2
Race–ethnicity					
Black, non-Hispanic	165,055	4.1	95.9	90.8	9.2
White, non-Hispanic	1,842,502	5.5	94.5	92.1	7.9
All others	88,735	2.7	97.3	93.2	6.8
Full-time experience					
Less than 5 years	334,688	7.5	92.5	85.4	14.6
5–14 years	841,359	4.9	95.1	91.1	8.9
15 years or more	973,694	4.9	95.1	95.1	4.9
Private	254,575*	11.3	88.7	88.5	11.5
Region					
Northeast	80,897	9.6	90.4	87.4	12.6
Midwest	65,328	8.6	91.4	90.2	9.8
South	70,274	13.0	87.0	88.3	11.7
West	38,075	16.6	83.4	88.3	11.7
School level					
Elementary	118,176	10.0	90.0	87.0	13.0
Secondary	48,580	11.7	88.3	92.0	8.0
Combined/other	58,192	14.8	85.2	89.1	10.9
Community type					
Rural/farming	100,180	11.9	88.1	89.1	10.9
Small city	62,099	8.7	91.3	91.5	8.5
Suburban	43,970	10.6	89.4	87.0	13.0
Urban	18,699	21.9	78.1	79.1	20.9

Table 9—Number of 1987–88 teachers and percentage distribution of 1987–88 teachers by 1988–89 teaching status and percentage distribution of those still teaching in 1988–89 by stayer/mover status, by sector and selected school and teacher characteristics: 1987–88 and 1988–89—Continued

	Number of 1987–88 teachers	1987–88 teachers		1987–88 teachers still teaching	
		Percent who left	Percent who still taught	Percent who stayed	Percent who moved
Free lunch eligibility					
Less than 20%	49,362	8.3	91.7	90.9	9.1
20–49%	12,723	11.6	88.4	74.6	25.4
50% or more	11,133	11.0	89.0	77.8	22.2
Minority enrollment					
Less than 5%	97,932	10.8	89.2	89.7	10.3
5–19%	73,566	8.9	91.1	90.8	9.2
20–49%	24,782	22.3	77.7	85.1	14.9
50% or more	28,667	12.1	87.9	81.6	18.4
Teaching level and field					
Elementary	127,353	10.6	89.4	86.7	13.3
Secondary					
Math/computer science	16,908	10.9	89.1	85.6	14.4
Science	17,372	7.1	92.9	91.1	8.9
Other	84,870	13.0	87.0	92.4	7.6
Special education	8,073	15.5	84.5	76.3	23.7
Sex					
Male	55,187	9.4	90.6	93.3	6.7
Female	199,255	11.9	88.1	87.2	12.8
Race–ethnicity					
Black, non-Hispanic	2,629	35.1	64.9	—	—
White, non-Hispanic	237,717	10.7	89.3	89.2	10.8
All others	11,360	13.6	86.4	88.0	12.0
Full-time experience					
Less than 5 years	70,216	13.4	86.6	83.6	16.4
5-14 years	108,653	13.0	87.0	88.3	11.7
15 years or more	74,273	7.2	92.8	93.1	6.9

—Too few cases for a reliable estimate.
*The total number of teachers and the numbers of public and private school teachers are less than numbers based on the Teacher Followup Survey published elsewhere (2,699,098; 2,387,174; and 311,924) because teachers missing data on row school or teacher characteristics or on teaching status due to item nonresponse were not included in this table.
NOTE: Details may not add to totals due to rounding or cell suppression.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires) and Teacher Followup Survey, 1988–89.

Specific indicators might include the percentages of teachers and new hires with standard certificates in the field they teach, the percentages certified in any field and the percentages with standard, probationary, or temporary certification.[27] These indicators show the extent to which qualified teachers could be found to fill the positions, how difficult it was to find teachers with standard certification, and to what extent schools granted temporary certificates in order to fill vacancies. Since certification requirements and procedures for probationary and temporary certification vary by state, these indicators must be reported by state. However, if these indicators are also reported by teaching field, they can help pinpoint those areas where efforts should be made to generate a greater supply of teachers.

SASS provides data on all these indicators of shortages and surpluses, and some of them are reported by teaching field. In addition to the numbers of filled and unfilled positions reported earlier in the demand section, private schools and public districts report the percentage of new and all teachers with standard credentials in their fields. Teachers also provide detailed information on their qualifications, including the type of certification in the primary and secondary fields in which they were teaching. Tables 10 and 11 show the percentage of teachers who were new hires and the percentage who had standard certificates, by public district and private school characteristics and by state (for public school teachers). Table 12 shows the percentages of public school teachers with various types of credentials in their fields, by teaching level/field and by state.

[27]Ibid., 46; 71–72.

Table 10—Number of full-time-equivalent (FTE) teachers, percentage distribution of teachers by hiring status, and percentage of teachers with standard certification, by sector and selected public district and private school characteristics: 1987–88

	Number of 1987–88 FTE teachers	Hiring status (percent)		Percent with standard certification	
		Newly hired	Continuing teachers	All teachers	Newly hired teachers
Total	2,638,931	8.8	91.2	93.5	88.6
Public districts	2,316,942	7.6	92.4	95.4	92.6
Region					
Northeast	504,973	5.5	94.5	94.8	93.8
Midwest	583,141	6.3	93.7	98.2	98.1
South	824,531	9.2	90.8	94.2	91.2
West	404,296	9.0	91.0	94.5	89.3
Free lunch eligibility					
Less than 20%	861,137	7.3	92.7	96.3	94.7
20–49%	992,828	8.0	92.0	94.6	92.6
50% or more	433,841	7.4	92.6	95.1	88.5
Minority enrollment					
Less than 5%	648,653	6.6	93.4	97.5	95.9
5–19%	550,432	7.7	92.3	95.7	95.0
20–49%	533,054	8.8	91.2	95.1	91.5
50% or more	582,078	7.6	92.4	92.9	88.6
Private schools	321,989	17.1	82.9	79.9	75.7
Region					
Northeast	93,377	17.3	82.7	74.2	68.1
Midwest	86,492	16.3	83.7	88.3	85.6
South	90,635	16.7	83.3	79.3	74.9
West	51,485	18.9	81.1	77.2	75.2
Free lunch eligibility					
Less than 20%	66,555	15.7	84.3	86.8	84.8
20–49%	17,431	21.2	78.8	83.8	80.4
50% or more	17,073	18.8	81.2	72.1	66.5
Minority enrollment					
Less than 5%	134,075	16.8	83.2	82.1	79.2
5–19%	98,215	16.4	83.6	80.6	74.8
20–49%	38,909	18.0	82.0	76.8	74.6
50% or more	42,381	20.0	80.0	74.2	69.4

NOTE: Details may not add to totals due to rounding. The number of full-time-equivalent teachers in this table was estimated using data from the Teacher Demand and Shortage Questionnaires and therefore differs from the number in table 1, which was estimated using data from the Teacher Questionnaires. It differs from the number shown in table 7 (which was also estimated from the Teacher Demand and Shortage Questionnaires) because the number in table 7 includes pre-Kindergarten teachers.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Demand and Shortage Questionnaires).

Table 11—Number of full-time-equivalent (FTE) public school teachers, percentage distribution of teachers by hiring status, and percentage of teachers with standard certification, by state: 1987–88

	Number of FTE teachers	Hiring status (percent)		Percent with standard certification	
		Newly hired	Continuing teachers	All teachers	Newly hired teachers
Total	2,316,942	7.6	92.4	95.4	92.6
Alabama	36,983	7.8	92.2	92.4	90.4
Alaska	6,088	5.8	94.2	99.5	89.0
Arizona	27,596	11.8	88.2	99.5	99.4
Arkansas	29,543	12.3	87.7	96.7	96.1
California	203,036	8.4	91.6	93.3	84.1
Colorado	29,857	9.0	91.0	97.5	99.0
Connecticut	33,935	6.4	93.6	96.1	82.0
Delaware	6,579	5.4	94.6	87.9	95.4
District of Columbia	5,099	6.1	93.9	80.4	100.0
Florida	91,036	8.4	91.6	89.7	90.9
Georgia	63,730	12.3	87.7	95.6	96.3
Hawaii	8,677	9.6	90.4	100.0	100.0
Idaho	10,186	9.9	90.1	99.2	99.6
Illinois	108,747	5.5	94.5	99.2	98.8
Indiana	55,490	6.5	93.5	93.5	96.1
Iowa	33,233	6.7	93.3	98.9	96.8
Kansas	26,722	9.0	91.0	98.2	99.4
Kentucky	38,551	6.9	93.1	99.3	98.6
Louisiana	40,962	7.5	92.5	82.9	76.7
Maine	15,814	8.7	91.3	98.3	93.1
Maryland	32,626	8.0	92.0	97.5	85.7
Massachusetts	61,718	6.6	93.4	96.2	93.0
Michigan	81,963	4.4	95.6	99.0	98.1
Minnesota	42,414	7.3	92.7	98.7	99.0
Mississippi	26,772	8.7	91.3	96.8	97.8
Missouri	51,708	8.0	92.0	99.3	97.0
Montana	12,225	7.7	92.3	97.8	98.9
Nebraska	16,850	8.4	91.6	99.0	99.7
Nevada	7,731	13.2	86.8	96.4	82.2
New Hampshire	11,401	12.7	87.3	97.9	90.3
New Jersey	76,689	5.9	94.1	98.2	98.0
New Mexico	13,847	12.8	87.2	94.6	82.4
New York	186,059	5.5	94.5	97.5	94.1
North Carolina	62,583	9.1	90.9	97.3	98.5
North Dakota	8,052	5.5	94.5	99.0	99.7
Ohio	105,623	6.1	93.9	97.4	98.8
Oklahoma	38,449	6.0	94.0	98.7	94.9
Oregon	24,526	8.1	91.9	97.1	97.8
Pennsylvania	104,117	3.2	96.8	84.7	97.1
Rhode Island	9,012	4.1	95.9	98.9	—
South Carolina	34,255	9.6	90.4	97.7	95.4
South Dakota	8,649	8.5	91.5	99.0	99.6
Tennessee	45,722	6.3	93.7	92.9	95.7
Texas	183,932	11.9	88.1	96.5	86.5

Table 11—Number of full-time-equivalent (FTE) public school teachers, percentage distribution of teachers by hiring status, and percentage of teachers with standard certification, by state: 1987–88—Continued

	Number of FTE teachers	Hiring status (percent)		Percent with standard certification	
		Newly hired	Continuing teachers	All teachers	Newly hired teachers
Utah	15,751	12.3	87.7	80.7	95.3
Vermont	6,227	8.8	91.2	97.4	97.4
Virginia	65,076	8.1	91.9	89.5	89.9
Washington	38,031	8.1	91.9	92.8	94.7
West Virginia	22,632	5.3	94.7	92.3	87.9
Wisconsin	43,692	5.8	94.2	99.3	96.4
Wyoming	6,745	4.5	95.5	98.9	99.6

—Too few cases for a reliable estimate.

NOTE: Details may not add to totals due to rounding or cell suppression. Numbers and percentages for Delaware, the District of Columbia, Hawaii, Nevada, and West Virginia are universe figures because all school districts in these jurisdictions were included in the sample. Estimates for all other states except Maryland and Utah are based on samples of at least 30 cases. The number of sample cases is 18 for Maryland and 29 for Utah..

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Demand and Shortage Questionnaires).

Table 12—Percentage of public school teachers certified in their main and other assignment fields and percentage distribution of certified teachers by type of certification, by teaching level and field and by state: 1987–88

	Certified in main field	Type of certification			Certified another field	Type of certification		
		Standard	Probationary	Temporary		Standard	Probationary	Temporary
Total	97.5	91.6	2.9	5.4	65.0	91.1	3.4	5.5
Teaching level and field								
Elementary	98.2	90.8	2.7	6.4	49.5	89.9	3.7	6.4
Secondary								
Math/computer science	93.8	92.6	2.9	4.5	70.2	91.5	3.8	4.7
Science	96.5	91.7	3.8	4.5	76.2	91.8	3.7	4.6
Other	97.5	93.5	3.0	3.5	69.3	93.0	3.0	4.0
Special education	97.1	88.0	3.4	8.7	73.9	85.6	4.1	10.3
State								
Alabama	98.8	96.0	2.1	1.9	61.4	97.2	—	—
Alaska	93.0	99.0	0.0	—	50.0	100.0	0.0	0.0
Arizona	96.4	91.7	2.5	5.8	55.7	90.1	4.6	5.3
Arkansas	98.2	95.2	1.1	3.7	65.6	97.2	0.0	2.8
California	96.9	89.1	3.8	7.1	65.7	91.5	2.3	6.3
Colorado	97.1	94.8	2.6	2.5	52.4	93.7	—	4.5
Connecticut	98.2	80.1	6.8	13.1	62.9	84.0	9.0	7.0
Delaware	96.9	93.9	2.9	3.2	56.2	92.7	—	—
District of Columbia	93.4	79.7	14.1	6.2	—	—	—	—
Florida	94.7	89.2	4.1	6.7	55.4	88.0	2.6	9.3
Georgia	98.5	90.7	3.3	6.0	50.0	91.8	4.0	4.2
Hawaii	94.9	90.7	7.2	2.1	33.1	—	—	—
Idaho	98.9	94.9	—	4.6	70.2	96.0	—	3.0
Illinois	95.6	91.2	1.3	7.5	60.1	93.9	—	6.0
Indiana	99.0	94.9	1.1	4.0	70.1	92.4	2.2	5.4
Iowa	99.0	95.1	1.2	3.7	73.0	95.7	—	2.8
Kansas	99.0	97.5	—	2.3	75.3	95.9	—	3.4
Kentucky	99.0	89.9	1.8	8.3	75.5	91.3	0.0	8.7
Louisiana	96.5	93.1	2.2	4.6	56.3	93.9	—	4.9
Maine	97.4	86.2	5.5	8.3	54.8	83.5	—	11.8
Maryland	97.9	92.9	3.1	3.9	57.8	96.5	—	0.0
Massachusetts	95.9	96.1	—	3.7	61.0	96.2	—	2.2
Michigan	97.8	90.3	3.2	6.5	81.5	88.2	2.5	9.3
Minnesota	99.1	93.3	3.7	3.0	69.4	92.2	6.2	—
Mississippi	99.4	94.4	1.4	4.2	61.2	95.0	—	3.9
Missouri	98.8	96.7	0.5	2.8	77.8	87.5	1.9	10.6
Montana	99.0	93.1	4.4	2.5	68.6	93.3	5.8	—
Nebraska	98.4	90.7	8.2	1.1	55.5	95.3	—	—
Nevada	96.4	91.5	3.6	5.0	70.2	97.3	—	0.0
New Hampshire	97.2	94.1	3.1	2.8	44.5	100.0	0.0	0.0
New Jersey	97.6	98.1	0.0	1.9	63.9	97.8	0.0	2.2
New Mexico	97.2	95.5	—	3.9	71.8	96.0	0.0	4.0

Table 12—Percentage of public school teachers certified in their main and other assignment fields and percentage distribution of certified teachers by type of certification, by teaching level and field and by state: 1987–88—Continued

	Certified in main field	Type of certification			Certified another field	Type of certification		
		Standard	Probationary	Temporary		Standard	Probationary	Temporary
New York	95.4	85.6	5.3	9.1	54.5	82.4	8.5	9.1
North Carolina	98.4	89.9	6.4	3.7	66.1	83.9	6.1	10.0
North Dakota	99.5	97.5	1.8	0.7	71.2	98.1	—	—
Ohio	99.1	90.2	1.3	8.5	67.6	88.7	3.2	8.1
Oklahoma	98.1	95.2	0.9	3.9	65.7	94.3	3.5	2.2
Oregon	98.2	90.4	5.8	3.8	53.9	87.1	9.9	—
Pennsylvania	98.7	92.6	3.5	3.9	69.6	87.9	4.0	8.1
Rhode Island	97.8	94.5	2.2	3.4	75.3	86.4	8.3	5.3
South Carolina	96.1	97.3	—	2.5	51.4	89.8	—	6.6
South Dakota	99.4	97.6	1.3	1.2	69.0	97.3	—	0.0
Tennessee	97.7	89.1	6.3	4.6	73.5	87.0	12.8	—
Texas	97.0	91.2	2.3	6.5	71.2	91.7	3.5	4.8
Utah	97.9	93.9	2.1	4.0	64.1	89.5	5.8	4.7
Vermont	99.7	89.2	9.6	1.2	56.7	—	—	—
Virginia	96.6	92.4	3.8	3.8	62.3	91.4	5.5	3.1
Washington	97.5	90.1	5.4	4.5	66.0	90.1	6.2	3.7
West Virginia	98.1	90.0	3.3	6.8	78.7	92.8	3.1	4.0
Wisconsin	99.7	94.5	1.7	3.8	71.7	94.4	—	4.4
Wyoming	99.0	95.5	1.3	3.2	71.3	94.0	—	3.6

—Too few cases for a reliable estimate.
NOTE: Details may not add to totals due to rounding or cell suppression.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires).

Chapter 3

Teacher Attrition

Teacher Attrition Theory

Rates of teacher attrition (meaning leaving teaching) follow a U-shaped distribution by age and experience. For example, teachers in their early careers, with 1–10 years of teaching experience, have relatively high attrition rates, while teachers in mid-career, with 10–25 years of experience, have relatively low attrition rates. When teachers are late in their careers, attrition rates become high again as they begin to retire.[28] Human capital accumulation, uncertainty and incomplete information, and life cycle changes in family status help explain these differing rates.[29]

Human Capital

Human capital theory maintains that people make systematic assessments of the monetary and nonmonetary benefits associated with different occupations when they make occupation-related decisions.[30] Monetary benefits include income, promotion, medical and other benefits, pension plans, and job security. Nonmonetary benefits include the conditions at work that can make a job more or less desirable, such as the physical environment, the convenience of hours and schedules, relations with co-workers and supervisors, the types of clients (in this case, students) and availability of materials and equipment. In addition, in order to train for a new occupation, there are costs in training and in forgone earnings that must be considered as well. Individuals enter into an occupation or change within or between occupations to maximize the net returns, taking into account both benefits and costs .

Three types of human capital accrue by remaining in an occupation, a geographic location, and a firm.[31] Occupation-specific human capital consists of the knowledge, skills, and contacts that are relevant to that occupation. The longer one stays in an occupation, the more occupation-specific human capital one accrues from that occupation, and the less applicable the skills are to other occupations. Individuals also acquire generic human capital in jobs that is sometimes applicable to other occupations, although some of these skills are more transferable than others.[32] Location-specific human capital refers to the investments one makes to a particular area, such as home ownership, knowledge of an area, and support networks in that city or town.[33] Finally, firm-specific human capital refers to the knowledge and seniority one acquires within a specific institution or organization.

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[28]David W. Grissmer and Sheila Nataraj Kirby, *Teacher Attrition: The Uphill Climb to Staff the Nation's Schools* (Santa Monica: The RAND Corporation, 1987), xii–xv; Haggstrom, *Assessing Teacher Supply and Demand,* 15–16.
[29]This discussion of the theory of teacher attrition is based largely on Grissmer and Kirby, *Teacher Attrition,* 6–22.
[30]Ibid., 10.
[31]Ibid., 11–12.
[32]Ibid., 13.
[33]Keith Rust (Westat, Inc.) notes that teaching qualifications are "portable" relative to other occupations. Teachers are needed wherever there are children. Therefore, teachers give up less of their human capital than some might

According to human capital theory, the more occupation-specific, location-specific, and firm-specific human capital teachers have, the lower their probability of attrition.[34] Teachers with less human capital have less to lose by starting over in a new occupation or location, while teachers with more human capital in teaching cannot as easily afford to start over. In addition, the costs in forgone earnings while preparing for a non-teaching occupation are greater for older, more experienced teachers who have higher salaries and possibly larger debts than do younger teachers. Therefore, teachers would be expected to be much more likely to leave early in their careers and to be less likely to leave later, unless they are offered a much more attractive package of working conditions and benefits.

Uncertainty and Incomplete Information

A major assumption of human capital theory is that individuals have complete information about salaries, benefits, and working conditions in teaching and in all other occupations when they make occupational and job choices.[35] Because this is never true, the role of incomplete information and uncertainty in job decisions cannot be ignored.[36] Individuals usually accept jobs without perfect information about the job, and school systems hire individuals without complete information about the teaching abilities of these individuals. There is an initial period of evaluation on the part of teachers and school districts in which the job is compared with the perception of other available jobs and the teachers are compared with other available teachers. As a result of this process, teachers may either stay, leave, or be fired. While this process of evaluation continues throughout a teacher's career, it is more likely to result in either voluntary or involuntary attrition during the first years of teaching. The early voluntary attrition could be caused by more information about alternative jobs, by more experience with the teaching job itself, or both.

Life Cycle Considerations

Changes in family status, residence, and retirement reflect common life cycle patterns that also affect teaching. Marriage, the birth of children, geographical moves, and retirement are all events that are more likely to occur at certain ages.

During their 20s and 30s, teachers have a high probability of getting married, having children, and/or moving.[37] Many teachers who marry have children, and some teachers who marry relocate to be near a spouse's job. People of this age group are also likely to move whether or not they are married because they have less location-specific human capital to lose than those who are older. These changes often lead to attrition among teachers because most teachers are women.[38] Compared with men, women are more likely to have the responsibility for young children or to move for their spouse's job because they often have less human capital to lose by leaving the labor market or moving. However, both women and men beginning teachers are more likely to move than are mid-career teachers.[39]

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think when they move. Consequently, one might expect greater proportions of movers among teachers than among individuals with other occupations (personal communication to the authors, November 14, 1992).

[34]Grissmer and Kirby, *Teacher Attrition*, 12.

[35]Ibid., 13.

[36]Ibid., 14–16.

[37]Ibid., 16–19.

[38]Ibid., 17.

[39]Ibid., 18–19.

Attrition due to retirement occurs sometime between the minimum retirement age/experience level and the mandatory retirement age.[40] Teachers decide when to retire by comparing the perceived benefits of continuing to teach with the perceived benefits associated with the amount of pension they will receive and the quality of retirement life.

Teacher Attrition Rates

Human capital accumulation, uncertainty and incomplete information, and life cycle considerations together provide useful explanations for the higher attrition rates among early- and late-career teachers, and the lower rates for those in mid-career. During the first 10 years of teaching, career and life cycle stages all conspire to produce high attrition rates.[41] For example, new teachers are experiencing the working conditions and benefits of teaching and are comparing those conditions and benefits to other teaching and non-teaching jobs. They are also evaluating their expectations about teaching. Some expect to stay in teaching, while others see teaching as a stepping stone to other education jobs or other occupations.[42] However, all have relatively little human capital invested in teaching and can still afford to enter or train for other occupations. In addition, they have relatively little location- and firm-specific human capital so they can also maximize their benefits by changing schools or districts.

New teachers are also likely to be in the most common age range for marriage and having children. These family formation activities often conflict with work, either in time or location, especially for women. In addition, this age group is likely to be geographically mobile.

Involuntary attrition is also highest in the early years of teaching,[43] with schools evaluating new teachers and firing those who are not performing well. Teachers hired under temporary certification may fail to achieve regular certification. Moreover, reductions in force are more likely to affect new teachers, because they are the most recently hired.

All of these reasons also explain why mid-career teachers have lower attrition rates.[44] Those who stay past 10 years have made it though the period of teacher evaluation when they might have most easily moved to another occupation. Their human capital in teaching—occupation-specific and firm-specific—has accumulated, so that a switch to another occupation would entail greater costs. In addition, with seniority and earlier job moves, they have most likely found a teaching position that is optimal. Their seniority also protects them from being laid off. Finally, they are less prone to career disruption due to family formation and geographic moves. In all probability they have either already started a family or moved, or they are too invested in their job and location to stop teaching or move in mid-career.

The high attrition of late-career teachers is easily explained by retirement and death.[45] The specific timing of that retirement, however, is a function of some individual choice as well as the age and experience requirements of their retirement systems. At a given age, some teachers might derive greater benefits from teaching than from retirement, while for others it may be the reverse.

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[40]Ibid., xiv.
[41]Ibid., xii–xiii.
[42]Ibid., 12–3.
[43]Ibid., 19–21.
[44]Ibid., xiii–xiv.
[45]Ibid., xiv.

These considerations suggest models for predicting which teachers will leave and when. In addition, they suggest which subgroups of teachers need to be modeled separately. Human capital accumulation, uncertainty and incomplete information, and life cycle considerations all assume choice on the part of teachers and therefore are best suited for explaining voluntary attrition. They are not useful for explaining involuntary attrition such as death, illness, mandatory retirement, and reductions in force. While these involuntary events are related to factors such as teacher age and school policies, the relationship between these factors and the probability of leaving is different for teachers who leave involuntarily than for those who leave voluntarily. Consequently, the attrition of teachers who leave involuntarily should be modeled separately from those who leave voluntarily.

Teachers who leave teaching voluntarily might differ in their reasons for leaving, depending on their circumstances. For instance, those who leave for retirement would be reacting to different circumstances than those who leave for other reasons, and the same model would not explain the attrition of both groups. Reasons for leaving may also be different for early-career and mid-career teachers. For instance, those who leave teaching temporarily for family or location reasons might have different characteristics and relationships to teaching than those who leave teaching permanently. Among those who leave permanently, those who leave to pursue higher positions in education may be very different from those who leave for other fields. Thus, various models may be needed to explain the attrition of these diverse groups.

Teacher Attrition 1987–88 to 1988–89

Based on the theories of attrition discussed previously, this section describes various aspects of teacher attrition between 1987–88 and 1988–89. The tables also provide information on the subgroups of teachers that are later emphasized in the multivariate analysis.

As table 9 (Chapter 2) showed, only a small proportion of all teachers left teaching in 1 year: 6 percent between 1987–88 and 1988–89. However, while only 5 percent of public school teachers left teaching, 11 percent of private school teachers left. This finding suggests the need to model attrition patterns separately for public and private school teachers (or at least to distinguish between them in some way).

Table 13 indicates that attrition rates between 1987–88 and 1988–89 were slightly different for female and male teachers, with men being slightly less likely to leave (5 percent) than women (6 percent). This table also illustrates the U-shaped curve of attrition by age (teachers aged 36–50 were less likely to leave than were younger or older teachers) and by experience (teachers with 11–25 years of teaching experience were less likely to leave than were teachers with more or less experience). This finding suggests that attrition models must focus on teachers at particular career stages, because teachers in various stages leave teaching at different rates and for a number of reasons. Table 14 shows the percentage distribution of teachers by age, sector, and selected school and teacher characteristics, which can be used to predict the future attrition due to retirement.

Among the teachers who left, about one-third of both public and private school teachers left for career reasons (table 15). However, public school teachers were more likely to leave for retirement (28 percent) than were private school teachers (5 percent), while private school teachers were more likely to leave for family/health reasons (30 percent) than were public school teachers (15 percent). About one-fifth of each group left for childrearing purposes, and about 5 percent left involuntarily.

Table 16 shows the educational backgrounds of teachers who left for various reasons, and the percentages of teachers who left and stayed who were certified in their main assignment field.

Among public school teachers, 98 percent of all 1987–88 teachers who stayed in 1988–89 were certified in their main assignment field, as were 96 percent or more of all teachers who left voluntarily. However, certification among private school teachers ranged from 49 percent for those who left for career reasons to 72 percent for those who left for childrearing. Only 71 percent of those who stayed in teaching were certified in their main assignment field. Among both public and private school teachers, the educational backgrounds of teachers who stayed and those who left were very similar.

However, educational levels varied by reason for leaving. Among public school teachers, those who left for career reasons or retirement were more likely than those who left for childrearing to have a master's degree in education. This may be partly related to age: teachers who leave for childrearing are more likely to be younger and therefore have had less time to earn a master's degree.

Table 17 shows that 42 percent of the voluntary, non-retiring leavers planned to return to teaching, and among those who planned to return, 62 percent planned to return the following year. Finally, table 18 shows the range of activities in which teachers who left for reasons other than retirement were engaged. This table shows that 20 percent of public school leavers and 9 percent of private school leavers took non-teaching jobs in education, highlighting the fact that those who leave for career reasons may not be leaving teaching because they do not like education, but because they seek different responsibilities within the education field. Their reasons for leaving teaching might be very different from the 20 percent of public school leavers and 40 percent of private school leavers who found non-education jobs.

Table 13—Attrition rate: percentage of teachers who left teaching (leavers) by sex, age, years of teaching experience, by sector and selected school and teacher characteristics: 1987–88 and 1988–89

	Sex		Age			Years teaching experience		
	Female	Male	Less than 36	36–50	51 or more	Less than 11	11–25	26 or more
Total	6.3	5.1	7.7	3.3	10.6	7.3	4.0	10.3
Public	5.5	4.7	6.8	2.7	10.6	6.3	3.6	10.6
Region								
Northeast	4.5	4.1	6.8	1.7	9.6	5.9	2.2	11.4
Midwest	6.1	4.2	6.7	1.9	12.7	6.6	4.1	8.3
South	5.4	6.2	6.9	3.4	11.4	7.1	3.4	13.3
West	6.2	4.3	6.5	3.9	8.1	4.6	5.4	9.8
School level								
Elementary	5.2	3.7	6.0	2.7	9.3	5.3	3.8	10.6
Secondary	5.1	4.6	6.5	2.8	9.3	6.6	2.9	9.6
Combined/other	7.4	5.0	6.2	4.2	16.3	7.8	5.7	6.4
Community type								
Rural/farming	4.9	4.4	5.4	2.7	7.6	5.4	4.1	6.4
Small city	5.7	3.5	6.9	3.9	7.2	7.0	3.4	6.6
Suburban	4.8	4.5	6.4	2.1	9.5	5.3	3.1	13.4
Urban	5.8	5.0	6.3	2.5	15.3	5.9	3.7	18.6
Free lunch eligibility								
Less than 20%	5.6	4.0	7.7	2.9	8.5	7.1	3.1	8.9
20–49%	4.9	4.3	5.0	2.8	9.9	4.6	3.7	11.7
50% or more	5.4	5.7	5.9	2.6	12.9	6.0	4.2	10.2
Minority enrollment								
Less than 5%	5.3	4.1	5.8	2.5	10.7	6.1	3.5	8.3
5–19%	6.0	3.8	6.9	3.5	8.9	7.1	3.3	10.7
20–49%	4.4	5.0	5.4	2.7	9.7	3.8	3.6	14.9
50% or more	5.4	5.1	6.9	2.6	8.6	6.3	4.0	8.1
Teaching level and field								
Elementary	5.6	3.0	7.1	2.2	10.4	6.0	3.7	11.0
Secondary								
Math/computer science	4.1	6.3	6.3	3.2	11.2	7.5	3.1	—
Science	6.6	4.6	5.0	4.7	12.4	5.6	4.1	—
Other	5.4	4.9	8.0	2.5	10.4	7.2	2.9	9.5
Special education	5.9	5.1	4.9	4.8	13.1	5.6	6.0	—
Sex								
Male	(*)	4.7	6.0	2.6	9.9	5.9	2.6	10.9
Female	5.5	(*)	7.0	2.7	10.9	6.5	4.0	10.3
Race–ethnicity								
Black, non-Hispanic	4.0	4.5	2.8	1.0	13.0	2.8	3.3	13.0
White, non-Hispanic	5.8	4.7	7.3	2.9	10.7	6.8	3.7	10.6
All others	2.9	2.1	2.8	2.5	2.9	3.0	2.2	—

Table 13—Attrition rate: percentage of teachers who left teaching (leavers) by sex, age, years of teaching experience, by sector and selected school and teacher characteristics: 1987–88 and 1988–89—Continued

	Sex		Age			Years teaching experience		
	Female	Male	Less than 36	36–50	51 or more	Less than 11	11–25	26 or more
Private	11.9	9.4	13.5	9.6	10.8	12.9	9.9	8.2
Region								
Northeast	9.9	8.8	12.5	8.2	5.6	13.0	5.1	5.7
Midwest	9.2	5.2	13.9	5.4	9.0	12.4	5.7	3.0
South	13.6	10.4	13.5	12.7	13.0	10.7	18.5	—
West	18.0	13.4	15.2	14.9	—	16.7	10.9	—
School level								
Elementary	9.2	17.0	12.5	8.1	8.6	12.4	6.7	7.4
Secondary	16.4	5.3	14.9	9.5	—	15.8	9.0	—
Combined/other	17.1	7.4	13.8	15.5	19.2	12.2	22.1	—
Community type								
Rural/farming	12.4	10.3	12.7	11.0	12.0	11.9	12.0	—
Small city	9.5	5.6	11.4	5.9	8.8	9.3	9.7	—
Suburban	11.5	6.6	15.6	7.8	7.1	13.4	9.3	—
Urban	23.3	16.9	19.0	24.6	—	26.6	12.7	—
Free lunch eligible								
Less than 20%	7.8	12.6	13.9	3.0	10.5	10.9	5.0	—
20–49%	11.5	—	11.3	14.0	—	20.6	—	—
50% or more	5.6	—	3.3	—	—	14.2	—	—
Minority enrollment								
Less than 5%	12.4	5.1	14.1	9.4	7.3	12.4	9.6	6.5
5–19%	8.9	9.0	10.9	7.7	7.3	10.0	10.0	—
20–49%	28.5	6.2	21.9	17.6	—	20.1	21.5	—
50% or more	8.4	33.3	8.4	17.1	—	14.8	9.4	—
Teaching level and field								
Elementary	9.8	21.0	13.1	8.4	9.8	13.0	7.1	6.8
Secondary								
Math/computer science	8.4	15.7	13.1	—	—	14.3	—	—
Science	6.0	8.9	6.8	7.6	—	7.5	—	—
Other	18.1	5.2	16.8	10.6	11.8	13.4	14.1	—
Special education	14.7	—	4.8	—	—	14.8	—	—
Sex								
Male	(*)	9.4	9.8	8.8	10.5	12.3	4.3	—
Female	11.9	(*)	14.7	9.8	10.9	13.0	11.6	6.7
Race–ethnicity								
Black, non-Hispanic	24.6	—	—	—	—	30.2	—	—
White, non-Hispanic	11.6	7.6	13.3	9.0	8.9	12.2	9.8	5.9
All others	14.2	—	14.9	—	—	13.0	—	—

—Too few cases for a reliable estimate.
(*) Not applicable.
NOTE: Details may not add to totals due to rounding or cell suppression.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires) and Teacher Followup Survey, 1988–89.

Table 14—Percentage distribution of teachers by age, by sector and selected school and teacher characteristics: 1987–88

	Percent in age group									
	< 26	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66+
Total	5.8	11.1	15.0	22.3	17.7	11.8	8.5	5.4	2.0	0.4
Public	5.2	10.6	15.0	22.6	18.1	12.0	8.8	5.5	1.9	0.3
Region										
Northeast	4.1	8.7	13.1	24.2	19.4	12.3	9.6	6.1	2.2	0.3
Midwest	5.4	9.9	14.6	22.0	18.6	12.5	8.8	5.7	2.1	0.4
South	6.2	12.7	17.1	22.9	16.7	10.9	7.2	4.5	1.5	0.2
West	4.1	9.5	13.4	21.0	18.8	13.3	11.1	6.6	1.9	0.4
School level										
Elementary	5.6	10.8	15.2	23.1	17.3	11.8	8.6	5.6	2.0	0.3
Secondary	4.3	9.8	14.6	22.7	19.6	12.6	9.2	5.3	1.6	0.3
Combined/other	6.4	13.8	17.1	21.3	16.0	10.5	7.8	4.9	1.9	0.3
Community type										
Rural/farming	4.2	9.5	13.8	21.5	18.9	12.9	9.8	6.6	2.2	0.4
Small city	4.4	9.3	13.0	22.4	20.6	13.1	9.7	5.6	1.6	0.4
Suburban	5.1	10.7	15.4	23.9	17.7	11.8	8.5	5.0	1.8	0.2
Urban	6.7	12.5	17.7	23.5	15.7	10.4	7.1	4.5	1.7	0.2
Free lunch eligibility										
Less than 20%	4.7	9.5	13.7	23.2	19.5	13.1	9.4	5.3	1.5	0.2
20–49%	5.7	11.5	16.4	22.8	16.8	11.4	8.0	5.4	1.9	0.3
50% or more	5.3	11.5	15.8	22.3	17.2	10.9	8.5	5.7	2.3	0.5
Minority enrollment										
Less than 5%	5.4	10.8	15.8	24.5	17.3	11.4	8.1	4.7	1.7	0.2
5–19%	4.9	9.5	14.3	22.8	19.7	12.6	9.0	5.4	1.6	0.2
20–49%	5.2	11.3	14.9	20.9	18.1	12.4	9.0	6.3	1.7	0.2
50% or more	4.9	10.6	14.9	22.1	17.5	12.0	9.3	5.8	2.4	0.6

Table 14—Percentage distribution of teachers by age, by sector and selected school and teacher characteristics: 1987–88—Continued

	Percent in age group									
	< 26	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66+
Teaching level and field										
Elementary	5.5	9.8	14.5	22.7	17.6	12.2	9.1	6.0	2.3	0.3
Secondary										
Math/computer science	7.1	10.3	12.3	24.6	20.8	11.0	7.9	4.0	1.8	0.2
Science	4.4	12.4	14.5	21.0	18.4	13.9	8.7	4.9	1.5	0.1
Other	3.8	9.3	14.4	22.5	19.9	12.9	9.4	5.8	1.6	0.3
Special education	7.7	17.9	22.0	22.2	12.1	7.8	5.6	3.4	1.1	0.3
Sex										
Male	3.1	9.0	13.7	23.7	19.7	13.0	10.2	5.7	1.5	0.3
Female	6.1	11.3	15.5	22.2	17.4	11.6	8.2	5.4	2.0	0.3
Race–ethnicity										
Black, non-Hispanic	2.2	8.0	16.1	22.9	18.7	12.5	10.0	6.7	2.5	0.5
White, non-Hispanic	5.6	10.8	14.9	22.6	18.2	12.1	8.7	5.3	1.8	0.2
All others	4.8	13.0	16.3	23.2	16.2	10.0	7.9	5.5	2.0	1.0
Private	10.9	14.9	15.1	19.6	14.6	10.0	6.2	4.8	2.8	1.2
Region										
Northeast	12.9	14.1	15.9	15.5	14.7	10.1	6.6	4.4	4.2	1.6
Midwest	11.6	16.2	12.6	18.8	15.6	9.6	6.6	4.7	2.6	1.7
South	8.6	13.5	16.9	23.0	14.0	9.9	5.5	5.4	2.5	0.8
West	10.0	16.6	14.7	22.6	13.8	10.5	6.0	4.4	1.1	0.3
School level										
Elementary	11.6	15.1	15.9	19.7	13.5	8.9	6.5	4.2	2.8	1.8
Secondary	6.8	13.7	13.6	19.7	17.7	12.6	5.6	5.4	3.4	1.3
Combined/other	12.6	16.2	15.5	20.0	13.5	8.3	6.0	5.2	2.1	0.6
Community type										
Rural/farming	9.8	14.9	17.6	21.0	14.3	9.1	6.5	3.9	1.7	1.2
Small city	10.1	16.3	13.7	17.7	15.5	11.5	5.1	5.6	3.2	1.1
Suburban	12.1	16.1	14.2	19.7	13.5	7.0	7.8	3.6	3.6	2.4
Urban	15.6	11.2	12.5	20.0	13.2	10.1	5.0	7.9	3.8	0.8

Table 14—Percentage distribution of teachers by age, by sector and selected school and teacher characteristics: 1987–88—Continued

	Percent in age group									
	< 26	26–30	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66+
Free lunch eligibility										
Less than 20%	11.9	12.8	14.6	18.6	15.4	10.2	7.4	4.7	3.3	1.1
20–49%	15.7	11.5	19.8	19.7	7.9	6.7	8.9	3.0	3.9	3.0
50% or more	14.3	19.1	18.8	13.4	12.0	7.7	8.6	2.6	1.9	1.5
Minority enrollment										
Less than 5%	11.2	14.3	16.8	19.9	14.6	9.5	6.2	3.9	2.4	1.4
5–19%	9.9	15.9	14.2	20.7	13.4	10.5	6.1	5.2	2.4	1.6
20–49%	11.8	15.9	12.3	17.2	15.3	9.7	5.3	6.9	4.6	1.2
50% or more	11.7	15.6	16.4	19.7	14.7	6.6	7.8	4.4	2.6	0.6
Teaching level and field										
Elementary	12.0	15.2	14.9	20.2	14.0	9.0	5.8	5.0	2.3	1.5
Secondary										
Math/computer science	16.3	12.0	11.9	17.9	13.4	13.0	5.8	6.7	3.0	0.0
Science	10.4	15.6	15.4	22.8	13.5	10.3	6.8	—	4.5	0.0
Other	7.5	13.9	16.2	18.7	16.5	11.3	6.3	5.1	3.3	1.3
Special education	16.1	26.6	14.6	15.2	8.6	5.2	10.7	1.5	1.1	—
Sex										
Male	7.8	15.5	17.0	19.3	15.5	9.7	6.6	4.6	3.6	0.5
Female	11.8	14.7	14.5	19.7	14.3	10.1	6.0	4.8	2.6	1.4
Race–ethnicity										
Black, non-Hispanic	11.9	14.0	22.4	20.0	15.7	4.2	6.1	0.9	4.3	—
White, non-Hispanic	11.0	15.1	14.9	19.3	15.0	10.0	6.2	4.9	2.5	1.1
All others	10.7	12.4	15.0	24.3	10.2	12.1	5.3	4.2	5.1	0.8

—Too few cases for a reliable estimate.

NOTE: Details may not add to totals due to rounding or cell suppression.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987-88 (Teacher Questionnaires).

Table 15—Percentage distribution of leavers by main reasons for leaving, by sector, by selected school and teacher characteristics: 1987–88 and 1988–89

	Public					Private				
	Career*	Family/ health	Child-rearing	Retire-ment	Invol-untary	Career	Family/ health	Child-rearing	Retire-ment	Invol-untary
Total	32.8	15.2	19.4	28.0	4.6	36.4	29.8	22.2	5.2	6.4
Region										
Northeast	35.6	10.7	14.9	32.3	6.4	48.8	16.9	23.3	3.3	7.8
Midwest	29.7	17.8	15.9	31.5	5.1	23.3	35.2	28.7	7.2	5.7
South	36.9	14.8	23.9	20.6	3.8	31.2	46.0	9.7	7.2	5.9
West	40.4	18.6	11.7	24.0	5.3	38.8	21.1	33.5	—	4.6
Community type										
Rural/farming	43.8	8.1	21.0	23.8	3.2	42.4	26.8	22.0	2.2	6.6
Small city	36.2	12.3	25.9	18.7	6.9	28.2	34.6	19.5	10.9	6.7
Suburban	35.3	18.8	15.3	26.9	3.6	39.0	33.6	22.9	2.4	2.2
Urban	27.6	22.4	11.8	32.6	5.6	22.4	34.2	27.1	8.6	7.7
School level										
Elementary	29.8	14.2	26.0	27.5	2.4	33.9	27.8	25.9	6.1	6.2
Secondary	45.0	17.8	6.8	22.1	8.3	60.0	10.1	21.9	2.3	5.7
Combined/other	31.5	16.5	12.3	32.9	6.8	22.2	48.4	18.1	5.3	6.0
Teaching level and field										
Elementary	21.3	15.0	30.0	32.2	1.6	27.6	31.8	27.4	5.4	7.8
Secondary										
Math/computer science	53.7	12.7	3.6	24.4	5.7	53.6	22.0	3.6	13.9	—
Science	60.1	12.9	4.6	15.1	7.2	—	—	—	—	—
Other	38.4	17.3	10.9	26.5	6.9	44.8	32.6	14.6	4.4	3.6
Special education	36.3	11.1	19.4	25.3	7.8	—	—	—	—	—
Sex										
Male	50.6	11.2	0.0	31.5	6.7	50.9	13.7	13.4	9.2	12.9
Female	26.2	16.8	26.5	26.7	3.8	33.2	33.4	24.2	4.3	5.0

Table 15—Percentage distribution of leavers by main reasons for leaving, by sector, by selected school and teacher characteristics: 1987–88 and 1988–89—Continued

	Public					Private				
	Career*	Family/ health	Child-rearing	Retire-ment	Invol-untary	Career	Family/ health	Child-rearing	Retire-ment	Invol-untary
Race–ethnicity										
Black, non-Hispanic	47.5	13.6	—	33.2	5.3	—	—	—	—	—
White, non-Hispanic	31.3	15.7	20.7	27.7	4.6	35.8	31.4	21.7	4.4	6.7
All others	37.4	13.8	28.9	15.9	4.0	—	—	—	—	—
Full-time										
Less than 5 years	37.6	21.4	30.4	—	10.0	52.8	24.2	16.8	0.0	6.2
5–14 years	34.6	22.4	32.9	5.9	4.2	23.8	38.0	33.8	—	3.9
15 years or more	28.5	5.7	1.9	61.7	2.1	41.0	18.1	—	26.7	13.4

—Too few cases for a reliable estimate.

*Teachers who left for career reasons include leavers who reported that they left to pursue another career, for better salary or benefits, to take courses to improve career opportunities inside or outside the field of education, to take a sabbatical or other break from teaching, or because they were dissatisfied with teaching as a career.

NOTE: Details may not add to totals due to rounding or cell suppression.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires) and Teacher Followup Survey, 1988–89.

Table 16—Number of teachers, percentage distribution of teachers by highest degree earned, and percentage of teachers certified in main assignment field, by sector, 1988–89 teaching status, and reason for leaving: 1987–88 and 1988–89

	Number of 1987–88 teachers	Degree (percent)						Percent certified in main assignment field
		AA/AS	BA/BS in education	BA/BS not in education	MA/MS in education	MA/MS not in education	Higher degree	
Total	2,376,612*	1.0	41.2	12.1	34.6	5.2	5.8	94.5
Public	2,123,982*	0.8	41.2	11.2	36.0	4.8	6.0	97.5
1988–89 status								
Still teaching	2,011,271	0.8	41.1	11.2	36.2	4.7	6.0	97.5
Not teaching	112,711	0.4	41.9	10.8	34.2	6.4	6.4	97.1
Reason for leaving								
Career	36,771	—	33.9	9.7	43.7	6.2	6.4	97.1
Family/health	16,950	0.7	41.8	21.6	27.2	4.0	4.7	98.7
Childrearing	21,890	—	72.2	7.3	16.3	2.7	1.6	95.6
Retirement	31,421	0.4	32.0	7.9	40.2	11.1	8.3	98.0
Involuntarily	5,123	—	34.2	16.6	31.1	4.3	12.2	93.3
Private	252,630*	3.1	42.0	19.4	22.3	8.7	4.5	69.9
1988–89 status								
Still teaching	223,859	2.5	42.2	19.5	22.7	8.9	4.2	71.0
Not teaching	28,771	8.2	40.4	18.7	18.4	7.6	6.8	61.9
Reason for leaving								
Career	10,475	6.4	27.7	28.9	18.3	8.5	10.3	49.3
Family/health	8,594	18.4	46.8	9.8	10.7	10.1	4.3	65.6
Childrearing	6,395	0.0	59.6	12.1	27.0	—	0.0	72.0
Retirement	—	—	—	—	—	—	—	—
Involuntarily	1,781	0.0	26.8	31.2	18.4	14.7	—	55.7

—Too few cases for a reliable estimate.
*The total number of teachers and the numbers of public and private school teachers are less than numbers based on the Teacher Followup Survey published elsewhere (2,699,098; 2,387,174; and 311,924) because teachers missing data on the row teacher characteristics, highest degree earned, or certification status in main field due to item nonresponse were not included in this table.
NOTE: Details may not add to totals due to rounding or cell suppression.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires) and Teacher Followup Survey, 1988-89.

Table 17—Number of voluntary, nonretiring leavers, percentage of voluntary, nonretiring leavers who planned to return, and percentage distribution of those who planned to return by when they planned to return, by sector and selected teacher characteristics: 1987–88 and 1988–89

	Number of voluntary nonretiring leavers	Percent who planned to return to teaching	When they planned to return			
			By next year	Within 5 years	In more than 5 years	Undecided
Total	105,217	41.9	61.8	25.7	8.5	4.1
Public	79,743	42.3	63.9	26.3	5.9	3.9
Teaching level and field						
Elementary	33,782	53.5	71.5	17.6	7.7	3.2
Secondary						
Math/computer science	5,141	33.4	—	—	—	—
Science	5,241	31.7	—	—	—	—
Other	25,886	33.5	54.3	36.9	3.2	5.6
Special education	9,543	37.9	51.4	39.7	7.6	—
Sex						
Male	19,597	22.8	61.2	28.7	6.6	3.6
Female	59,794	48.7	64.2	26.0	5.9	3.9
Race–ethnicity						
Black, non-Hispanic	4,197	12.4	—	—	—	—
White, non-Hispanic	71,674	43.9	65.0	25.4	5.9	3.6
All others	1,900	49.1	—	—	—	—
Full-time experience						
Less than 5 years	21,779	54.3	60.3	25.9	10.0	3.8
5–14 years	38,995	47.6	65.0	27.3	4.0	3.7
15 years or more	18,880	17.6	70.8	21.8	—	5.1
Private	25,474	40.8	54.8	23.7	16.6	4.8
Teaching level and field						
Elementary	11,714	48.4	49.6	26.0	21.0	3.4
Secondary						
Math/computer science	—	—	—	—	—	—
Science	—	—	—	—	—	—
Other	10,056	29.0	54.1	22.1	15.4	8.4
Special education	—	—	—	—	—	—
Sex						
Male	4,101	35.2	—	—	—	—
Female	21,373	41.9	50.4	25.0	19.0	5.6
Race–ethnicity						
Black, non-Hispanic	—	—	—	—	—	—
White, non-Hispanic	22,601	39.2	52.2	24.9	18.5	4.5
All others	—	—	—	—	—	—

Table 17—Number of voluntary, nonretiring leavers, percentage of voluntary, nonretiring leavers who planned to return, and percentage distribution of those who planned to return by when they planned to return, by sector and selected teacher characteristics: 1987–88 and 1988–89—Continued

	Number of voluntary nonretiring leavers	Percent who planned to return to teaching	When they planned to return			
			By next year	Within 5 years	In more than 5 years	Undecided
Full-time experience						
Less than 5 years	8,803	45.4	43.4	32.7	17.0	6.9
5–14 years	13,437	44.2	61.2	17.3	17.7	
15 years or more	3,234	14.4	—	—	—	—

—Too few cases for a reliable estimate.

NOTE: Details may not add to totals due to rounding or cell suppression.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires) and Teacher Followup Survey, 1988–89.

Table 18—Percentage distribution of voluntary, nonretiring 1987–88 leavers by 1988–89 occupational status, and percentage distribution of those in noneducation jobs by type of job, by sector and selected teacher characteristics: 1987–88 and 1988–89

	1988–89 Occupational status					Noneducation job				
	Attending college/ university	Home-making	Nonteaching job in education	Non-education job	Other	Prof./ technical	Manage-ment	Service/ sales	Clerical	Other
Total	7.5	35.5	17.3	25.2	14.5	10.5	23.3	17.6	33.4	15.2
Public	7.5	36.6	20.0	20.3	15.6	13.7	26.8	20.0	20.9	18.7
Teaching level and field										
Elementary	6.1	53.7	15.5	9.6	15.0	—	—	—	—	—
Secondary										
Math/computer science	12.9	9.4	24.3	36.2	17.1	—	—	—	—	—
Science	12.6	12.9	31.3	39.0	4.2	—	—	—	—	—
Other	7.5	26.3	23.2	28.6	14.4	11.0	28.1	12.0	31.9	16.9
Special education	6.8	30.3	18.7	17.4	26.9	—	—	—	—	—
Sex										
Male	10.4	—	25.0	44.3	20.2	14.8	18.6	22.0	24.1	20.5
Female	6.2	48.5	18.4	12.6	14.2	12.1	38.4	17.3	16.3	16.0
Race–ethnicity										
Black, non-Hispanic	4.4	3.9	74.7	7.4	9.6	—	—	—	—	—
White, non-Hispanic	7.6	38.9	16.0	21.3	16.2	13.7	26.9	17.2	21.8	20.4
All others	6.1	39.4	36.6	8.7	9.2	—	—	—	—	—
Full-time experience										
Less than 5 years	11.8	41.6	7.6	31.5	7.5	10.5	15.3	19.7	44.0	10.4
5–14 years	7.1	47.8	13.7	16.9	14.4	17.9	39.5	19.2	—	21.8
15 years or more	3.4	8.0	46.9	14.2	27.6	11.6	24.9	22.7	10.1	30.7

Table 18—Percentage distribution of voluntary, nonretiring 1987–88 leavers by 1988–89 occupational status, and percentage distribution of those in noneducation jobs by type of job, by sector and selected teacher characteristics: 1987–88 and 1988–89—Continued

	1988–89 Occupational status					Noneducation job				
	Attending college/ university	Home-making	Nonteaching job in education	Non-education job	Other	Prof./ technical	Manage-ment	Service/ sales	Clerical	Other
Private	7.7	32.3	8.8	40.4	10.8	6.2	18.5	14.3	50.6	10.4
Teaching level and field										
Elementary	6.6	46.2	9.0	28.7	9.5	—	23.8	29.6	35.0	9.8
Secondary										
Math/computer science	—	—	—	—	—	—	—	—	—	—
Science	—	—	—	—	—	—	—	—	—	—
Other	7.1	24.5	9.2	55.1	4.1	4.0	16.1	3.0	64.8	12.0
Special education	—	—	—	—	—	—	—	—	—	—
Sex										
Male	13.3	17.0	6.1	57.6	6.0	—	—	—	—	—
Female	6.6	35.2	9.3	37.2	11.8	4.5	15.4	14.0	61.1	5.0
Race–ethnicity										
Black, non-Hispanic	—	—	—	—	—	—	—	—	—	—
White, non-Hispanic	6.8	32.5	6.9	42.1	11.7	5.3	18.4	14.8	50.3	11.2
All others	—	—	—	—	—	—	—	—	—	—
Full-time experience										
Less than 5 years	18.6	23.8	8.2	40.5	8.9	4.6	24.7	16.6	38.0	16.1
5–14 years	2.0	44.9	1.1	41.1	10.8	7.5	12.5	13.5	59.7	6.8
15 years or more	1.4	—	42.4	37.6	16.1	—	—	—	—	—

—Too few cases for a reliable estimate.
NOTE: Details may not add to totals due to rounding or cell suppression.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires) and Teacher Followup Survey, 1988–89.

Chapter 4

Multivariate Analysis of Teacher Attrition

The aim of the multivariate analysis was to identify the characteristics of teachers and their schools and districts that are associated with high attrition. As indicated in the Introduction, these efforts were less successful than originally hoped. This chapter describes in some detail the hypotheses developed, the methodology used, and the results of the analysis. Chapter 5 contains the comments of the reviewers.

Hypotheses

Based on the theory of attrition discussed in the previous chapter, it was hypothesized that the likelihood of leaving would be positively related to the following teacher and school or district characteristics:

Teacher characteristics

female gender
married status
children (especially young children)
higher degrees (associated with more alternative job opportunities)
teaching in fields with more alternative job opportunities (such as math or science)
high family income (less need to work)

School/district characteristics

large class size, high pupil/teacher ratio
high percentage of Chapter 1 or free lunch eligible students
high minority enrollment
urban school location
high proportions of teachers in early careers[46]

It was also hypothesized that the likelihood of leaving would be negatively related to the following teacher and school or district characteristics:

Teacher characteristics

age
years of teaching experience
teaching in field best qualified
certification in primary assignment field
high influence over school policy
high control over classroom practices
high level of help from others in the school

[46]Teachers might be more likely to leave schools in which many of the other teachers were in their early careers, either because there would be fewer role models of successful mid-career teachers or because there was a reason that teachers left that school before they reached mid-career.

high satisfaction with salary
high satisfaction with teaching
receiving merit pay or other pay incentives
high teaching income
large increase in teaching income

School/district characteristics

large district size[47]
provision of medical/dental benefits
district/private school pension contributions
high salary schedule
availability of merit pay
pay incentives for shortages
greater proportion of teachers with higher degrees[48]

Methodology

The dependent variable selected for the analysis was dichotomous with a value of 1 for teachers who left teaching and 0 for teachers who continued teaching. The independent variables were various measures of the teacher, school, and district characteristics listed above that were expected to be related to attrition. Two major sets of models were tested; they differed in the samples selected for analysis and in the specification of the independent variables. Because the dependent variable was dichotomous, logistic regression analysis was used to test the models. The rest of this section describes, for each set of models, the sample used, the specific measures used for the independent variables, and the results of the regression analyses.

Initial Modeling Efforts

Sample

The sample chosen first for analysis was the group of teachers thought to be the most sensitive to changes in policy and working conditions—teachers who left voluntarily before retirement for career-related reasons. These included teachers who reported that their main reason for leaving was one of the following: to pursue another career; for better salary or benefits; to take courses to improve career opportunities in the field of education; to take courses to improve career opportunities outside the field of education; to take a sabbatical or other break from teaching; or because they were dissatisfied with teaching as a career. Involuntary leavers (that is, those who listed school staffing action as their main reason for leaving); retirees; and teachers who left for childrearing, health, or family or personal reasons were excluded from the sample. Involuntary leavers were excluded because they had no control over their leaving. In addition, retirees were excluded on the assumption that age would explain so much of the variation for this group that it would be difficult to identify other effects. Teachers who left for family reasons were excluded because such departures are sometimes voluntary and sometimes involuntary, and are caused by different factors than are career-related departures. Finally, public

[47]For public school teachers, district size represents mobility opportunities around the district, which might mean that they can find the best possible working conditions and continue teaching. On the other hand, it might also encourage them to move into administration, which means that they would leave teaching.

[48]Teachers might be more likely to stay in schools where more teachers have graduate degrees, because this would imply that other teachers with advanced degrees have found reasons to stay.

and private school teachers were examined separately, because many believe that each group responds differently to factors such as salary and working conditions, which are thought to affect attrition.

Independent Variables

The independent variables included teacher demographics, education, working conditions, experience, teaching load, and school and district type and policies (salaries, benefits, incentives, and so on). The selection of independent variables was influenced by the purpose of the analysis, which was to test theories about which teachers are most likely to leave. Therefore, variables such as the teacher's response to a question on how long she or he expected to stay in teaching were deliberately avoided. Such variables would likely be very highly correlated with leaving, but including them could easily obscure the effects of other more policy-relevant variables.

Two factors possibly related to leaving that were not included were family income and change in teacher income. Since teachers from families with higher family income might be more financially secure, they might be more likely than those from families with lower incomes to leave for career reasons. However, the data on family income were not very reliable, because some teachers included their own income when reporting family income and others did not. Change in teacher income over time might well affect the likelihood of leaving teaching, but the change in only 1 year (all that was available for this analysis) would not be a reliable indicator of earning prospects.

The multivariate analysis of teacher attrition involved using multi-level data that are hierarchical in nature—that is, teachers are located within schools, and schools are located within districts. The difficulty with simply attaching data on a teacher's school or district to the teacher with a teacher-level dependent variable is that teacher characteristics vary more among schools than within schools; however, this uneven pattern is not taken into account. In addition, the variation among schools is not modeled correctly when many teachers have the same school characteristics. Although there is a statistical method—hierarchical linear models (HLM)—to take care of these problems, HLM cannot be used with the SASS data set because the sample does not contain enough teachers per school (only one or two in the TFS).[49] Therefore, it was necessary to use a one-level model, with the teacher as the unit of analysis and school and district characteristics attributed to each teacher. This solution was acceptable because there were so few teachers per school and schools per district that the teacher, school, and district characteristics were almost congruent.

Bivariate tables were produced (for public and private school teachers separately) to show the differences between those who were leavers for career reasons and continuing teachers (stayers and movers) for each variable to be used in the regressions (see Appendix table 5).[50] Very few statistically significant differences were observed between the two groups. The intercorrelations of the independent variables and the correlations with the dependent variable were examined for possible multicollinearity. Almost all of the correlations were very low. Only the correlation between the percentage of minority teachers and the percentage of minority students was greater than .60, and the correlation was this high only for public school teachers.

Table 19 shows the independent variables used in the first set of regressions. The variables are listed by group according to how they were entered into the regression models. Group I

[49]See Anthony S. Bryk and Stephen W. Raudenbush, *Hierarchical Linear Models* (Newbury Park, CA: Sage Publications, 1992).

[50]These tables were produced using REPTAB, a statistical program developed by MPR Associates that estimates standard errors correctly for data from complex samples such as SASS.

consists of control/descriptive variables; Group II contains additional teacher and student contextual variables; Group III contains the compensation and benefit variables; and Group IV includes the perception of teaching and certification variables. The "alternative" groups show the different ways that the variables were expressed and tested in the regressions. Usually the alternatives consisted of changing the variable from a continuous to a dummy variable or trying different dummy groupings to try to express the variables in the most meaningful way.

WESLOG Analysis

The software used was WESLOG, a logistic regression program that takes into account the complex sampling design of the SASS and TFS surveys.[51] WESLOG uses either jackknife or balanced repeated replications (BRR) methods to compute the standard errors.

The variables in Group IA were entered first, followed by the variables in Groups IB–E, one group at a time. While WESLOG did compute coefficients, standard errors, and R^2s for these models, it was not able to compute an F value to test the fit of the model for the public school teacher sample because the matrix was singular. The F values of the private school teacher models were computed, but were never significant (they ranged from 1.55 to 2.11), indicating that no coefficients were different from 0. The R^2 ranged from .05 to .06 for the various public school teacher models, and from .07 to .11 for the private school teacher models.

When the model was tested using the entire Group I model—that is, with Groups IA–E all included simultaneously instead of entered separately as described above—WESLOG still could not compute an F value for the public school sample due to a singular matrix. For the private school teacher sample, it ended with an "abnormal termination," producing no output.

Table 20 shows the WESLOG results for the public school teacher model using all Group I variables together. The odds ratio (e^{β}) is shown for each significant independent variable. This ratio indicates the odds of a member of this group leaving teaching compared with a member of the reference group. The analysis showed that, among public school teachers, the odds of a secondary math/computer science teacher leaving teaching were about three times the odds of other secondary school teachers and about twice the odds of elementary school teachers. It also indicated that the odds for teachers with more than one child 6 years or older were about one-third the odds for those with no children, and that the odds for teachers in the south were about twice the odds of teachers in the Northeast. The factors most frequently thought to be associated with career-related attrition, such as experience, education, and gender were not significant.

The R^2 was .07 for the public school model. Some statisticians believe that the R^2 has meaning in logistic regression, but many do not. The authors of both the WESLOG and SAS manuals advocate using the R^2 as an indicator of the predictive ability of the model, and they report it (or the R) for that purpose. However, prominent experts in logistic regression, such as Hosmer and Lemeshow, argue that it is not an adequate goodness-of-fit statistic.[52]

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[51]WESLOG was developed by WESTAT, Inc. See, for example, C.J. Skinner, D. Holt, and T.M.F. Smith, eds., *Analysis of Complex Surveys* (New York: Wiley, 1989), or E.S. Lee, R.N. Forthofer, and R.J. Lorimer, *Analyzing Complex Survey Data* (Newbury Park: Sage, 1990), for a discussion of why it is necessary to take into account the complex design of SASS and TFS when conducting statistical analyses.

[52]D. W. Homer and S. L. Lemeshow, *Applied Logistic Regression* (Wiley and Sons, 1989), 148–9.

Table 19—Variables for first logistic regression analyses

Variable	Predictor	Reference group
Group I: Control/descriptive variables		
Group IA: Demographic variables		
Gender	Male	Female
Race–ethnicity	Black/non-Hispanic	White, non-Hispanic
	Other	White, non-Hispanic
Marital status	Never married	Married
	Previously married	Married
Children	One dependent child and youngest is 0–5 years	No children
	One dependent child and youngest is 6+ years	No children
	More than one dependent child and youngest is 0–5 years	No children
	More than one dependent child and youngest is 6+ years	No children
Region	West	Northeast
	South	Northeast
	Midwest	Northeast
Urbanicity	Urban	Suburban
	Rural	Suburban
Level, subject	Secondary, math or computer science	Elementary
	Secondary, science	Elementary
	Secondary, other	Elementary
	Special education	Elementary
School size	Enrollment	(continuous)
Group IA (Alternative)		
School size	Enrollment 500 or more	Enrollment less than 500
Group IB: Teaching experience		
Teaching experience	Years of full-time teaching experience	(continuous)
Group IB (Alternative 1)		
Teaching experience	5–14 years full-time experience	0–4 years full-time experience
	15+ years full-time experience	0–4 years full-time experience

Table 19—Variables for first logistic regression analyses—Continued

Variable	Predictor	Reference group
Group IB (Alternative 2)		
Teaching experience	0–2 years full-time experience	15+ years full-time experience
	3–4 years full-time experience	15+ years full-time experience
	5–9 years full-time experience	15+ years full-time experience
	10–14 years full-time experience	15+ years full-time experience
Group IB (Alternative 3)		
Teaching experience	5–9 years full-time experience	0–4 years full-time experience
	10–14 years full-time experience	0–4 years full-time experience
	15+ years full-time experience	0–4 years full-time experience
Group IC: Education		
Highest degree earned	Less than BA/BS	BA/BS in education
	BA/BS not in education	BA/BS in education
	MA/MS in education	BA/BS in education
	MA/MS not in education	BA/BS in education
	Higher degree	BA/BS in education
Group ID: Career		
Career pattern	Interrupted career	Steady career
Group IE: School context		
Students	Percent free lunch eligible (public school only)	(continuous)
	Percent minority students	(continuous)
Teachers	Percent minority teachers	(continuous)
Group IE (Alternative)		
Students	5–19% minority enrollment	0–4% minority enrollment
	20–49% minority enrollment	0–4% minority enrollment
	50%+ minority enrollment	0–4% minority enrollment
	20–49% free lunch eligible	0–19% free lunch eligible
	50%+ free lunch eligible	0–19% free lunch eligible
Teachers	10%+ minority teachers	0–9% minority teachers

Table 19—Variables for first logistic regression analyses—Continued

Variable	Predictor	Reference group
Group II: Additional school contextual variables		
Students	Number of students/class	(continuous)
	Student/teacher ratio	(continuous)
	% teachers with <3 years experience	(continuous)
	% teachers with >BA/BS	(continuous)
Group III: Compensation and benefit variables		
Teaching income	Teacher income	(continuous)
	Highest district salary level (public schools)	(continuous)
	Average school salary (private schools)	(continuous)
Satisfaction with salary	Low satisfaction with salary	Medium or high satisfaction
Merit pay	Received merit pay	Did not receive merit pay
	Merit pay offered (private schools)	Merit pay not offered
Incentives	Received incentive pay	Did not receive incentive pay
	Incentives offered (private schools)	Incentives not offered
Benefits	Benefits offered	Benefits not offered
Retirement	Retirement not offered (private schools)	Retirement offered
Group IV: Certification and perception of teaching		
Certification	Not certified in main field (private schools)	Certified
Assignment	Teaching in best qualified field	Not in best qualified field
Influence on policy	Low influence on school policy	Medium or high influence
Control in classroom	Low control in classroom	Medium or high control
Help from others	Low help from others	Medium or high help
Satisfaction	Low satisfaction with teaching	Medium or high satisfaction

Table 20—Logistic regression results using WESLOG and SAS with first sample (public school teachers: leavers for career reasons only): Group I variables

Independent Variables	WESLOG Results			SAS Results		
	Coef-ficient (ß)	Standard Error	$e^{ß}$	Coef-ficient (B)	Standard Error	$e^{ß}$
Intercept	-4.36	.88		-4.36	.90	
Male	.42	.29		.42	.33	
Black, non-Hispanic	-.13	.95		-.13	.56	
Other	-.74	.94		-.74	1.03	
Never married	.32	.38		.32	.40	
Previously married	-.34	.35		-.34	.51	
Have one child (0-5 yrs)	-.67	.53		-.67	.69	
Have one child (6+ yrs)	-.50	.61		-.50	.49	
Have more than 1 child (0-5 yrs)	-.52	.38		-.52	.52	
Have less than 1 child (6+ yrs)	-1.07**	.30	.34	-1.07*	.46	.34
South	.70*	.33	2.01	.70	.46	
Midwest	.19	.45		.19	.47	
West	.77	.46		.77	.49	
Urban	-.27	.43		-.27	.44	
Rural	-.27	.32		-.27	.39	
Secondary math/comp sci.	1.12**	.36	3.06	1.12*	.54	3.06
Secondary science	1.14	.62		1.14*	.56	3.13
Other secondary	.80**	.31	2.23	.80*	.40	2.23
Special education	.35	.48		.35	.53	
Less than BA/BS	-1.42	6.84		-1.42	3.55	
BA/BS in non-education	-.31	.37		-.31	.55	
MA/MS in education	.65	.39		.65	.35	
MA/MS in non-education	.39	.45		.39	.72	
Higher degree	.31	.42		.31	.63	
Interrupted career	.02	.24		.02	.32	
Full-time teaching 5–years	-.40	.29		-.40	.48	
Full-time teaching 10–14 years	-.38	.43		-.38	.47	
Full-time teaching 15+ years	-.56	.39		-.56	.44	
School size (enrollment)	-.0003	.0002		-.0003	.0003	
Percent free lunch eligible	.01	.01		.01	.01	
Percent minority students	.002	.01		.002	.01	
Percent minority teachers	-.01	.01		-.01	.01	
R^2		.07			.00	
F Test for all B=0	Could not compute			Not provided		
Model Chi Square	Not provided			35.33 with 31 d.f. (not sig)		

NOTE: * probability <.05 **probability <.01

Some argue that there is no good measure of goodness-of-fit for logistic regression models and that the only way to assess models is to compare them to an equation with only an intercept (that is, with no independent variables), and then judge whether having specific variables in the model increases the log likelihood or not.[53] In order to compare models with added variables, the exact same sample size is necessary, which means that only cases with nonmissing values for all the variables in all the models can be included. The -2 (log likelihood) is then compared among models using a chi-square distribution of the difference. One problem, however, is that the -2 (log likelihood) rises with the number of cases and with the improved predictability of the variables. Therefore, the change in this value must be carefully considered.

One approach to interpreting the results of logistic regressions is to create a classification table, calculating the probability of leaving teaching for each case and assigning it to leaving if it were greater than 0.50 and to staying in teaching if it were less than 0.50. Then the probability could be compared with the actual value. However, this does not really measure how well the model fits either because "the expected error rate is a function of the magnitude of the slope, not necessarily the fit of the model."[54] In addition, this is difficult to do when the dependent variable has a low probability. Consequently, predicting staying would be fairly accurate, but not predicting leaving.

One recommendation was that instead of using the odds ratio (e^{β}), which indicates how well a variable did in relation to a reference group, we calculate the "estimated probability" of each group by using the Betas and the values of the variables, choosing the value of the variable, multiplying each value by its Beta, and adding them up.[55] This is the logit (L) for that group. The estimated probability (P) of that group leaving teaching would then be computed using the following formula: $P= e^{L} / (1 + e^{L})$. This probability has a confidence interval that can be calculated.

SAS Analysis

To determine whether or not the problems in obtaining an F value were due to using the BRR method with the particular data that were being used or to the specification of the model, the models were tested using SAS, which produces the same coefficients as WESLOG, but computes inaccurate standard errors. This occurs because it assumes a simple random sample and cannot take into account the complex sample design of SASS and TFS. It was also decided to test the models using SAS as a rough gauge of their usefulness. Although the SAS-generated standard errors would be incorrect, it seemed likely that if very strong (or very weak) relationships were found between the dependent variable and any of the independent variables, these results would probably hold when the standard errors were computed correctly.

The first SAS regressions were run using only the Group I independent variables (Groups Ia-e together). Table 20 compares the SAS and WESLOG results for public school teachers for Group I variables. The coefficients were the same (as they should have been), but the SAS-computed standard errors were not consistently smaller than the WESLOG-computed standard errors as was expected given the clustered sample design. This result suggests that it would not be accurate simply to inflate the SAS-computed standard errors by a design effect to approximate the standard errors that would be generated using the BRR procedure.

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[53]Trond Peterson: Personal communication with author. Berkeley, CA, March 18, 1992.

[54]Homer and Lemeshow, 147.

[55]Trond Peterson: Personal communication with author. Berkeley, CA, March 18, 1992.

The major test for goodness-of-fit provided by SAS is the "Model Chi Square."[56] It tests the null hypothesis that the coefficients for all terms in the current model except the constant were 0. The Model Chi Square was not significant for the public school teacher model that used all the Group I independent variables.

Despite the lack of overall significance for the model, some variables were individually significant. In fact, these variables were very similar (although not exactly identical) to the variables that were statistically significant in the WESLOG analysis, even though the standard errors were computed differently. Therefore, it was concluded that it would be worthwhile continuing to explore the relationship between leaving and other variables using SAS, although definitive results could not be obtained because SAS does not compute the standard errors accurately.

The next step was to test additional models using SAS. These models included Group I variables in combination with other groups: Group II; Groups II and III; Groups II, III, and IV; and Group IV. Table 21 lists the variables that proved to be significant for each combination of groups, with public and private school teachers being shown separately. The Model Chi Square was not significant for any of the public school teacher models, but was significant for all the private school models.

The private school models (which have greater credibility because the Model Chi Square was significant) suggested that teachers were more likely to leave teaching if they were "other" secondary teachers, had a degree higher than a BA/BS, received incentive pay, taught in urban schools, or reported low satisfaction with teaching. These models also suggested that teachers were less likely to leave if they had been teaching fulltime 15 or more years.

These results were interesting, and supported some of the hypotheses posed at the beginning of this chapter. However, many variables that were expected to be significant were not. More important is the fact that the analysis could not be completed using WESLOG (because of the singular matrix problem), and therefore the models could not be tested using accurately computed standard errors. Nevertheless, the similarity in the significance of variables using WESLOG and SAS for the model that WESLOG could test suggested that further exploration of the models using SAS would be useful.

Additional Efforts

In consultation with NCES, a second set of models was selected for testing. These models were tested using two different samples of teachers. First, the "full-sample" models included all those who were still teaching (stayers and movers) and all voluntary leavers (rather than just leavers for career reasons). The definition of voluntary leavers for this part of the analysis was expanded to include those who were not teaching and who listed their main reason for leaving as childrearing, family/health considerations, or retirement as well as leavers for career reasons. Involuntary leavers—those who listed school staffing action (which could be layoffs or firings) as their main, second, or third reason for leaving—were still excluded from this sample. Second, the "reduced sample" included only those who left for career reasons (that is, the same sample used in the first models).

[56]This tests the difference between the -2 log of the likelihood (the probability of the observed results given the parameter estimates) of a model with only a constant versus -2 log of the likelihood of the current model.

Table 21—List of significant logistic regression results using SAS with first sample (leavers for career reasons only) for public and private school teachers: significant variables from Groups I–IV

Independent Variables	Public school teachers			Private school teachers		
	Coef-ficient (ß)	Standard Error	$e^{ß}$	Coef-ficient (B)	Standard Error	$e^{ß}$
Group I						
Have more than 1 child (6+ yrs)	-1.07*	.46	.34			
Secondary math/comp science	1.12*	.54	3.06			
Secondary science	1.14*	.56	3.13			
Other secondary	.80*	.40	2.23	.98*	.41	2.66
Higher degree				1.74*	.71	5.70
Full-time teaching 15+ years				-1.11*	.48	.33
Groups I and II						
Have more than 1 child (6+ years)	-1.23*	.50	.29			
Secondary math/comp science	1.24*	.57	3.46			
Secondary science	1.34*	.58	3.82			
Other secondary	.93*	.42	2.53	1.16*	.42	3.19
Higher degree				1.78*	.72	5.93
Full-time teaching 15+ years				-1.07*	.50	.34
(no new variables were significant)						
Groups I, II, and III						
Have more than 1 child (6+ years)	-1.19*	.59	.30			
Percent free lunch eligible	.02*	.009	1.02			
Other secondary	.80*	.40	2.23	1.24*	.49	3.46
Received incentive pay				1.51*	.69	4.53
Groups I, II, and IV						
Have more than 1 child (6+ years)	-1.17*	.49	.31			
Secondary math/comp sci.	1.27*	.55	3.56			
Secondary science	1.13*	.57	3.10			
Other secondary	.81*	.41	2.25	1.00*	.43	2.72
Urban				1.21*	.43	3.35
Full-time teaching 15+ years				-.98*	.49	.37
Low satisfaction w/ teaching				1.46**	.44	4.31
R^2	.00			.00-.01		
Model Chi Square	Never significant			67-82**(always sig)		

NOTE: * probability <.05 **probability <.01

The use of the full sample was based on the assumption that trying to predict the attrition of only about 3 percent of the teachers made it difficult to distinguish this group from the others and contributed to the relatively few significant variables. It was hoped that increasing the sample would make leaving a less rare (and, therefore, more predictable) event. However, including all voluntary leavers meant that the analysis would identify only those factors related to leaving that were common to all the subgroups of leavers. The impact of factors that affected only one subgroup would be buried.

The specification of the model and that of the sample was changed somewhat. For instance, the number of categories for some of the variables and the total number of variables in the models were reduced to make the analyses clearer. In addition, changes were made to some of the variables, such as squaring the experience variable to make it nonlinear.

Table 22 shows the variables tested in the new models. A core set of variables (Group I) was included in every model. The three additional groups were added separately, one group at a time, to the core group. The final model consisted of the core group and any variables that were significant in the separate models. The models were run separately for public and private school teachers and for the full and reduced samples.

A second attempt was made to conduct the analysis with correctly computed standard errors. It seemed possible that the abnormal terminations obtained with WESLOG stemmed from using the BRR method with a model containing many dummy variables and a relatively small number of cases in which the dependent variable was 1 (that is, the teacher was a leaver).[57] Using the BRR procedure in logistic regression involves taking repeated half samples and performing the regressions on these half samples. When the sample is drawn, half of the cases have their weights doubled, and half are assigned weights of 0. Cases with weights of 0 are essentially "thrown out." It seemed possible that one or more of the half samples might have had perfect correlations among some of the variables, leading to a singular matrix.

To get around this problem, Rust suggested that the BRR procedure be continued, but with an alternative set of weights (Fay weights). The Fay weights multiply the original weights by 1.5 or .5 (rather than 2 or 0), and therefore do not involve throwing out half the sample. This approach was tried with the second models. Using the Fay weights solved the problem of abnormal terminations of the computer runs, but WESLOG still could not compute the F value for any of the public school teacher models and could do so for only one of the private school teacher models because it again encountered singular matrices.

Tables 23 and 24 show the results of testing the full sample and revised independent variables using WESLOG (with Fay weights) and SAS. All the public school teacher models and all but one of the private school models tested with SAS had significant Model Chi Squares. It must be kept in mind, however, that for neither the WESLOG nor SAS models were the standard errors accurately computed. Therefore, this analysis must be considered only exploratory. More variables were significant when tested with WESLOG than with SAS. Some of the findings were counterintuitive.

[57]Keith Rust: Personal communication with the author, 1992.

Table 22— Revised variables for logistic regression analysis

Variable	Predictor variable	Reference variable
Group I: Control/descriptive variables		
Gender	Male	Female
Age	Years	(continuous)
Gender/age	Gender * age	(continuous)
Teaching experience	0–3 years	4+ years
Race–ethnicity	Minority	White, non-Hispanic
Group II: Teacher characteristics		
Marital status	Never married	Married or previously married
Children	No dependent children	Dependent children
Education	Any graduate degree	Non-education BA/BS degree or less
	Education BA/BS degree	Non-education BA/BS degree or less
Level, subject	Secondary, math or computer science	Secondary, other
	Elementary	Secondary, other
	Special education	Other
Field	Teaching in best qualified field	Teaching in other field
Group III: Workplace conditions/satisfaction		
Influence on school policy[1]	Low influence on school policy	Medium influence on school policy
	High influence on school policy	Medium influence on school policy
Control in classroom[1]	Low control in classroom	Medium control in classroom
	High control in classroom	Medium control in classroom
Help from others[1]	Low help from others	Medium help from others
	High help from others	Medium help from others
Satisfaction with teaching[2]	Low satisfaction with teaching	Medium satisfaction with teaching
	High satisfaction with teaching	Medium satisfaction with t teaching
Satisfaction with salary[3]	Low satisfaction with salary	Medium satisfaction with salary
	High satisfaction with salary	Medium satisfaction with salary
Physical abuse of teachers	A problem in teacher's school	Not a problem in teacher's school
Verbal abuse of teachers	A problem in teacher's school	Not a problem in teacher's school
Group IV: School/district characteristics		
School size	Enrollment	(continuous)
Minority enrollment	% minority enrollment	(continuous)
Free lunch eligible	% free lunch eligible	(continuous)
Retirement	Retirement benefits offered (private)	Retirement benefits not offered

[1]Calculated by taking the average of responses to 4 or 5 questions, with low=<2.5; medium=2.5 to <4.5; high=4.5 to 6.0 on a 6-point scale.

[2]Low=1; medium=2 or 3; high=4 or 5 on a 5-point scale.

[3]Low=1; medium=2 or 3; high=4 on a 4-point scale.

Table 23—List of significant logistic regression results using WESLOG with full sample (all voluntary leavers) for public and private school teachers: all significant variables from Groups I—IV

Independent Variables	Public school teachers			Private school teachers		
	Coef-ficient (ß)	Standard Error	$e^{ß}$	Coef-ficient (ß)	Standard Error	$e^{ß}$
Group I						
Male	4.75**	.98	115.58	6.21**	1.52	497.70
Age in years	-.12**	.02	.89			
Age^2	.001**	.0002	1.00			
Male * Age	-.24**	.05	.79	-.37*	.08	.69
Male * Age^2	.003**	.001	1.00	.005*	.001	1.01
Teaching experience 0–3 years	.40**	.09	1.49			
Minority	-.61*	.31	.54			
Groups I and II						
Male	3.29**	1.01	26.84	4.65**	1.79	104.58
Age in years	-.16**	.03	.85	-.11**	.04	.90
Age^2	.002**	.0003	1.00	.001*	.0003	1.00
Male * Age	-.16**	.05	.85	-.31**	.10	.73
Male * Age^2	.002**	.001	1.00	.004*	.002	1.01
Teaching experience 0–3 years	.26*	.11	1.30			
Minority	-.70**	.11	.50			
Never married	-.68**	.10	.51	-1.07**	.11	.34
No children	.51**	..09	1.67	.66**	.15	1.93
BA in Education				-.26*	.13	.77
Secondary science teacher				-1.01**	.21	.36
Elementary teacher				-.51*	.17	.60
Special Education teacher	-.27*	.12	.76			
Teaching in best qualified field	-.26*	.12	.77	-.62**	.16	.54
Groups I and III						
Male				7.82**	1.82	2489.91
Age in years	-.15**	.03	.86	-.05*	.02	.95
Age^2	.002**	.0003	1.00			
Male * Age	-.24**	.11	.79	-.47**	.10	.63
Male * Age^2	.003**	.001	1.00	.006**	.001	1.01
Teaching experience 0–3 years	.40**	.10	1.49			
Minority	-.73**	.33	.48			
High control in classroom	-.20*	.10	.82	-.34**	.10	.71
Low amt. of help from others	-.29**	.10	.75			
High amt of help from others	-.42**	.20	.66			
Low satisfaction with teaching	.66**	.21	1.93			
High satisfaction with teaching				-.94**	.11	.39
High satisfaction with salary				.53**	.11	1.70
Physical abuse of tchrs a problem				2.19**	.52	8.94

Table 23—List of significant logistic regression results using WESLOG with full sample (all voluntary leavers) for public and private school teachers: all significant variables from Groups I—IV—Continued

Independent Variables	Public school teachers			Private school teachers		
	Coefficient (ß)	Standard Error	$e^{ß}$	Coefficient (ß)	Standard Error	$e^{ß}$
Groups I and IV						
Male	4.81**	1.07	126.47			
Age in years	-.16**	.03	.885			
Age^2	.002**	.0003	1.00			
Male * Age	-.23**	.05	.79			
Male * Age^2	.002**	.001	1.00			
Teaching experience 0–3 years	.48**	.10	1.62			
Minority	-.81**	.15	.44			
School size in enrollment				-.001*	.001	1.00
Percent minority enrollment				-.01*	.004	.99
Percent free lunch eligible				-.01*	.004	.99
R^2	.04—07			.03—09		
F value	Could not compute			Could not compute Groups I—II 6.55** for Groups I and IV		

NOTE: * probability <.05 **probability <.01

Table 24—List of significant logistic regression results using SAS with full sample (all voluntary leavers) for public and private school teachers: all significant variables from Groups I–IV

Independent Variables	Public school teachers			Private school teachers		
	Coef-ficient (ß)	Standard Error	$e^{ß}$	Coef-ficient (ß)	Standard Error	$e^{ß}$
Group I						
Male	4.77*	2.19	117.92	6.25**	3.10	518.00
Age in years.	-.12**	.02	.89			
Age^2	.001**	.0002	1.00			
Male * Age	-.24*	.11	.79	-.38*	.16	.68
Male * Age^2	.003*	.001	1.00	.005*	.002	1.01
Minority	-.61*	.31	.54			
Groups I and II						
Age in years.	-.16**	.03	.85			
Age^2	.002**	.0003	1.00			
Male * Age^2				.004*	.002	1.01
Minority	-.70*	.33	.50			
Never married	-.68*	.29	.51	-1.07**	.26	.34
No children	.51**	.19	1.67	.66**	.24	1.93
Secondary science teacher				-1.01*	.49	.36
Elementary teacher				-.50*	.23	.61
Teaching in best qualified field				-.62**	.21	.54
Groups I and III						
Male	4.70*	2.24	109.95	7.84*	3.26	2540.20
Age in years.	-.15**	.03	.86			
Age^2	.002**	.0003	1.00			
Male * Age	-.24*	.11	.79	-.47**	.17	.63
Male * Age^2	.003*	.001	1.00	.006**	.002	1.01
Minority	-.73*	.33	.48			
High amt of help from others	-.42*	.20	.66			
Low satisfaction with teaching	.66**	.21	1.93			
High satisfaction with teaching				-.94**	.23	.39
High satisfaction with salary				.53*	.21	1.70
Physical abuse of tchrs a problem				2.19**	.30	8.94
Groups I and IV						
Male	4.83*	2.37	125.21			
Age in years.	-.16**	.03	.85			
Age^2	.002**	.0003	1.00			
Male * Age	-.24*	.12	.79			
Male * Age^2	.					
Minority	-.80*	.36	.45			
R^2	.03—04			.00—03		
Model Chi Square	56–81** (always sig)			7–60**(Grp IV not sig)		

NOTE: * probability <.05 **probability <.01

The full-sample analysis suggested that public school teachers were more likely to leave teaching if they were male, had 0–3 years of teaching experience, had no children, or reported low satisfaction with teaching. It also indicated that these teachers were less likely to leave if they were older, an older male, minority, never married, teaching in the field for which they were best qualified, special education teachers, or if they reported a low (WESLOG model only) or high amount of help from others or high control in the classroom (WESLOG model only).

In the case of private school teachers, the full-sample analysis suggested that teachers were more likely to leave if they were male, had no children, reported high satisfaction with their salary, or reported that physical abuse of teachers was a problem in their school. They were less likely to leave if they were an older male, older (WESLOG model only), never married, had a bachelor's degree in education (WESLOG model only), taught secondary science or elementary school, taught in their best qualified field, or if they reported high control in the classroom (WESLOG model only) or high satisfaction with teaching.

Tables 25 and 26 show the WESLOG and SAS models for the reduced sample (that is, for teachers who left teaching only for career-related reasons). Fewer variables were significant, especially in the models tested using SAS. This may explain why relatively few variables were significant when the reduced sample was used for the first WESLOG and SAS models.

Because of the methodological difficulties encountered, a draft of this report was submitted to four outside reviewers who are acknowledged experts in the areas of teacher supply and demand, statistics, and logistic regression analysis. They were invited to comment on the conceptual models, the methodology, and the results of the logistic regression analysis. The next chapter summarizes their comments.

Table 25—List of significant logistic regression results using WESLOG with reduced sample (leavers for career reasons only) for public and private school teachers: all significant variables from Groups I–IV

Independent Variables	Public school teachers			Private school teachers		
	Coef-ficient (ß)	Standard Error	$e^{ß}$	Coef-ficient (ß)	Standard Error	$e^{ß}$
Group I						
Male	4.68**	.97	107.77			
Age in years	-.11**	.02	.90			
Age^2	.001**	.0002	1.00			
Male * Age	-.16**	.05	.85			
Male * Age^2	.001**	.001**	1.00			
Teaching experience 0–3 years				.64**	.13	1.90
Groups I and II						
Male	3.53**	1.00	34.12			
Age in years	-.12**	.03	.88	.12*	.05	1.13
Age^2	.001**	.0004	1.00	-.002**	.001	1.00
Male * Age	-.11*	.05	.90			
Teaching experience 0–3 years				.64**	.15	1.90
No children	.39**	.12	1.48	.47**	.15	1.60
Any graduate degree				-.32*	.16	.73
BA in Education	.37**	.14	1.45	-.71**	.15	.49
Secondary science teacher				-.74*	.29	.48
Elementary teacher	-.63**	.12	.53	-.46*	.20	.63
Teaching in best qualified field	-.41**	.13	.66	-.74**	.21	.48
Groups I and III						
Male	4.51**	1.09	90.92	2.41*	1.18	8.50
Age in years	-.12**	.02	.88			
Age^2	.001*	.003	1.00			
Male * Age	-.16**	.05	.85			
Male * Age^2	.001*	.001	1.00			
Teaching experience 0–3 years	.27*	.12	1.31	.48**	.16	1.62
Low influence on policy	.23*	.10	1.26			
High influence on policy	-.42*	.20	.66			
Low control in classroom	.77*	.28	2.16	-11.57*	4.65	.0001
High control in classroom				-.56**	.14	.57
Low help from others	.34**	.11	1.40			
High help from others				.62**	.14	1.86
Low satisfaction with teaching	.28**	.12	1.32	.53**	.19	1.70
High satisfaction with teaching	-.83**	.40	.44	-1.23**	.17	.29
Physical abuse of teachers a problem				1.41*	.63	4.10

Table 25—List of significant logistic regression results using WESLOG with reduced sample (leavers for career reasons only) for public and private school teachers: all significant variables from Groups I–IV—Continued

Independent Variables	Public school teachers			Private school teachers		
	Coef-ficient (ß)	Standard Error	$e^{ß}$	Coef-ficient (ß)	Standard Error	$e^{ß}$
Groups I and IV						
Male	4.65**	1.09	104.58			
Age in years	-.13**	.02	.88			
Age^2	.001**	.0002	1.00			
Male * Age	-.16**	.05	.85			
Male * Age^2	.001*	.001	1.00			
Teaching experience 0–3 years				1.29**	.27	3.63
Minority	-.49*	.17	.61			
Percent minority enrollment				.01**	.002	1.01
Percent free lunch eligible				-.02**	.004	.98
R^2	.06-.09			.03-.11		
F value	Could not compute			Could not compute Groups I and II Groups I and III: 9.59** Groups I and IV: 6.70**		

NOTE: * probability <.05 **probability <.01

Table 26—List of significant logistic regression results using SAS with reduced sample (leavers for career reasons only) for public and private school teachers: all significant variables from Groups I–IV

Independent Variables	Public school teachers			Private school teachers		
	Coefficient (ß)	Standard Error	$e^{ß}$	Coefficient (ß)	Standard Error	$e^{ß}$
Group I						
Age in years	-.11**	.02	.90			
Age^2	.001**	.0004	1.00			
Groups I and II						
Age in years	-.12**	.03	.89			
Age^2	.001**	.0004	1.00			
Teaching in best qualified field				-.74**	.33	.48
Groups I and III						
Age in years	-.12**	.03	.89			
Age^2	.001*	.0005	1.00			
High satisfaction with teaching	-.83**	.40	.44	-1.23**	.41	.29
High satisfaction with salary				.71*	.34	2.03
Groups I and IV						
Age in years	-.16**	.03	.85			
Age^2	.002**	.0003	1.00			
(no new variables were significant)						
R^2	.02—03			.00—02		
Model Chi Square	32-51** (always sig)			9-45 (Grps I and IV not sig)		

NOTE: * probability <.05 **probability <.01

Chapter 5

Reviewers' Comments

The four outside reviewers' comments covered three broad areas: the general approach taken for this analysis, the specification of the variables used, and the interpretation of the results. Their comments are summarized here.

Bonnie S. Billingsley, Ed.D., Associate Professor
Virginia Tech, College of Education

General Approach

It is obvious from the review of theories in Chapter 3 that the authors have a good grasp of the teacher retention literature. They review several different theories and a broad range of variables that influence retention, and rely upon the writings of Grissmer and colleagues extensively, which makes sense given their recent contributions to the knowledge base in this area. The hypotheses posited for the multivariate analysis are consistent with the theories proposed in Chapter 3 and appear to be logical. Many of the variables have been included in previous research studies on attrition/retention and commitment. Some of the hypotheses have strong support based on the theories reviewed and previous research (e.g., age, gender).

The first and second models include different samples, recognizing that attrition factors are likely to differ for subgroups of teachers. I would also suggest investigating an "early career" model and including a sample of stayers and leavers with less than 10 years of experience (or under a certain age, such as 35), since this is a likely-to-leave group. The proportion of those leaving will also be higher among this group.

Specification of Variables

The authors have included the major groups of variables needed to investigate attrition among teachers. There are other variables I would suggest including, but some of these are not in the SASS database. Others are suggested below.

The relatively large number of variables and their groupings complicate and confound the analysis. The authors do not provide a rationale for the groupings of variables, and it is not clear why some of the variables are grouped the way they are. For example, the demographic variable groups include variables that are not demographic measures (e.g., subject level taught). Also, the fact that the different groups are entered using a manual stepwise approach implies that the specific composition of the groups influence the various forms (specifications) of the model and consequently influence the statistical results.

Perhaps consider reducing the number of variables using either principal components or factor analysis to identify more defensible variable groups. These can be used in the logit analysis as conceptual dimensions that reflect the meaningful information contained in the entire set of variables. In effect, the conceptual dimension "indexes" would reduce the number of variables required in the analysis. In their current form, the models are likely to include too many variables grouped in a questionable manner that confound the analysis through the application of the manual stepwise approach.

I would use a conceptual framework for teachers' career decisions based on a review of attrition/retention literature to evaluate the specific independent variables included in the models.[58]

Professional qualifications. Several variables that relate to teachers' professional qualifications are included in the analysis such as: highest degree earned, whether or not they are teaching in the field for which they are best qualified, whether or not they are certified in their primary assignment field, and teaching experience. Although a variety of other professional qualifications might be considered, they are not available on the SASS database. However, it would be worth considering whether there is a good proxy for "entry path" (teachers entering through traditional versus nontraditional routes).

Work conditions and work rewards. Prior research suggests that work conditions and rewards are associated with teacher retention. The authors discuss several "work condition/work reward" hypotheses. Some of the variables included in this analysis are more "behavioral" (e.g., number of students/class, student/teacher ratio, high minority enrollment, urbanicity, school size, teaching income, merit pay), while others might be considered "affective reactions" to the conditions of teaching (e.g., satisfaction with salary, satisfaction with teaching). It seems logical that the behavioral variables might be predictive of the affective measures (e.g., high class sizes predictive of lower job satisfaction).

Some of the student variables are likely to be highly correlated (high minority enrollment and free lunch eligible as well as number of students/class and student/teacher ratio). Perhaps high influence over school policy and high control over classroom practices could be combined into one "control" variable.

Another problem in evaluating these variables is that the reader is not provided with a description of the measures, and no reliability coefficients are given. Section 5 of the questionnaire contains many work-related items. However, I could only guess which items made up job satisfaction. Also, I could not determine whether the variables listed under item 31 (school problems) were included in the analyses. I would use factor or principal components analysis as outlined above to identify defensible work-related variables from those included in the SASS database. I would also include (a) support variable(s) (e.g., administrative, colleague, and parents) in the analyses, given the fact that previous research suggests an association between support and attrition. Other work-related variables of interest include opportunities for professional development, workload, and school climate. I would also consider including grade level in the analyses since a number of researchers have found that grade level taught has been related to attrition, with secondary teachers leaving sooner than elementary teachers.[59]

Personal factors. Appropriate teacher characteristics (e.g., age, race–ethnicity, gender, marital status, children, high family income) have been included in the models.

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[58]B. Billingsley, "Teacher Retention and Attrition in Special and General Education: A Critical Review of the Literature," *The Journal of Special Education* (forthcoming).

[59]M.M. Bentzen, R.C. Williams, and P.A. Heckman, "A Study of Schooling: Adult Experiences in School," *Phi Delta Kappan* 61 (1980): 394-397; B. Heyns, "Educational Defectors: A First Look at Teacher Attrition in the NLS–72," *Educational Researcher* 17 (1988): 24–32; P.M. Keith, R.D. Warren, and H.E. Dilts, "Teacher Education Graduates: Sex, Career Plans, and Preferences for Job Factors," *Urban Education* 18 (1983): 361–75; R.J. Murnane, J.D. Singer, and J.B. Willett, "The Influences of Salaries and "Opportunity Costs" on Teachers' Career Choices: Evidence from North Carolina," *Harvard Educational Review* 59 (1989): 325–346.

Interpretation of Results

Multicollinearity. It was asserted that almost all of the correlations among the independent variables were "very low." Yet WESLOG could not compute an F value for the public school sample due to a singular matrix. Such singularity generally implies the presence of at least two redundant variables. I suggest that a complete correlation matrix be provided. Further, it would be helpful to evaluate a more comprehensive set of multicollinearity diagnostics such as variance inflation factors, the eigenvalues and eigenvectors of the correlation matrix, or both. The singular matrix generated by WESLOG is a signal that such additional analysis of the specification is appropriate.

Goodness-of-fit. The R^2s do not inspire much confidence as reported. I suggest re-evaluating the goodness-of-fit of the models in light of the fact that dichotomous dependent variable models are unlikely to produce R^2s close to 1. Research by Morrison explains why it is important in interpreting logit models to recognize that the upper bound for R^2 is probably significantly less than 1.[60] I suggest using Morrison's approach to estimate the upper bound for R^2 under the assumption that the predicted probabilities follow a beta distribution. An "effective" R^2 can be estimated as the ratio of the observed-to-the-upper bound for R^2. The observed (empirical) R^2 is computed as: (model χ^2 - 2k)/-2L(0), where k is the number of variables omitting the intercept, and L(0) is the maximum log-likelihood including only the intercept. This analysis will add a more meaningful indication of goodness-of-fit to the analysis. Further, I suggest reporting and evaluating the number of correctly classified observations.

Interpretation of the estimated coefficients. I suggest reporting and interpreting the logit regression elasticity coefficients rather than the simple coefficients. Define Prob ($Y_i = 1$) as the probability that teacher i will leave teaching; Z_i as the arbitrary index used to ensure that the predicted probabilities reside in the unit interval for all Xs (the vector of explanatory variables); and f(Z) as the value of the logistic density function for each possible value of the Z_i index. Thus, the elasticity coefficients can be an estimate for each explanatory variable as follows:

$$[\delta \text{Prob}\,(Y_i = 1)/\delta X_i\,]\; X_i/\text{Prob}\,(Y_i = 1) = f(Z_i)\;[\beta X_i/\text{Prob}\,(Y_i = 1)]$$

I suggest using the mean value of each explanatory variable and the mean predicted probability of membership in class 1.[61] The elasticity coefficients are easier to interpret than the current statistics.

Summary

Overall, the lack of meaningful results are possibly due to several factors, including: 1) the extreme split between leavers and stayers as you suggest; 2) the use of variables that at least appear to be highly correlated; 3) the use of too many dummy variables (it would be preferable to use continuous variables); and 4) the possible lack of good work-related measures (e.g., school climate, administrative support, etc.), although it was difficult to evaluate these variables due to insufficient description.

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[60]D.Morrison, "Upper Bounds for Correlations Between Binary Outcomes and Probabilistic Predictions," *Journal of the American Statistical Association,* 67 (1972), 68–70.

[61]For more information, see Robert S. Pindyck and Daniel L. Rubinfeld, *Econometric Models and Economic Forecasts.* (New York: McGraw Hill, 1981).

General Approach

In summary, I believe that the technical procedures to handle the complex nature of the data are state-of-the-art. My concern with the manuscript lies in the implementation of the logistic regression modeling procedure itself.

The discussion of the use of SAS versus WESLOG is sound. Landis et al. discuss this approach of using standard linear modeling software (with weights) in comparison to a procedure that accounts for the complex sample design, and advocate the approach the authors have used as a sound practical procedure.[62]

Restricting the analysis to voluntary leavers seems sound, with one exception. One aspect of teaching that is attractive to many is the fact that it is a career in which it is relatively easy to regain employment after a move (due to a spouse's relocation, for example). Thus, in a sense, such a move is voluntary—if the teacher were only able to obtain work in a few specific locations, this might well affect the decision of the family to relocate. It might be useful to develop models with and without movers, both for this reason and because at a higher level (e.g., national) movers do not constitute attrition at all.

The decision to model public and private teachers separately, rather than just to include sector as an independent variable, may have been a mistake. Differences between public and private attrition rates might be explained by differences in the age and sex distributions of these two groups of teachers, for example, and it would not be possible to discern and establish this confounding relationship with separate models for public and private school teachers. One could learn a lot by discovering which other factors have significant interaction with public/private and also by being able to measure and test the effect of public/private school, controlled for other factors. If there were many interactions, or if different data were available for public versus private teachers (e.g., district level data), then the use of distinct models would be appropriate; however, these issues need to be investigated more fully. This also raises the question about movers between public and private school systems. To what extent do teachers leave public schools to teach in private schools and vice versa?

Using multi-level data is not as much of a problem as it appears to be in this report, because the one-level model analysis used takes into account the hierarchical nature of the data. It is true that the models available are more restrictive. One cannot measure interactions between random effects at one level and fixed effects at another level, for example; they must be assumed to be 0. Also, one cannot partition the variance of the random components into, for example, school and teacher components. However, the inference about the parameters in the model will be correct and will not suffer from the problems of incorrect inference that occur if one simply attaches school-level variables to teachers and then analyzes teacher data ignoring the clustering of teachers in schools. The analyses would be equally valid if there were many teachers per school and district, but in that case, an alternative methodology (HLM) would be available.

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[62]J.R. Landis, J.M. Lepkowski, S.A. Eklund, and S.A. Stehouwer, "A Statistical Methodology for Analyzing Data from a Complex Survey: The First National Health and Nutrition Examination Survey," in *Vital and Health Statistics,* Series 2, no. 92 (Public Health Service Publication 82-1366, Washington, D.C.: U.S. Government Printing Office, 1982).

To illustrate these points, consider a simple HLM:

$$\text{logit}(P) = \beta_0 + \beta_1 X + \varepsilon$$

$$\beta_0 = \gamma_{00} + \gamma_{10} Y + \delta$$

$$\beta 1 = \gamma_{01} + \gamma_{11} Y + \theta;$$

where P is the probability of staying; X is some teacher characteristic; Y is a school characteristic; and ε, δ, and θ are random terms. This model can be expressed as:

$$\text{logit}(P) = (\gamma_{00} + \gamma_{10} Y + \delta) + (\gamma_{01} + \gamma_{11} Y + \theta) X + \varepsilon$$

$$= \gamma_{00} + \gamma_{01} X + \gamma_{10} Y + \gamma_{11} XY + \theta X + (\delta + \varepsilon).$$

Provided that $\sigma_\theta^2 = 0$ and that one is not concerned about establishing the relative magnitude of σ_γ^2 and σ_ε^2, then this model is reduced to a single (teacher) level model, with the school characteristic Y treated as a teacher-level variable. WESLOG can give correct inference and estimates for the parameters γ_{00}, γ_{01}, γ_{10}, and γ_{11}. The weakness of this approach is the reliance for its validity on the assumption that $\sigma_\theta^2 = 0$.

Specification of Variables

The factors "high satisfaction with salary" and especially "high satisfaction with teaching" are co-outcomes or at least intervening variables. One cannot change a person's satisfaction with teaching without changing some other factors such as salary or pupil/teacher ratio. Thus, before including such factors in the model, I think that it is necessary to ensure that they capture an important component not reflected in the other variables, and that at least there are some ideas or theories as to what the (unmeasured) underlying factors are. It is not very useful to learn that the main reason teachers left teaching was because they did not like it.

The idea of considering continuous variables as both continuous and dichotomous is sound. It enhances the ability to detect continuous variables that have threshold or ceiling effects.

Interpretation of Results

R^2 meaning. My experience leads me to endorse the discussion about the inappropriateness of the R^2 statistic for logistic regression, and I think that the discussion about this is sound. I also agree that the estimated probability of a group's leaving can be computed using the formula $P=e^L/(1+e^L)$. With the variance-covariance matrix, one can derive large-sample confidence intervals for L in each case. Using the fact that P is a monotone function of L, one can derive an asymmetric large-sample confidence interval for P. That is, if the confidence limits for L are L_l

and L_u, (lower and upper, respectively), then confidence limits for P are $e^{L_l} / (1 + e^{L_l})$ and $e^{L_u}/(1 + e^{L_u})$, respectively.

Statistical significance of the model. If the model lacks significance overall using SAS, then might it not be concluded that none of these variables is worth pursuing further, even though some are individually significant using WESLOG (and SAS)? Otherwise, why worry about the overall test of fit at all?

I am very puzzled that with so many significant terms in the model, the overall model fit was not significant. Are the results being interpreted correctly? For instance, in the Private School Groups I, IV example, the overall model was highly significant with $p < 0.001$ ($F=6.55$ with 10, 39 degrees of freedom). Alternatively, perhaps this is a result of including so many terms in the model. Did you consider using a stepwise procedure because of the large number of variables involved? I am also somewhat surprised that the results overall are not significant for public schools, yet are for private schools. Presumably the sample sizes are smaller for private schools, and the sizes of the effects of the significant variables do not look very different. I wonder if the weights within each group (public and private) have been scaled so that they have a mean of 1.0 in each case. However, if they have not, I would expect the result to understate significance for private school teachers and overstate it for public school teachers, since my guess is that SASS oversamples private school teachers. (This is indicated by the sample sizes.)

Singular matrices. Korn and Graubard discuss the issue of singular matrices in analyzing complex survey data.[63] I do not think this is a serious problem here as the approach of using SAS to assess overall model fit, checking against WESLOG results for the comparability of individual parameter significance, is quite sound.

Fay weights. The WESLOG results can be corrected by simply multiplying all of the standard error estimates obtained from WESLOG by a factor of 2 (derived from the use of factors 0.5 and 1.5 in obtaining the Fay weights). This will eliminate some variables from tables 21 and 23 and probably change some **s to *s. It will also make the results of these tables very similar to those in tables 22 and 24, again showing that you could reasonably proceed, on the basis of these analyses, with just using the SAS analyses.

Summary

The authors have done a good job of trying to deal with the technical issues involved in using logistic regression with complex survey data. However, I see three major problems. First, logistic regression just does not really explain why teachers leave teaching. The values in tables 22 and 24 are either close to 1 or else are extremely unreliable, as in the case of "male." Second, no consideration has been given to possible interactions among the significant main effects. It seems highly plausible that such interactions might exist and might even substantially increase the explanatory power (fit) of the models. Finally, there is no discussion of the interpretation or plausibility of the final models. What is the overall message? Does it make sense, for example, in table 24 that "high satisfaction with salary" has a positive coefficient, indicating that those more satisfied are more likely to leave?

The discussion in Chapter 6 (Conclusions) of whether the sample of teachers who leave for career reasons is too small to be systematically different from other teachers gets to the heart of the problem in identifying the characteristics of a relatively rare group. It is unlikely that the

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[63]Edward L. Korn and Barry I. Graubard, "Simultaneous Testing of Regression Coefficients With Complex Survey Data: Use of Bonferroni *t* Statistics," *The American Statistician* 44 (1990):270–76.

really important variables have been measured. The only real hope lies in looking at two-way and perhaps higher order interactions, which was not done.

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General Approach

My comments focus on the logistic regression modeling used in this report. I am not familiar with the WESLOG program, but appreciate the fact that it is trying to incorporate the proper statistical weights into the estimation process. My comments relate to building the logistic regression model with conventional software. I believe that if you were to find a satisfactory model using standard software first, and then refit the final model with WESLOG, the process could be considerably easier and more understandable than it currently is. Also, many of the basic procedures used in building logistic regression models are simply not set up for situations where the statistical weights are unequal for each subject. It would be important to assess the performance of the model with traditional software because it is not possible with the more specialized software. Procedures such as goodness-of-fit testing, analysis of logistic regression diagnostics, and area under ROC curves should not be omitted.

All the models are over-parameterized. There are simply too many nonsignificant variables included in each model. This is manifested by the matrix singularities and strange results in the odds ratios and associated confidence intervals. The fact that the models are full of nonsignificant independent variables has led to very unstable results. For example, table 18 demonstrates a very poor model. Notice the very large standard errors associated with the "less than BA/BS" category or the large standard error of the "Black, non-Hispanic" group relative to the beta in that group. These are indications that the model has fallen apart statistically. It is much better to build smaller models that behave in a stable manner, have statistically significant terms, and fit. My approach would have been to build smaller, significant, and well-fitting models with SAS, and then to refit those models with the WESLOG method incorporating jackknifing or BRR to corroborate the results and better estimate parameters.

I would concentrate more on assessing the performance of the models. With modern computer software it is easy to fit models to data. For example, anyone can fit a straight line to a set of X's and Y's, but the straight line is not always appropriate. This has to be checked with logistic regression, as well by computing goodness-of-fit tests and examining diagnostic statistics to see if there are any highly influential or poorly fit covariate patterns. More attention should be paid to these issues.

Specification of Variables

The use of dummy variables in logistic regression analysis is very important. The 0, 1 coding chosen for the dummy variables is fine if there is an appropriate reference group. An alternative would be to use +1, -1 coding to allow comparison of each region to the national average, rather than to a single reference group. This "deviation from means" type of coding is quite useful in some instances, as opposed to the more commonly used "reference cell" type of coding used in this report.

I would suggest that the scale of an independent variable X be checked before including it in the logistic model as a continuous variable. Inclusion assumes that the logit is linear in X, which may or may not be the case. This assumption must be tested. If it is not true, then the

variable can be categorized or transformed to make it more appropriate for inclusion in a logistic regression model.

The report mentions that bivariate tests were conducted relating each independent variable to the dependent variable. It is very important that this be done in order to select (from many potential predictor variables) those that are related to the outcome in a crude sense. If a variable is not related to the outcome in this simple screen, it probably will do more harm than good to include it in the model. The P values associated with these bivariate tests should be reported.

It is also mentioned that "the intercorrelations of the independent variables and the correlations with the dependent variable were examined for possible multicollinearity." Multicollinearity in logistic regression manifests itself by large regression coefficients, large standard errors associated with these coefficients, and highly variable confidence intervals for odds ratios. Although very useful in multiple linear regression, computing the tolerance or other functions of intercorrelations between the independent variables is not useful with logistic regression.

Interpretation of Results

I object very strongly to the use of R^2 as a measure of performance of logistic regression models. It simply does not have the same interpretation as it does for linear regression and is not useful. Some people use the Pearson chi-square or the deviance chi-square to assess fit. This also is an incorrect procedure for the type of data being analyzed here.

I would strongly suggest that any models be evaluated with formal goodness-of-fit tests. These are easy to perform with standard statistical packages such as SAS, SYSTAT (LOGIT module), STATA, and others that have the Hosmer–Lemeshow procedure built in. Because WESLOG will not do this, I suggest building and assessing the models first assuming the sample is a simple random one, and then after you are satisfied that you have a good model, refitting the coefficients and standard errors in a manner that accounts for the complex nature of the sample.

While the Hosmer–Lemeshow test is not without imperfections, it is the best we have right now, and it will let you know immediately if your model is not reflecting the true outcome experience in the data. The likelihood ratio test is not a measure of *fit*. It simply tests the *significance* of terms in a model or between models.

There is some discussion about 2 x 2 classification tables. We believe that such tables are only of limited value if the objective of your model is to make a binary prediction for each subject. The model may have very poor fit and have good classification. First, you need to examine fit. Also, when you place a subject into a 2 x 2 classification table, you are losing a lot of information about that subject's probability of having the outcome. That is, a subject whose probability is .02 is considered the same for purposes of classification as another subject whose probability is .48. Similarly, a subject whose probability is .48 is predicted to have an entirely different outcome than one whose probability is .52. This seems to me to represent a distortion of the meaning of probability. Confidence intervals could be calculated for each subject, but it is not clear what you would do with them.

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General Approach

The study involves the binary response variable of teachers who are leavers or stayers. Such studies are modeled using the binomial distribution. The probabilities are functions of linear combinations of teacher and school characteristics. Since some of the characteristics are continuous, the general logistic regression model is appropriate.

The classical statistical models involve assumptions that do not reflect the complexity in the SASS and TFS surveys.[64] Therefore, they require software that will take into account the complex sampling design. The purpose of the analysis was to assess the impact of possible explanatory variables on the binary response variable. Prentice and Pyke have shown the remarkable fact that in this type of study the estimators of the parameters for the explanatory variables in a logistic regression model are consistent, as is the sample information matrix.[65] The Prentice–Pyke result does assume that the logistic model is correct. However, this has yet to be established in this study.

The number of variables should be reduced. Table 18 gives the overall view of the data with all 31 variables included. The improvement in the model is measured by the likelihood ratio test with $\chi^2_{31} = 35.33$. The next step should be a backwards elimination of nonsignificant variables. I would recommend deleting some of the nonsignificant variables, and recomputing the model and the χ^2 goodness-of-fit test. I believe what will happen is that χ^2 will be only slightly smaller than 35.33, but the degrees of freedom will change from 31 to 9 (4 for child, 4 for secondary, and 1 for free lunch). The test will then be very significant. SAS will do this automatically, but all dummy variables in a group should be retained if one is retained. The model can be further simplified by compressing the nonsignificant levels in a group into one level. To check that the deleted variables are really not significant, one can do a forward regression to compute the improvement with *only* that group of variables included.

Since the significant variables are either categorical or can be converted into such variables I would also suggest categorical modeling. Since the dependent variable has only two responses, CATMOD and LOGIST will yield the same parameter estimates. The advantage of CATMOD is that the output will contain observed and predicted values for each cell.[66] SPSSX uses the observed and expected frequencies to compute a Pearson goodness-of-fit test.[67]

It would help to have a longer period of study to increase the number of leavers. If a 3-year interval were possible, the total sample would only increase slightly, but the number of leavers would be tripled.

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[64]See, for example, Kirk Wolfer, *Introduction to Variance Estimation* (New York: Springer-Verlag, 1985), and C.J. Skinner, D. Holt and T.M.F. Smith, *Analysis of Complex Surveys* (New York: John Wiley, 1989).

[65]C.J. Skinner, D. Holt and T.M.F. Smith, 192–199. R.L. Prentice and R. Pyke, "Logistic Disease Incidence Models and Case-Control Studies," *Biometrika* 66 (1979), 403–11.

[66]SAS Institute, *SAS/STAT User's Guide Version 6,* Fourth Edition (Cary, N.C.: SAS Institute, 1990); 472, 487, and 514–516.

[67]*SPSSX Manual,* 1983, 565.

Specification of Variables

The continuous variables appear to be monotone with respect to the binary response variable. Since retirees are not included in the study, the anticipated U-shaped relationship between leaving and age should have been eliminated.

Interpretation of Results

The R^2 is not appropriate for logistic models. As noted by Agresti, "Despite several attempts to define analogs of R^2 for models for categorical responses, no proposed measure seems as widely useful as the regression R^2."[68] Agresti proposes a couple of measures that are essentially based on the maximized log likelihood. This study uses the (quite reasonable) approach of reporting the odds ratio.

The logit L for a group is really $x'\beta$. When the variable is categorical, you can report e^{β}. However, when the variable is continuous, for example, AGE*AGE in table 21, the value reported $e^{\beta} = 1.00$ is the odds for a teacher who is 1-year-old! For a teacher with AGE = 25, the odds is exp (.002*25*25)= $3.5 \neq 1.00$. The odds can be reported by centering the continuous variables at their mean value.

I do not believe that reporting the estimated probabilities $P = e^{x'\beta}/(1 + e^{x'\beta})$ will be very informative. However, it might be worth trying to do so since this is not difficult to calculate.[69]

The stochastic assumptions for the classical logistic models are not satisfied by complex designs. In particular, the homogeneity of the population clusters will tend to increase the variance of the estimated parameters over the usual asymptotic estimators. It is interesting that this phenomenon did not occur, perhaps indicating that teachers are acting independent of the school effect.

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[68]Alan Agresti, *Categorical Data Analysis* (New York: John Wiley, 1990), 110.

[69]See SAS User's Guide Version 6, 1091.

Chapter 6

Conclusions

Previous work on teacher supply and demand and attrition provided a strong basis for expecting to find a relationship between teacher attrition and various teacher, school, and district characteristics. Despite the extensive data on these characteristics available from SASS, the logistic regression methods used failed to provide evidence of many of the expected relationships. In addition, methodological problems plagued efforts to obtain definitive results. The reviewers, whose comment were summarized in Chapter 5, seemed to agree that our major hypotheses were sound, that the types of variables we included were appropriate, and that logistic regression was an appropriate methodology for testing them. However, they had a number of useful comments on the general approach taken in developing the models tested, the specification of the variables, and the interpretation of the results. They proposed a number of interesting possibilities that merit serious consideration for additional research. This chapter outlines our major conclusions and makes recommendations for additional analysis taking these comments into consideration.

1) The models tested were too large and should be reformulated.

Several reviewers believed that we had too many variables and that this was leading to unstable results and possibly causing the problems with singular matrices. Additional analysis with fewer variables might produce more definitive results. Although a much smaller model would be a useful goal, theory suggests that it is important to include variables that measure personal characteristics, qualifications, and working conditions. Selecting only a few variables may be difficult because of the relatively large number of factors that previous research has shown to be related to attrition. One possibility (suggested by Billingsley) would be to use either principal components or factor analysis to identify variable groups. Interactions among the independent variables also need more thorough analysis.

2) A test of the overall fit of the model should be performed.

Currently, the only valid test of the overall fit of a logistic regression model is the Hosmer-Lemeshow test. This test is available in SAS 6.07, but not in WESLOG, the logistic regression program we used because it was designed for analyzing data collected in surveys using complex sampling designs. Lemeshow suggested that we fit the model with SAS first, perform the Hosmer-Lemeshow test, and then once we have a model that we like, re-run the model using WESLOG so that the standard errors of the parameters can be computed correctly.

3) The relatively small number of leavers may have contributed to the difficulty in obtaining results.

The sample of teachers who left for career reasons may have been too small to be systematically different from all teachers. That is, leaving may have been too rare an event. With only a small percentage of all teachers leaving for career reasons, there may have been too much variation in the rest of the population of teachers to identify systematic differences. For example, even though a certain number of math teachers will leave because of better employment opportunities, *most* math teachers will not leave. Even if teachers who left had a distinguishing characteristic such as a BA in education, the group of stayers included many with a BA in

education. Not only would a statistical test not find the difference significant because of the small sample of leavers, but from a practical standpoint, if the larger group includes all the characteristics that seem to be defining the leavers, then it is not possible to predict which of the teachers with the characteristic are likely to leave.

Modeling public and private school teachers together (with sector as a dummy variable) might help solve this problem, because the total number of leavers would be increased. Rust suggested another reason for combining public and private school teachers in one model. He pointed out that differences in attrition rates may be due to differences in the distributions of public and private school teachers by age and sex and that this might not be possible to detect with separate models. Being able to examine public/private school effects controlling for factors such as age and sex would be interesting.

4) The time frame for the analysis may have been too short.

The TFS data allow us to measure attrition in only one year. It is possible that this is too short a time period. The leavers may not differ systematically from non-leavers in a given year, but might over a longer time period. In other words, math teachers might have a greater probability than other teachers of leaving teaching at some time, but the probability that a math teacher leaves in a given year may be small. It is almost certainly smaller than the probability of leaving in a five year period. To identify factors related to attrition, it may be necessary to study attrition over periods longer than one year. With the SASS and TFS data, however, the analysis is necessarily limited to one–year attrition.

Despite the lack of definitive findings from the multivariate analysis, this research effort has contributed to our understanding of how the SASS and TFS data can be used to study issues related to teacher supply and demand and what methodological approaches are feasible. NCES will continue to work in this area and will pursue some of the directions suggested in this report.

Appendix A

Supplemental Tables

Table A.1a—Percentage distribution of teachers by selected teacher and school characteristics, by sector and teaching status: 1987–88 and 1988–89

	1988–89 status		Gender		Race–ethnicity			Marital status			Dependent children	
	Leavers	Stayers and movers	Male	Female	White, non-Hispanic	Black, non-Hispanic	Other	Married	Previously married	Single	None	One
Total	2.9	97.1	28.8	71.2	88.8	6.9	4.3	71.4	11.9	16.6	42.9	18.7
Public	2.5	97.5	29.7	70.3	88.1	7.6	4.2	72.5	12.7	14.8	41.8	19.5
Stayers and movers	0.0	100.0	29.5	70.5	88.1	7.6	4.3	72.9	12.5	14.6	41.5	19.7
Leavers	100.0	0.0	38.7	61.3	87.8	10.2	2.0	59.8	17.3	22.9	53.3	14.6
Private	6.4	93.6	21.7	78.3	94.4	0.9	4.7	62.6	6.0	31.4	51.3	11.6
Stayers and movers	0.0	100.0	21.5	78.5	94.9	0.8	4.3	63.1	5.9	30.9	50.6	11.8
Leavers	100.0	0.0	24.7	75.3	87.3	2.9	9.9	55.4	6.3	38.3	61.5	8.6

NOTE: Percentages may not add to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires, School Questionnaires, Teacher Demand and Shortages Questionnaires) and Teacher Followup Survey, 1988–89.

Table A.1b—Percentage distribution of teachers by selected teacher and school characteristics, by sector and teaching status: 1987–88 and 1988–89

	Dependent children (cont.)	Age of children				Highest education						Career type	
	Two or more	0–2	3–5	6–12	13+	Less than BA	BA/BS in education	BA/BS not in education	MA/MS in education	MA/MS not in education	Higher degree	Steady career	Interrupted career
Total	38.5	15.9	13.2	33.4	37.5	1.1	40.7	11.9	35.1	5.0	6.1	62.7	37.3
Public	38.6	15.8	13.0	32.4	38.7	0.8	40.7	11.0	36.7	4.6	6.3	63.3	36.7
Stayers and movers	38.8	15.7	13.0	32.6	38.8	0.8	41.0	11.0	36.4	4.5	6.2	63.3	36.7
Leavers	32.1	23.4	16.6	24.8	35.2	0.4	30.8	10.2	46.0	5.1	7.5	65.7	34.3
Private	37.1	17.0	14.4	42.3	26.3	3.8	40.2	19.5	22.7	8.9	5.0	57.4	42.6
Stayers and movers	37.6	17.2	14.6	42.4	25.8	3.6	41.1	18.7	23.0	8.9	4.8	57.4	42.6
Leavers	30.0	12.3	10.7	41.0	36.0	6.2	27.1	31.4	18.2	9.2	7.8	57.4	42.6

NOTE: Percentages may not add to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires, School Questionnaires, Teacher Demand and Shortages Questionnaires) and Teacher Followup Survey, 1988–89.

Table A.1c—Percentage distribution of teachers by selected teacher and school characteristics, by sector and teaching status: 1987–88 and 1988–89

	Teaching field					Type of field		Certification		Influence on school policy		
		Secondary				Teaching	Not		Not			
	General elementary	Math/ computer science	Science	Other	Special education	in best qualified field	in best qualified field	Certified in main field	certified in main field	Low	Medium	High
Total	44.9	6.3	5.5	33.7	9.5	82.3	17.7	94.1	5.9	16.8	52.6	30.5
Public	44.5	6.2	5.4	33.6	10.3	82.9	17.1	97.4	2.6	17.6	54.0	28.4
Stayers and movers	45.0	6.1	5.3	33.5	10.1	83.2	16.8	97.4	2.6	17.4	53.9	28.7
Leavers	25.4	8.6	8.8	37.0	20.3	72.8	27.2	96.1	3.9	26.7	56.6	16.6
Private	48.5	7.7	6.5	34.1	3.2	77.1	22.9	68.4	31.6	10.7	41.2	48.1
Stayers and movers	49.0	7.6	6.5	33.6	3.3	77.6	22.4	70.0	30.0	10.5	40.5	49.0
Leavers	41.8	9.5	5.9	41.1	1.7	69.0	31.0	45.7	54.3	13.6	51.2	35.2

NOTE: Percentages may not add to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires, School Questionnaires, Teacher Demand and Shortages Questionnaires) and Teacher Followup Survey, 1988–89.

Table A.1d—Percentage distribution of teachers by selected teacher and school characteristics, by sector and teaching status: 1987–88 and 1988–89

	Control in classroom			Help from others			Salary satisfaction			Teacher satisfaction		
	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
Total	1.4	25.0	73.7	14.1	43.8	42.1	8.1	58.7	33.2	20.3	44.4	35.3
Public	1.5	26.5	72.0	14.9	44.6	40.5	7.7	59.7	32.7	21.4	44.5	34.1
Stayers and movers	1.4	26.4	72.2	14.7	44.5	40.8	7.7	59.7	32.6	21.1	44.4	34.5
Leavers	3.3	29.7	67.0	22.0	50.3	27.6	7.2	58.8	34.0	30.7	50.7	18.6
Private	0.5	12.8	86.7	8.2	37.2	54.6	11.5	51.2	37.3	12.1	43.2	44.8
Stayers and movers	0.5	12.3	87.3	8.1	36.7	55.2	11.7	51.5	36.8	11.4	42.4	46.2
Leavers	0.4	20.2	79.3	9.6	44.2	46.2	9.5	46.1	44.4	21.1	54.3	24.6

NOTE: Percentages may not add to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires, School Questionnaires, Teacher Demand and Shortages Questionnaires) and Teacher Followup Survey, 1988–89.

Table A.1e—Percentage distribution of teachers by selected teacher and school characteristics, by sector and teaching status: 1987–88 and 1988–89

	Merit pay		Other incentives		1986–87 Occupational status					Region		
	Received	Not received	Received	Not received	Taught 1986–87	Worked outside ed in 1986-87	Attended college or univ in 1986-87	Home-making	Other activities	Northeast	Midwest	South
Total	18.7	81.2	9.7	90.3	93.1	1.8	2.3	1.2	1.6	22.7	26.2	34.4
Public	18.7	81.3	10.1	89.9	93.8	1.5	2.1	0.9	1.7	21.6	26.2	35.2
Stayers and movers	18.7	81.3	10.2	89.8	94.1	1.4	2.1	0.8	1.6	21.7	26.2	35.1
Leavers	16.0	84.0	7.0	92.9	85.0	5.8	4.6	2.3	2.3	15.4	25.6	40.3
Private	19.4	80.6	6.9	93.1	87.7	4.1	3.4	3.5	1.3	32.0	26.1	27.9
Stayers and movers	19.5	80.5	6.9	93.1	88.4	3.8	3.1	3.5	1.2	32.1	26.9	27.4
Leavers	17.6	82.4	6.9	93.0	76.4	9.5	7.4	3.7	3.0	30.8	14.8	34.6

NOTE: Percentages may not add to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires, School Questionnaires, Teacher Demand and Shortages Questionnaires) and Teacher Followup Survey, 1988–89.

Table A.1f—Percentage distribution of teachers by selected teacher and school characteristics, by sector and teaching status: 1987–88 and 1988–89

	Region (cont.)	Community type			School level			Type of school				
	West	Urban	Suburban	Rural	Elementary	Second	Combined	Regular	Special program emphasis	Special education	Voc/tech	Other
Total	16.7	27.1	22.7	50.2	57.8	35.0	7.2	89.2	5.0	1.0	1.3	3.5
Public	17.1	25.1	22.0	52.9	58.3	36.6	5.1	90.3	4.8	0.7	1.4	2.8
Stayers and movers	17.0	25.1	22.0	52.9	58.6	36.3	5.1	90.3	4.8	0.7	1.4	2.8
Leavers	18.7	25.7	22.5	51.9	45.2	48.5	6.2	88.2	4.5	2.7	1.1	3.5
Private	14.1	44.1	28.2	27.7	53.7	21.2	25.1	80.3	6.8	2.8	–	10.1
Stayers and movers	13.7	43.5	28.7	27.7	54.0	20.8	25.3	80.8	6.4	2.9	–	10.0
Leavers	19.8	52.1	20.8	27.1	50.2	27.5	22.3	73.8	13.3	1.4	0.0	11.5

NOTE: Percentages may not add to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires, School Questionnaires, Teacher Demand and Shortages Questionnaires) and Teacher Followup Survey, 1988–89.

Table A.1g—Percentage distribution of teachers by selected teacher and school characteristics, by sector and teaching status: 1987–88 and 1988–89

	Minority teachers		Minority enrollment				Free lunch enrollment			Benefits		Merit Pay
	Less than 10%	10% or more	Less than 5%	5-19%	20-49% or more	50% or more	Less than 20%	20-49%	50% or more	Offered	Not offered	Offered
Total	68.0	32.0	34.4	25.2	20.9	19.5	43.7	35.4	20.8	86.5	13.5	12.1
Public	65.6	34.4	33.4	24.1	22.0	20.5	42.7	36.2	21.1	88.5	11.5	11.8
Stayers and movers	65.6	34.4	33.6	24.0	21.9	20.4	42.7	36.3	21.1	88.6	11.4	11.8
Leavers	63.1	36.9	25.0	28.3	25.0	21.7	44.3	34.0	21.6	83.0	17.0	12.9
Private	88.2	11.8	43.0	34.0	11.5	11.5	68.3	16.4	15.3	71.0	29.0	14.9
Stayers and movers	88.9	11.1	43.2	34.3	11.3	11.2	68.2	16.4	15.4	71.2	28.8	14.7
Leavers	77.8	22.2	40.0	29.8	14.1	16.0	70.5	17.7	11.8	69.1	30.9	18.5

NOTE: Percentages may not add to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires, School Questionnaires, Teacher Demand and Shortages Questionnaires) and Teacher Followup Survey, 1988–89.

Table A.1h—Percentage distribution of teachers by selected teacher and school characteristics, by sector and teaching status: 1987–88 and 1988–89

	Merit Pay offered (cont.)	Incentive offered		Retirement offered		Minimum retirement age			Minimum years served for retirement			
	Not offered	Offered	Not offered	Offered	Not offered	Less than 55	56-64	65 or more	Less than 10	10-14	15-29	30 or more
Total	87.9	10.9	89.1	97.1	2.9	51.8	36.1	12.1	15.7	30.0	27.8	26.5
Public	88.2	10.2	89.8	99.1	0.9	54.8	36.4	8.8	15.0	28.6	28.6	27.8
Stayers and movers	88.2	10.2	89.8	99.1	0.9	55.0	36.2	8.8	15.0	28.6	28.6	27.8
Leavers	87.1	11.9	88.1	99.6	0.4	48.7	44.3	7.0	12.9	31.8	28.9	26.5
Private	85.1	16.6	83.4	79.3	20.7	16.1	32.0	51.9	28.2	52.3	15.0	4.5
Stayers and movers	85.3	16.6	83.4	80.7	19.3	16.3	32.0	51.7	27.9	52.7	15.0	4.5
Leavers	81.5	15.4	84.6	59.7	40.3	11.1	31.9	57.0	34.3	46.5	14.7	4.5

NOTE: Percentages may not add to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires, School Questionnaires, Teacher Demand and Shortages Questionnaires) and Teacher Followup Survey, 1988–89.

Table A.2a—Averages for selected teacher, school, and district characteristics for 1987-88 teachers, by sector and teaching status: 1987–88 and 1988–89

	Age	Years full-time experience	Students per class	Teaching income	% change in income 86-87/ 87-88	School size in students	Student/ teacher ratio	% free lunch eligible	% minority students	% teachers < 3yrs experience
Total	40	13	25	$27,636	47.9	681	18	0.3	0.3	11.5
Public	40	14	25	28,333	39.2	717	18	0.3	0.3	10.7
Stayers and movers	40	14	25	28,360	27.5	716	18	0.3	0.3	10.7
Leavers	36	12	23	27,269	814.0	760	19	0.3	0.3	10.1
Private	39	11	24	22,119	120.9	380	18	0.2	0.2	17.7
Stayers and movers	39	12	25	21,928	40.3	385	18	0.2	0.2	17.5
Leavers	37	8	22	24,830	2513.9	313	16	0.2	0.2	21.2

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires, School Questionnaires, Teacher Demand and Shortage Questionnaires) and Teacher Followup Survey, 1988–89.

Table A.2b—Averages for selected teacher, school, and district characteristics for 1987-88 teachers, by sector and teaching status: 1987–88 and 1988–89

	% with less than BA	Salary highest level	Gross annual salary	District size	Minimum retire-ment age	Minimum years service for retirement
Total	0.5	$30,283	$26,106	42,593	58	18
Public	0.5	31,200	27,040	47,214	58	18
Stayers and movers	0.5	31,218	27,060	46,773	58	18
Leavers	0.5	30,492	26,213	65,299	58	18
Private	0.4	21,904	17,576	390	62	11
Stayers and movers	0.4	21,943	17,573	395	62	11
Leavers	0.4	21,360	17,627	320	63	10

SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey, 1987–88 (Teacher Questionnaires, School Questionnaires, Teacher Demand and Shortage Questionnaires) and Teacher Followup Survey, 1988–89.

Appendix B

Technical Notes

SASS Sample Selection[70]

Selection of Schools

The public school sample of 9,317 schools was selected from the Quality of Education Data (QED) file of public schools. All public schools in the file were stratified first by state (50 states and the District of Columbia) and then by three grade levels (elementary, secondary, and combined elementary and secondary). Within each stratum, the schools were sorted by urbanicity, percent minority (four categories), zip code (first three digits), highest grade in the school, enrollment, and PIN number (assigned by QED). For each stratum within each state, sample schools were selected by systematic (interval) sampling with probability proportional to the square root of the number of teachers within a school.

The private school sample of 3,513 schools was selected primarily from the QED file of private schools. Because this list of private schools did not fully cover all private schools in the country, two additional steps were taken to improve coverage. The first step was to update the QED file with current lists of schools from 17 private school associations. All private schools obtained in this way and the private schools on the QED list were stratified by state and within state by grade level and affiliation group. Sampling within each stratum was done as it was for public schools.

The second step taken to improve private school coverage was to select an area frame of schools contained in 75 Primary Sampling Units (PSUs) selected from the universe of 2,497 PSUs with probability proportional to the square root of the PSU population. The PSUs, each of which consisted of a county or group of counties, were stratified by Census geographic region (Northeast, Midwest, South, and West), Metropolitan Statistical Area (MSA) status (MSA or non-MSA), and private school enrollment (two groups). Within each of the 75 PSUs, a telephone search was conducted to find all in-scope private schools. Sources included yellow pages, religious institutions (except for Roman Catholic religious institutions, because each Catholic diocese is contacted annually when the QED list is updated), local education agencies, chambers of commerce, local government offices, commercial milk companies, and commercial real estate offices. All schools not on the QED file or the lists from private school associations were eligible to be selected for the area sample. Most of these schools were selected with certainty, but when sampling was done, schools were sampled with probability proportional to the square root of the number of teachers (for schools that could be contacted) or a systematic equal probability procedure (for schools that could not be contacted).

The private school sample was designed to allow detailed comparisons among the following affiliations: Catholic, Friends, Episcopal, Jewish, Lutheran, Seventh Day Adventist, Christian Schools International, American Association of Christian Schools, Exceptional Children, Military Schools, Montessori, and Independent Schools. At least 100 schools were selected from each affiliation, or all schools in the affiliation if there were fewer than 100 schools.

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[70] For a detailed description of the sample design see Steven Kaufman, *1988 Schools and Staffing Survey Sample Design and Estimation,* Technical Report, U.S. Department of Education, National Center for Education Statistics, May 1991, 23-43.

Selection of LEAs

All local education agencies (LEAs) that had at least one school selected for the school sample were included in the LEA sample for the Teacher Demand and Shortage Survey. In addition, a sample of 70 LEAs that did not contain eligible schools was selected directly. Only 8 of these 70 were actually in scope (that is, reported hiring teachers). The total LEA sample was 5,592.

Selection of Teachers

All 56,242 public and 11,529 private school teachers in the teacher samples were selected from the public and private school samples. The specified average teacher sample size was four, eight, and six teachers for public elementary, secondary, and combined schools, respectively and four, five, and three teachers for private elementary, secondary, and combined schools, respectively.

A list that included all full- and part-time teachers, itinerant teachers, and long-term substitutes was obtained from each sample school. Within each school, teachers were stratified by experience into two groups: new teachers and all others. New teachers were those who, counting 1987–88, were in their first, second, or third year of teaching. New teachers in private schools were oversampled by 60 percent; oversampling in public schools was not necessary. Within each new and experienced teacher stratum, elementary teachers were sorted into general elementary, special education, and "other" categories; and secondary teachers were sorted into mathematics, science, English, social science, vocational education, and "other" categories. Within each school and teacher stratum, teachers were selected systematically with equal probability.

In order to obtain more reliable estimates of bilingual–ESL teachers, both the public and private school teacher samples included a bilingual–ESL (English as a second language) supplement that included teachers who used a native language other than English to instruct students with limited-English proficiency and teachers who provided intensive instruction in English to students with limited-English proficiency.[71] The bilingual–ESL supplement of 2,447 teachers was selected independently from the basic sample. It was designed to provide estimates for California, Texas, Florida, Illinois, New York, and for all other states combined. The sample size within each school was chosen to be proportional to the weighted number of bilingual-ESL teachers in the school. Within a school containing bilingual–ESL teachers, the teachers were selected systematically with equal probability.[72]

Selection of Teachers for the Teacher Followup Survey

The 1988–89 occupational status of teachers responding to the 1987–88 SASS was determined by contacting their schools to determine whether they were still at the school, had left to teach elsewhere, or had left for a non-teaching job. All leavers were included in the sample. Continuing teachers were sorted by Census region, by urbanicity, teacher subject, and school enrollment within each public stratum. Within each private stratum, continuing teachers were sorted by affiliation, urbanicity, teacher subject, and school enrollment. After the teachers were sorted, teachers were selected within each stratum using a probability proportional to size procedure. The measure of size was the SASS basic weight (inverse of the probability of selecting a teacher in the SASS teacher sample). This sample allocation method yielded a total sample size of 7,172 teachers, of whom 2,987 were leavers and 4,185 were stayers or movers.

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[71] The supplement was funded by the Department of Education's Office of Bilingual Education and Minority Language Affairs (OBEMLA).

[72] Bilingual-ESL teachers selected in both the basic and supplement samples were unduplicated so that each teacher appears only once in the combined sample of bilingual–ESL and all other teachers.

Data Collection Procedures

The data were collected for the National Center for Education Statistics (NCES) by the U.S. Bureau of the Census. Questionnaires were mailed to school districts, schools, administrators, and teachers in January and February 1988.[73] Six weeks later, a second questionnaire was sent to each nonrespondent. A telephone followup of nonrespondents was conducted during April, May, and June. Because of the large number of nonresponding teachers and the need to complete the survey before the end of the school year, the telephone followup was conducted for only a subsample of teachers. The weights for this subsample were adjusted to reflect the subsampling.

The Teacher Followup Survey was conducted in two phases. First, in October 1988 schools were contacted to determine the status of all teachers in the 1987–88 SASS. Principals were asked to indicate whether the teacher was still at the school in a teaching or non-teaching capacity or had left the school to teach elsewhere or for a non-teaching job. In March 1989, the questionnaire for former teachers was sent to the 2,987 persons who had left the teaching profession, and the questionnaire for current teachers was sent to a sample of 4,185 persons reported as still teaching. If this questionnaire was not returned within four to five weeks, a second questionnaire was sent. Finally, if neither questionnaire elicited a response, a telephone call was made in May.

Weighting[74]

Weights of the sample units were developed to produce national and state estimates for public schools, teachers, administrators, and LEAs. The private sector data were weighted to produce national and affiliation group estimates. The affiliation groups for private schools were Catholic, other religious, and nonsectarian. The basic weights were the inverse of the probability of selection and were adjusted for nonresponse.

Standard Errors

The estimates in these tables are based on samples and are subject to sampling variability. Standard errors were estimated using a balanced repeated replications procedure that incorporates the design features of this complex sample survey. The standard errors indicate the accuracy of each estimate. If all possible samples of the same size were surveyed under the same conditions, an interval of 1.96 standard errors below to 1.96 standard errors above a particular statistic would include the universe value in approximately 95 percent of the cases. Note, however, that the standard errors do not take into account the effects of biases due to item nonresponse, measurement error, data processing error, or other possible systematic error.

Accuracy of Estimates

The statistics in this report are population estimates derived from the samples described in the preceding section. Consequently, they are subject to sampling variability. In addition, they are subject to nonsampling errors, which can arise because of nonresponse, errors in reporting, or errors in data collection. These types of errors can bias the estimates and are not easy to measure. They can occur because respondents interpret questions differently, remember things incorrectly, or misrecord their responses. Nonsampling errors can also be due to incorrect editing, coding, preparing, or entering of the data or to differences related to the time the survey was conducted.

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[73] Copies of the questionnaires may be obtained by writing to the Special Surveys and Analysis Branch of NCES.

[74] For a detailed description of the weighting processes see Kaufman, *Op. Cit.*, 47-57.

The precision with which one can use survey results to make inferences to a population depends upon the magnitude of both sampling and nonsampling errors. In large sample surveys, such as the SASS, sampling errors are generally minimal, except when estimates are made for relatively small subpopulations (Native Americans, for example).

Response Rates and Imputation

Most item-level missing data on the district and school files were imputed using a sequential hot deck procedure that matched the nonrespondent district or school with the most similar respondent in the same stratum. "Most similar" was determined on the basis of metropolitan status, percent minority, and enrollment. On the public school file, all missing items were imputed. On the private school file, items 7 and 35 were not imputed. On both the public and private teacher demand and shortage file, items 3, 11, 12, 13, and 28 were not imputed.

No imputation was done for either the teacher or administrator files or for the teacher followup. Item nonresponse was treated as missing data in the computation of estimates for tables that include data from either of these files. This is equivalent to assuming equal distributions for both respondents and nonrespondents. Not imputing for item nonresponse when averages are estimated results in bias, and the nature of this bias is unknown.

The weighted response rates for the each of the surveys were as follows:

Survey	Public	Private
Teacher demand and shortage	90.8	66.0
Administrator	94.4	79.3
School	91.9	78.6
Teacher	86.4	79.1
Teacher followup[75]	84.1	75.9

The response rates for the items used from the teacher files are listed below. They do not reflect additional response loss due to complete questionnaire refusal.

[75]The effective response rate shown here is the product of the response rates to the Teacher Survey, which were 86.4 percent (public) and 79.1 percent (private), and the Followup Survey, which were 97.3 percent (public) and 96.0 percent (private).

Table number	Variable name	Response rate for public sector (percent)	Response rate for private sector (percent)
Tables 1,2,3	Year began teaching	99.5	98.5
	Activity 1986–87	99.3	99.5
Table 4,16	Highest degree earned	100.0	100.0
Table 5,8	Teaching status: stayers, movers	99.9*	
	Teaching status: leavers	100.0*	
Table 12	Type of certification in main field	82.1	87.1
	Type of certification in other field	77.8	84.0
Table 13	Teacher sex	99.6	99.9
	Years of teaching experience	100.0	100.0
Table 13, 14	Year of birth	98.9	98.2
Table 15,17,18	Main reason for leaving teaching	99.4*	
Table 16	Certification in main field	99.0	99.4
Table 17	Plans to return to teaching (leavers)	99.4*	
	When might return to teaching (leavers)	98.6*	
Table 18	Occupational status	98.3*	
	Type of job	81.7*	
Row variables			
	Teaching level	98.8	98.8
	Teaching field	100.0	100.0
	Race	98.3	98.3
	Hispanic origin	97.9	97.8

*Applies to public and private school teachers.

Variable Definitions

Public and Private Schools

A public school was defined as an institution that provides educational services, has one or more teachers, is located in one or more buildings, receives public funds as primary support, and is operated by an education agency. Prison schools and schools operated by the Department of

Defense and the Bureau of Indian Affairs were included. A private school was defined as a school not in the public system that provides instruction for any of grades 1–12 where the instruction was not given exclusively in a private home.

To be included in SASS, a school was required to have a minimum school day of 4 hours and a minimum school year of 160 days, and it had to provide instruction to students at or above the first-grade level and not be in a private home. (If it could not be determined that instruction was not in a private home, the school had to have at least 10 students or more than one teacher.) In addition, the school could not offer only adult, night, or specialized courses.

Community Type

Respondents to the School Questionnaire were asked to describe the community that best described the community in which the school was located. They were given ten choices, which were aggregated into four categories as follows:

Rural/farming	A rural or farming community or an Indian reservation.
Small city	A small city or town of fewer than 50,000 people that was not a suburb of a larger city.
Suburban	A suburb of a medium-sized, large, or very large city, or a military base or station.
Urban	A medium-sized city (50,000 to 100,000 people), large city (100,000 to 500,000 people), or very large city (more than 500,000 people).

School Level

Elementary	A school that had grade 6 or lower, or "ungraded," and no grade higher than the 8th.
Secondary	A school that had no grade lower than the 7th, or "ungraded," and some grade between 7th and 14th.
Combined	A school that had grades higher than the 8th and lower than the 7th.

Minority Enrollment

Less than 5%, etc.	Categories were based on the percentage of the students who were American Indian or Alaskan Native; Asian or Pacific Islander; Hispanic, regardless of race (Mexican, Puerto Rican, Cuban, Central or South American, or other culture or origin); Black (not of Hispanic origin).

Public School District

A public school district (or Local Education Agency, LEA) was defined as a government agency administratively responsible for providing public elementary and/or secondary instruction and educational support services. The agency or administrative unit had to operate under a public board of education. Districts that operated only one school and districts that did not operate schools

but did hire teachers were included. A district was considered out of scope if it did not employ elementary or secondary teachers.

Region

Northeast	Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania
Midwest	Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas
South	Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, Texas
West	Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Washington, Oregon, California, Alaska, Hawaii

Teacher

For the purposes of SASS, a teacher was any full- or part-time teacher whose primary assignment was to teach in any of grades K–12. Itinerant teachers and long-term substitutes who were filling the role of a regular teacher on an indefinite basis were also included. An itinerant teacher was defined as a teacher who taught at more than one school.

Teachers were classified as elementary or secondary on the basis of the grades they taught rather than the schools in which they taught. An elementary school teacher was one who, when asked for the grades taught, checked:

- Only "ungraded" and was designated as an elementary teacher on the list of teachers provided by the school; or
- 6th grade or lower, or "ungraded" and no grade higher than 6th; or
- 6th grade or lower and 7th grade or higher, and reported a primary assignment of prekindergarten, kindergarten, or general elementary; or
- 7th and 8th grades only, and a reported primary assignment of prekindergarten, kindergarten, or general elementary; or
- 6th grade or lower and 7th grade or higher, and reported a primary assignment of special education and was designated as an elementary teacher on the list of teachers provided by the school; or
- 7th and 8th grades only, and reported a primary assignment of special education and was designated as an elementary teacher on the list of teachers provided by the school.

A secondary school teacher was one who, when asked for the grades taught, checked:

- "Ungraded" and was designated as a secondary teacher on the list of teachers provided by the school; or

- 6th grade or lower and 7th grade or higher, and reported a primary assignment other than prekindergarten, kindergarten, or general elementary; or
- 9th grade or higher, or 9th grade or higher and "ungraded"; or
- 7th and 8th grades only, and reported a primary assignment other than prekindergarten, kindergarten, general elementary, or special education; or
- 7th and 8th grades only, and reported a primary assignment of special education and was designated as a secondary teacher on the list of teachers provided by the school; or
- 6th grade or lower and 7th grade or higher, or 7th and 8th grades only, and were not categorized above as either elementary or secondary.

Comments and More Information

We are interested in your reaction to the information and analysis presented here and to the content of the questions used to produce these results. We welcome your recommendations for improving our survey work. If you have suggestions or comments or want more information about this report, please contact:

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*U.S. Government Printing Office: 1993 — 342-109/83131

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