The Career Paths of Teachers

Implications for Teacher Supply and Methodological Lessons for Research

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Attempts to determine whether enough qualified teachers will be available to staff the nation's schools in the coming years have been hampered by methodological difficulties that are inherent in the study of teacher career patterns. In this article, we have applied an analytic technique rarely used in educational research, proportional hazards modeling, *to resolve these problems and to investigate the relationship between teachers' background characteristics and their career durations. We find that teacher demographic characteristics and subject specialty are important predictors of length of stay in teaching. Our results call into question several assumptions about teacher career persistence implicit in the national teacher supply and demand model. We also argue that proportional hazards modeling has wide applicability to many educational research questions.*

How many new teachers will be needed in American schools in the coming years? Will there be enough qualified teachers? The answers to these questions matter to various actors in the educational system, including school board members and superintendents evaluating the adequacy of teacher salaries and teacher recruitment budgets and college students assessing the potential attractiveness of careers in teaching. The primary sources of quantitative information for addressing these questions are teacher supply and demand models. In fact, numerical projections of the size of the impending teacher shortage or surplus, based on the National Center for Education Statistics' (NCES) national teacher supply and demand model, have customarily been the figures most widely cited in the media.

Unfortunately, projections of teacher shortages and surpluses have not proven reliable in predicting the sizes of supply and demand imbalances or their timing (National Research Council, 1987). Although there are many contributing factors, including some explored by Heyns (1988) in a recent issue of this journal, a critical one is inadequate knowledge of teacher career patterns. Little is known about teachers' decisions on how long to stay in teaching and whether to return to teaching after a career interruption. As Grissmer and Kirby (1987) have explained, these decisions are among the most important determinants of the demand for new teachers.[1]

The primitive state of knowledge about teacher career persistence is reflected in the NCES model. This model relies on a single quantity to summarize the persistence of teacher careers, the overall attrition rate (defined as the percentage of teachers working in public schools in the U.S. in one year who are not doing so in the next year). Thus, the NCES model implicitly assumes that attrition rates are the same for teachers of different subject matter specialties, attrition rates do not change over time,[2] and teachers who leave teaching do not return.

After describing the state of research on teachers' career patterns, this article reports findings suggesting that all three of the assumptions implicit in the NCES model are subject to serious question. Using a relatively new modeling technique, which we describe in some detail, we show that (a) teacher career paths do differ by subject specialty; (b) attrition rates are likely to change over time because the age distribution of teachers entering the profession has changed; and (c) many teachers who leave the classroom return after a relatively short career interruption. These patterns indicate that the application of an overall attrition rate conceals, more than reveals, the complexities of the teacher labor market.

The article also discusses the particular value to educational research of the statistical methodology that enabled us to conduct the analysis. We suggest that diverse, significant educational research issues should be framed as questions that treat time as the dependent variable and that *proportional hazards modeling* provides a powerful statistical tool for analyzing such questions.

Research on Teachers' Careers

Quantitative research on teacher career patterns has been of two kinds: the estimation of attrition rates from one year to the next for populations of teachers employed in the schools in a particular geographical area at one point in time, and longitudinal studies of the careers of samples of teachers who began to teach at the same point in time. A considerable amount has been learned from both types of research; however, past studies in both these areas have suffered from important limitations.

Estimation of teacher attrition rates typically has been based on two waves of data. For example, matching of computer files containing data for two consecutive years on the population of teachers working in a particular geographical area (school district, state, nation) has been used to provide an esti-

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mate of the overall attrition rate.

Longitudinal studies have followed samples of teachers who began to teach in a particular school year and have reported the percentage of the sample that remained in teaching from year to year. These studies have documented a pattern familiar to many school administrators: Resignations are most common during teachers' early years on the job. The studies also have shown that, in some samples, survival rates for men and women differ (cf., Charters, 1970; Mark & Anderson, 1978, 1985). Although this information is useful, studies in this tradition have not pursued the logical next steps of identifying whether teacher characteristics other than gender are important predictors of survival and determining whether teachers who leave teaching early in their careers eventually return to the classroom.

Until recently, neither type of study had examined whether career persistence varies among teachers with different demographic characteristics or different subject matter specialties. A recent series of studies by Grissmer and Kirby (1987) has moved in this direction by providing separate estimates of attrition rates by the teachers' age and subject matter specialty. The Grissmer and Kirby research suggests that attrition is a U-shaped function of teaching experience: Attrition is high among beginning teachers, low for many years among experienced teachers, and then high again as teachers reach retirement age. This work suggests that, because attrition rates are sensitive to teacher characteristics, teacher career persistence may change as the composition of the teaching force changes.

The Grissmer-Kirby work has three important limitations. First, the authors estimated age- and subject-specific attrition rates by subdividing the sample; consequently they were unable to make inferences concerning the extent to which the rates differed among subsamples. Second, because their analyses were based on only two waves of data, they were unable to estimate the proportion of teachers who return to teaching after a career interruption. Third, they examined attrition rates only for the period 1976-1986, when enrollment declines led to many involuntary layoffs. Attrition patterns may differ when virtually all attrition is voluntary (Singer & Willett, in press).

The empirical work to be reported here complements the Grissmer-Kirby studies in several respects. First, within the multivariate framework of proportional hazards modeling, we were able to ask whether career persistence varies systematically by selected teacher characteristics. Second, because we followed nearly 6000 beginning teachers' careers for 12 years, we were able to study not only the lengths of their initial employment, the *first spell*, but also the likelihood of a return to teaching for a *second spell* and its length. To our knowledge, the only prior study that has examined second spells is a creative paper by Heyns (1988), who found that they were quite common in the National Longitudinal Study, 1972, follow-up data. Heyns did not report, however, whether career patterns differed by subject specialty. Third, because our sample consists of teachers who began their careers in 1972 or 1973 (a time before enrollment declines led to large numbers of involuntary layoffs of beginning teachers), our analysis may provide better predictions of the career patterns of teachers in the 1990s, when student enrollment should be relatively steady or rising and shortages of teachers are feared.

Trends examined in the study. Despite the practice teaching that is part of the requirements for certification in most states, many teachers start their first job with little idea of what it is really like to manage their own classroom. Although some new teachers find the job an invigorating and satisfying challenge, many others find the experience frustrating and unsatisfying. Initial difficulties may explain the high attrition rate among beginning teachers, a phenomenon that has been reported in many past studies (Charters, 1970; Heyns, 1988; Mark & Anderson, 1978, 1985) and is also evident among the teachers we studied. Teachers who do remain in teaching for 5 years are likely to stay for a great many more, and consequently attrition rates tend to be quite low among experienced teachers until they reach the age where retirement is considered.

TABLE 1

Demographic Composition of Sample Teachers by Subject Specialty

			Demographic group			
			Entry age ≤ 30		Entry age > 30	
Subject specialty	N	Percent of all teachers	Female	Male	Female	Male
Elementary school	3545	60.4	69.9	20.1	9.8	1.4
English	858	14.6	64.4	28.8	6.0	0.8
Mathematics	546	9.3	41.1	55.9	1.5	1.6
Social studies	464	7.9	22.6	70.2	3.7	3.4
Biology	408	7.0	27.5	68.3	1.4	2.7
Chemistry/Physics	48	0.8	8.5	89.0	0.0	2.4
All subjects	5869	100.0	58.6	32.6	7.3	1.5

Teachers leave teaching not only because they are "pushed" by frustration, however. They are also "pulled" to alternative opportunities, including full-time childrearing and more lucrative employment. Although our dataset does not contain information on marital status, it seems likely that young women, the group most likely to engage in full-time childrearing, would experience higher attrition than other groups. We also expect that these women would be more likely than other teachers who left teaching to return to the classroom. For this reason, we anticipate that a young woman's first spell of teaching is more likely to be followed by a second spell than is a man's or an older woman's. Another major reason teachers leave teaching is to pursue careers in other occupations where greater financial rewards for their subject matter expertise is available.

New Data on Teachers' Careers

The research reported here is based on a dataset that we compiled with support from the National Science Foundation. The dataset contains information on all of the 5869 white teachers who began their careers in Michigan public schools in 1972 or 1973,[3] teaching either an elementary school class, or any of the following secondary school academic subjects: English, social studies, mathematics, biology, chemistry, or physics. (We treated the 48 teachers with a subject specialty of either chemistry or physics as a single group.) The dataset contains information on the number of years that each teacher taught continuously in Michigan between the entry year and 1985, which we refer to as length of first spell. In addition, we know whether a second spell was started before 1985, and its length, if it was completed.

Table 1 presents the demographic composition of the sample by subject specialty. We selected the age-gender combinations shown because teacher career persistence differed dramatically among the subgroups so defined. For elementary school and English, the modal entering teacher was a woman under 31. For all other subject specialties, the modal entering teacher was a man under 31. Because 75% of all entering teachers were either elementary school or English teachers, the overall modal entering teacher was a woman under 31. Because age and gender were shown to be important predictors of career persistence, a consequence of the differences in sample age-gender distributions among subject specialties was that the answer to the question, "Are there differences in employment duration for teachers with different subject specialties?" depended on whether demographic characteristics were included as controls in the proportional hazards model.

One might argue that the model specification should not include age and gender as predictors because policymakers are typically concerned with potential shortages of teachers in particular subject areas and are not centrally concerned with teachers' age and gender. These policymakers might want to answer two questions: (a) Among currently employed teachers, does subject specialty predict length of stay in teaching? and (b) Can we extrapolate these results to teachers beginning their careers today? Estimating a proportional hazards model that contains only subject specialties as predictors will provide an answer to the first question. However, if the age and gender distribution of teachers entering the profession today is different from the distribution in this dataset (as we show below), then the answer to the second question will be wrong. To answer the second question correctly, we must build proportional hazards models that include not only subject specialty but also demographic characteristics.

The Development and Use of Proportional Hazards Models

Research questions about duration, and its relationship with other factors are of fundamental interest in research on teachers' career paths. For example, the researcher may ask how long prospective teachers are likely to remain in their jobs. Or, whether certain groups (such as women, minorities, physics teachers) stay in teaching longer. Thus, research interest focuses not only upon *the waiting-time* (length of time) to the event in question (e.g., termination of teaching) but also upon those characteristics of the individuals and of their treatment and environment that are associated with inter-individual variation in waiting-time.

Unfortunately, building models of waiting-time as a function of selected predictors is not completely straightforward (Allison, 1982; Willett & Singer, 1988). Generally, the sampled individuals are not followed for their entire lifetimes. Rather, the investigator gathers the waiting-time data during some specified and finite data-collection period. Although information may be available on all of the sampled individuals for the entire length of the data-collection period, the value of the dependent variable (waiting-time) may still not be known for all of these individuals, because the event of interest may not yet have occurred for all of them. For instance, some teachers may not have left teaching by the end of the data-collection period; all we then know is that they stayed in teaching longer than we observed them. These individuals, for whom the event of interest does not occur before the data-collection is over, possess truncated or *right-censored* waiting-times.

Analyzing the waiting-times of only those individuals for whom the event of interest has occurred necessarily results in an underestimate of the true length of service. For instance, in a naive assessment of how long teachers remain in the profession, the median lifetime of that sample of teachers who have already left teaching seriously underestimates the true median length of the teaching career because the estimation has ignored those teachers who have not yet left. Obviously, the very presence of unterminated teachers in the sample indicates that the true median career length is probably much longer than the naive approach would suggest. The fact that some percentage of any entering cohort has not left by some specific occasion contains much information, particularly information about the probability that teachers stay in teaching longer than the time that has already elapsed.

One common strategy for dealing with right-censoring is to create a new dependent variable by dichotomizing the waiting times. For example, the new dependent variable can be assigned a value of 1 for all teachers who stay in teaching for the period of observation, and a value of 0 for all teachers who leave teaching during the period of observation. Techniques such as logit analysis (which are appropriate when the dependent variable is dichotomous) can then be used to examine whether the probability of remaining in teaching is influenced by characteristics of the individual or the environment.

Although dichotomizing the waiting times may be a reasonable exploratory strategy, its routine application is unsatisfactory for two related reasons. First, the choice of a time point to use in deciding which teachers in the sample are "stayers" and which are "leavers" is arbitrary; yet the results may be very sensitive to this choice. Second, the strategy throws away much information because variation in waiting time on either side of the dividing line is ignored. For example, if the dividing line is 8 years, teachers who resign after 7 years are treated as having the same persistence as teachers who resign after 1 year. The ensuing loss of statistical power is likely to undermine the prediction of career persistence considerably.

Over the last 20 years, methodologists have responded to the biasing effect of right-censoring by creating new, and statistically sophisticated analytic methods known as *survival analysis* (Kalbfleisch & Prentice, 1980; Miller, 1981) or *event-history analysis* (Allison, 1984; Tuma, 1982; Tuma & Hannan, 1978). Rather than modeling the waiting-times directly, these strategies model mathematical transformations of the waiting-time that remain meaningful in the face of right-censoring and then transform back during the interpretation of the analyses. The particular mathematical transformations utilized in survival analysis are the *survivor function* and the *hazard function*.

Broadly speaking, the survivor function is a *plot* that indicates how likely it is that a teacher will survive in teaching beyond 1 year, 2 years, 3 years, 4 years, and so on. It is a picture of the probability of survival as a function of time. At the very beginning of the study, when all the teachers have just started their employment, 100% of them are 'alive,' engaged in teaching, and their survival probability is 1. As time passes, teachers gradually 'die,' leave the profession, and the survival probability drops steadily towards zero, although it may not reach this value during the period of observation due to right-censoring. A very useful statistic, which captures how rapidly the survivor function drops and describes how long a typical teacher might expect to 'live,' is the *median lifetime*. This quantity is the length of time that must pass before 50% of the teaching force leaves teaching, and its value can be obtained by simple graphical interpolation on the survival probability plot.

The hazard function is a plot of a more complex quantity that describes the risk of leaving teaching at any given time. It tells, for instance, whether the second year of teaching is particularly risky or whether the third year is less risky than the second, and so on. Formal definitions of hazard are related to the probability that a teacher will leave the profession *given that she has survived up to the immediately prior instant*. For the purposes of interpretation, however, it is easier to envision hazard as a measure of how rapidly the slope of the survivor plot is changing. If, at some particular point in time, the survivor plot drops dramatically, and thus the slope of the survivor plot changes quickly, then we can deduce that many teachers have left their jobs suddenly and we can infer that this particular time is very hazardous or risky for the profession. Hazard detects and describes such fluctuations in the slope of the survivor function.

Survival analysis was originally intended for examining clinical lifetime data. Such research examines how long cancer patients survive after diagnosis or treatment or how long heart-transplant recipients live after surgery. The event that terminates the observed waiting-times is death. (Thus, unfortunately for other disciplines where the event of interest is less morbidly terminal, the language of survival analysis borrows dark and forboding terms.) Readers wishing to investigate the survivor and hazard functions further should consult Allison (1984), Miller (1981), or Kalbfleisch and Prentice (1980).

Within the broad class of survival analysis techniques, one very popular strategy that investigates hazard as a function of selected predictors (and which bears a considerable resemblance to the more familiar multiple regression analysis) is the fitting of proportional hazards models by the method of partial-likelihood, or *Cox regression* (Cox, 1972; Kalbfleisch & Prentice, 1980). Although the statistical papers describing this technique are highly technical and difficult to understand, the strategy has recently become accessible to empirical researchers by virtue of appearing as a procedure in several statistical packages (e.g., as BMDP2L and SAS PROC PHGLM).

The Study of Teachers' Career Paths

In the research reported here, we have used proportional hazards models to estimate the extent to which the hazard function describing career duration varies systematically as a function of teacher demographics and subject specialty. Proportional hazards models do have one limitation: They implicitly assume that the logarithm of the hazard function shifts additively by levels of the predictors (the proportional hazards assumption). During exploratory analyses, we found evidence that the variable race violated the proportional hazards assumption. We therefore chose to include only white teachers, who made up 95% of our sample, in the analysis.

To test hypotheses concerning the relationship between teacher characteristics and hazard, we separated the predictors into two classes: demographic characteristics (age and gender) and subject specialty. We fit a hierarchy of proportional hazards models that explored the prediction of the hazard function by each class, first separately and then together. However, analyses of the demographic characteristics (as predictors of hazard) revealed that their effects were not simply additive but were multiplicative. As a result, all of our models that incorporate age and gender include both their main effects and their interaction. To examine the prediction of hazard by subject specialty, we estimated three sets of models: (a) main effects of subject specialty, (b) main effects of subject specialty, controlling for demographic characteristics, (c) main effects of subject specialty, demographic characteristics, and their interaction.

We summarize the effect of the various predictors on teachers' survival in two ways. First, we display survivor functions estimated from our fitted models. These plots indicate the estimated proportions of particular sorts of teacher who are predicted (by the fitted model) to remain in teaching for 1 year, 2 years, 3 years, and so on after entry. Second, from these fitted plots, we estimated and tabulated the median lifetimes of young teachers, female teachers, physics teachers, and other groups of interest. Our *analyses* made use of a conceptually remote idea, hazard, whereas our *interpretations* are statements about duration, a more easily understood concept. In some instances, because of the distribution of right-censoring in our sample, we were not able to estimate precisely the median lifetime, and thus we simply note that it is greater than a specific value.

Young women have the shortest spells. As illustrated in Figure 1, which presents the predicted first spell survivor function for each of the four age-gender groups, the effect of gender on length of first spell differed significantly by entry age: Among older teachers there was no difference; among younger teachers men stayed longer than women. (Column 2 of Table 2 lists the predicted median spell lengths.) This suggests that previous studies (Mark & Anderson, 1985) that reported that women as a group are more likely to leave teaching than men are somewhat misleading because the gender differential only holds among young teachers.

The variation in the gender differen-

TABLE 2

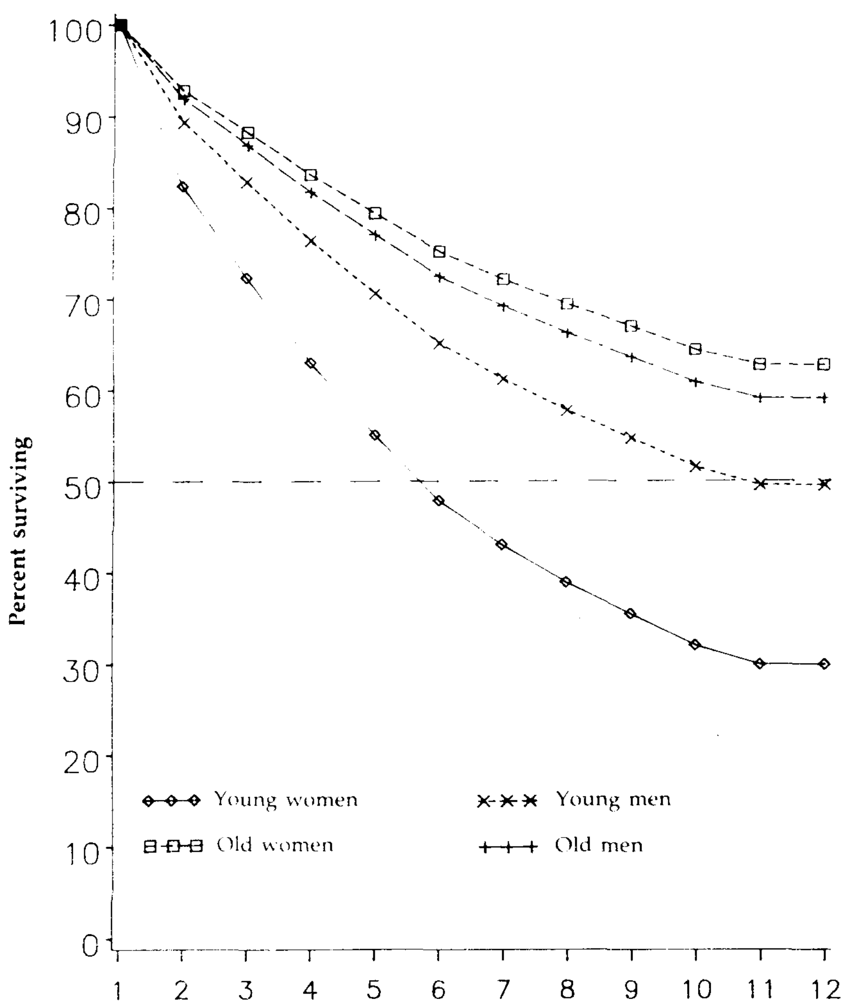
Predicted Median First and Second Spell Lengths by Age and Gender

Age/Gender category	Predicted median length of first spell (years)	Percentage of teachers returning to teaching after an interruption	Predicted median length of second spell (years)
Young women	5.7	31	5.0
Young men	10.8	25	> 10.0
Older women	> 12.0	29	> 10.0
Older men	> 12.0	28	> 10.0

tial by entry age was not important for determining teacher supply in the 1970s because so few of the entering teachers were older women. For example, between 1972 and 1973, only 11% of the women who entered teaching were over 30 whereas, between 1982 and 1984 (the last 3 years for which we have data), 41% were over 30.[4] The changing demographic composition of the entering teaching force implies that the age-gender interaction has implications for future predictions of teacher supply. In particular, if the patterns evident in our data persist into the 1990s, the increased age of new entrants implies that, on average, new entrants in the *future will stay longer in teaching than* did new entrants in the 1970s. This effect may counteract the tendency toward an increasing overall attrition rate that, as Grissmer and Kirby (1987) explain, may follow from the increase in new hires that will occur in the years ahead.

FIGURE 1.

Predicted Survivor Functions for First Teaching Spell (Demographic Effects)



(These are white teachers who entered in either 1972 or 1973 and taught either elem., bio., chem./phys., math, English, or soc. studies.)

Many teachers return. Between one quarter to one third of teachers who left the classroom within 8 years of entry returned to teaching after a career interruption, as Table 2 shows.[5] Young women had the highest return rate, 31%. Second spell lengths also differed significantly by entry age and gender: The group with the shortest median first spell, young women, also had the shortest median second spell. This difference may reflect the decisions of young women to leave teaching for a second time to engage in full-time childrearing. Unfortunately, the temporally limited nature of our data do not permit us to explore whether young women are more likely than other teachers to start a third teaching spell or to estimate the median lengths of such spells.

The large proportion of teachers in our sample who return to teaching after a career interruption calls into question the assumption implicit in the national teacher supply and demand model that newly minted college graduates are the sole source of teacher supply. Rather, we found that returning teachers are also a major source of teacher supply. Similar patterns have been reported in both Connecticut and New York. For example, Connecticut reported that 75% of the teachers newly hired in 1986 were returning teachers.[6] The analogous statistic for New York State is 70%.[7] This suggests that returning teachers may be an important source of supply in the years ahead.

Chemistry/physics teachers have short first spells. Predicted median lengths of first spell by the teachers' subject specialty appear in Table 3. Estimates in the second column are for the entire sample (predicted from a model in which age and gender were uncontrolled). Figure 2 displays the corresponding survivor functions. Across

TABLE 3

Predicted Median Length of First Spell (Years)

Subject specialty	All teachers (Age and gender uncontrolled)	Young women (Age and gender controlled)
Elementary	7.6	6.0
English	5.9	4.9
Mathematics	7.1	5.1
Social studies	7.8	4.9
Biology	9.2	5.5
Chemistry/Physics	5.9	3.7

all teachers, the duration of first spell differed significantly by subject specialty: English and chemistry/physics teachers had the shortest predicted median first spell length (5.9 years), biology teachers had the longest (9.2 years).

Because the predicted median length of first spell differed by age and gender and because the age and gender composition of the teaching force differed by subject specialty, we next investigated whether the ranking of predicted median length of first spell by subject specialty persisted after controlling for age and gender; and whether this *controlled* ranking differed by age/gender subgroup (i.e., whether there was an interaction between subject specialty and age/gender subgroup). We found that, although the controlled ranking of subject specialty differed from the uncontrolled ranking, there was no interaction between subject specialty and age/gender group. This lack of interaction indicates that the *ranking* of predicted median first spell length by subject specialty is *constant* across the four age/gender subgroups. Therefore, we have elected to present, in the third column of Table 3, the predicted median length of first spell only for the largest demographic subgroup, young women. Figure 3 displays the corresponding predicted survivor functions for young women with particular subject specialties.

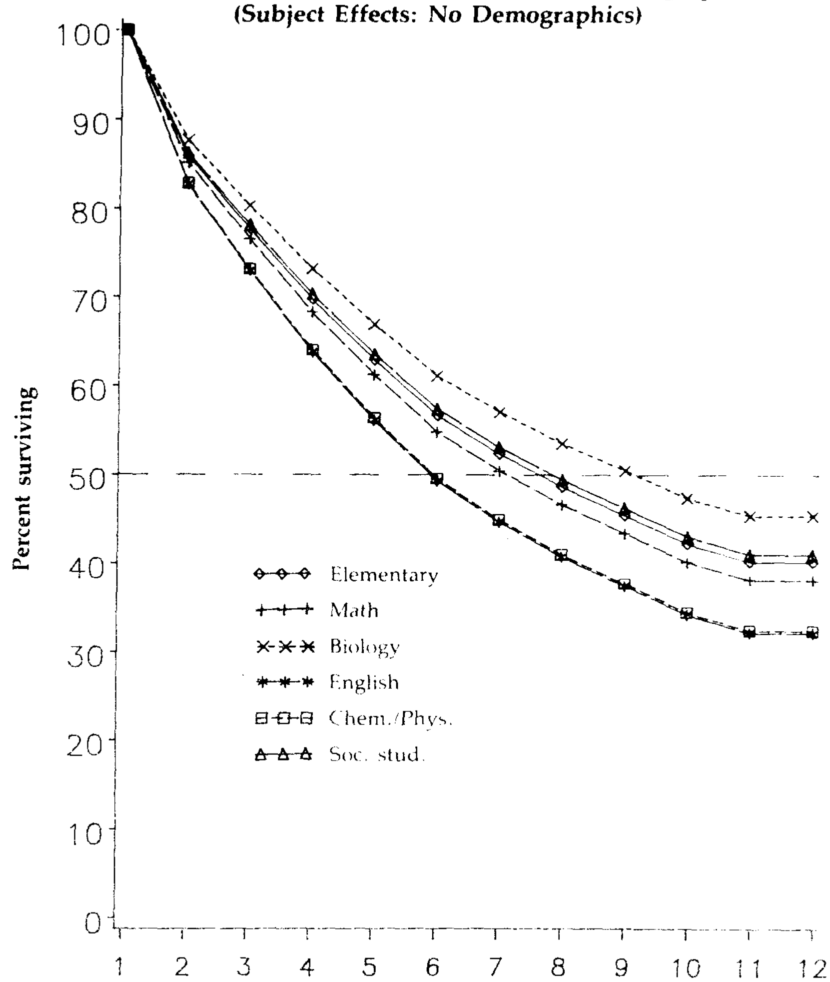
Notice first that all the estimates in column 3 are lower than the corresponding estimates in column 2; this difference is due to the shorter lengths of first spell experienced by young women. Second, notice that, controlling for demographic characteristics, the predicted median length of first spell still differed by subject specialty, but the *ranking* of the subjects changed: Biology teachers no longer had the longest predicted median length of first spell, having been replaced by elementary school teachers; and chemistry and physics teachers now clearly had the shortest median length of first spell. Thus, the picture of differential attrition by subject specialty derived from the uncontrolled model distorts the true hazard associated with each subject specialty.

Chemistry/physics teachers are unlikely to return to teaching. Estimates of the proportion of teachers who returned to teaching after a career interruption, overall and for teachers in the two largest demographic subgroups, young women and young men, are laid out in Table 4. Only teachers whose first spell length was 8 years or less are included in the computation of the return rates. Once again, we see that chemistry and physics teachers are the most dissimilar from teachers of other subject specialties; only 13% of the chemistry and physics teachers who left teaching returned, as compared with over 20% of teachers of all other subject specialties.

Table 5, which presents median second spell lengths, carries this theme

FIGURE 2.

Predicted Survivor Functions for First Teaching Spell (Subject Effects: No Demographics)



(These are white teachers who entered in either 1972 or 1973.)

one step further. Controlling for age and gender, we find that chemistry and physics teachers who do return to teaching have a shorter predicted median length of second spell than do teachers of other subject specialties. Furthermore, we find a larger discrepancy between chemistry/physics teachers and those in other subject specialties in the model that controls for demographic characteristics (because young males also tend to have longer second spells than do young females) than in the model that does not control for demographic characteristics. These differences can only be viewed as suggestive, however, because the parameters of the proportional hazards model that lead to them were not statistically different from one another at the .05 level. (The small number of chemistry and physics teachers who actually return for a second spell ensures that the referent standard errors used in any parameter comparison are necessarily large.)

TABLE 4

Percentage of Subject Matter Subsamples Returning to Teaching After a Career Interruption

Subject specialty	All teachers	Young women	Young men
Elementary school	32	32	29
English	27	30	20
Mathematics	25	26	24
Social studies	24	25	24
Biology	23	21	24
Chemistry/Physics	13	0	14

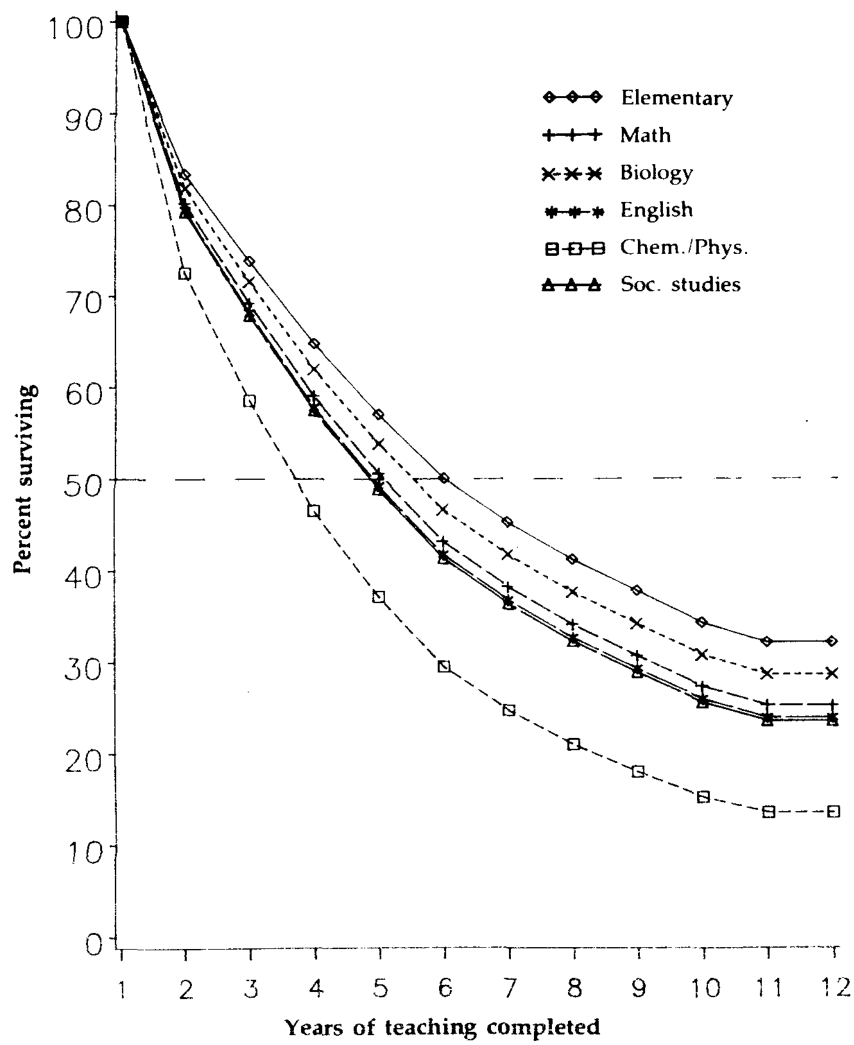
Opportunities outside teaching. The collective evidence on teacher employment duration suggests that chemistry and physics teachers have the shortest careers: Not only do they leave teaching earlier than do teachers of other subject specialties, they are also less likely to return. Moreover, those who do return appear to stay less long than other teachers. What explains this differential? At least part of the explanation lies in the attractiveness of alternative career opportunities. Although we do not have data on the options available to individual teachers, we explored the opportunities differentially available to teachers in different fields.

As shown in Figure 4, starting salaries in business and industry (expressed as a percentage of average starting salary in teaching) for college graduates trained in chemistry and physics were consistently higher than starting salaries for graduates in most other subject specialties throughout the period of our research interest. Thus, better salaries in other sectors of the economy may have been the important force pulling chemistry and physics teachers out of the classroom. The salary data also may explain the relatively long median first spell length for biology teachers. The average 12 month starting salaries paid in business and industry to college graduates trained in biology were considerably lower than starting salaries paid to chemistry and physics graduates, and in most years, the salaries were only slightly above the average 10 month salary paid to beginning teachers.[8]

Math teachers: an anomoly. There is one weakness in the argument that differences in attrition rates by subject specialty can be explained by salary differences in business and industry for

FIGURE 3.

Predicted Survivor Functions for First Teaching Spell (Subject Effects: Young Women)



(These are white teachers who entered in either 1972 or 1973.)

college graduates with different subject specialties. Average starting salaries for college graduates trained in mathematics were almost as high as starting salaries paid to graduates trained in chemistry and physics, yet the mathematics teachers in our sample have one of the longest predicted median first spell lengths. A possible explanation for this unexpected pattern is that the high paying jobs in business and industry may only have been available to the minority of math teachers who taught advanced math courses, and not to the majority of math teachers who teach algebra, geometry, and remedial math. Because our data do not permit differentiation among math teachers' assignments, we cannot test this hypothesis. We did find, however, that math teachers who were math majors in college did not have lower estimated median first spell lengths than did math teachers with other college majors.

TABLE 5

Predicted Median Length of Second Spell (Years)

Subject specialty	All teachers (Age and gender uncontrolled)	Young women (Age and gender controlled)
Elementary	5.6	5.0
English	5.9	5.1
Mathematics	7.5	5.2
Social studies	5.5	3.9
Biology	5.8	4.2
Chemistry/Physics	4.3	2.9

Implications of the study. One implication of our results is that if teacher supply and demand models are to provide reliable advance warnings of teacher shortages or surpluses, they must incorporate aspects of the complexity of teacher career patterns. For example, they must take into account that chemistry and physics teachers stay in teaching less long on average than do biology teachers and that the reserve pool of former teachers is an important source of supply of teachers for many subject fields.

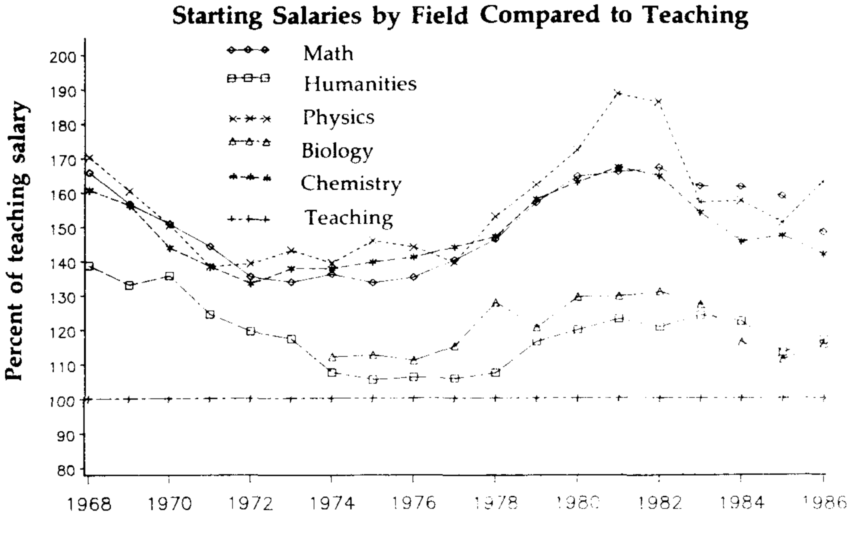
There is a second set of implications that concerns the impact of public policies on teacher career patterns. In recent years, states have introduced a variety of educational reforms, including mentoring programs for new teachers, increases in teacher salary scales, and changes in teacher certification requirements. Although all of these new policies have the general goal of improving the quality of instruction provided to students, there is in many cases a lack of clarity about the mechanisms through which the policies will impact on schools.

One promising research approach is to examine how these policies influence teachers' careers. For example, it would be valuable to investigate whether particular types of mentoring programs significantly alter the traditionally high attrition rate of beginning teachers. It would also be useful to explore how salary increases impact on attrition and on the probability that former teachers will return to the classroom. Finally, it would be important to learn how changes in state teacher certification requirements influence the number of older college graduates who enter teaching, a group that has become an increasingly important source of supply in recent years, and how these policy changes influence the probability that former teachers return.

The theme underlying these suggestions is that it is useful to examine the mechanisms through which policies may have their impact. One of the purposes of this paper is to demonstrate that a new and powerful methodology, proportional hazards modeling, is now available for use in isolating the influences of a particular policy, such as a mentoring program, on duration in teaching from the many other factors that influence duration. Use of this technique in a research program aimed at investigating the impact of educational policies on teachers' career choices may be a powerful strategy for collecting timely information about the effects of these policies.

FIGURE 4.

Starting Salaries by Field Compared to Teaching



SOURCES: College Placement Council; National Education Association

Proportional Hazards Models and Educational Research

We would encourage educational researchers to think about the extent to which their questions treat duration as the dependent variable. We are convinced that many areas of substantial educational interest are capable of generating such questions. Researchers, policy makers, and practitioners are forever asking: How long does it take to graduate, or to learn, or to respond?

What are the characteristics of those who graduate sooner, learn faster, respond quicker? Among the diverse research questions that could be fruitfully analyzed with proportional hazards models are:

Questions about the length of time required for a student to graduate or obtain a graduate degree. What is the typical length of time required to obtain a doctorate? Does it differ by institution? By substantive area? By level of financial support?

Questions about instructional "waiting times." What is the typical wait-time between the teacher asking a question and the response from the student? Does this wait-time differ by educational level? By the gender of the participants? How long does a mother wait before responding to her child? Is the pause a function of culture? Of social class? Of stress?

Questions about the length of time to achieve mastery of a set of skills or a content area. How long does it take to acquire elementary Spanish? Is the length of time influenced by an innovative treatment or by immersion in a bilingual program?

These questions demand a methodology that is appropriate and powerful, a methodology that makes full use of all the information gathered. Proportional hazards modeling is such a methodology. Its new accessibility has wide and far-ranging implications for educational research.

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[1]Grissmer and Kirby (1987, p. 2) present an example demonstrating the importance of teacher attrition in determining the demand for new teachers.

[2]As Gerald (1986) explains, the national model makes predictions of teacher supply and demand based on three alternative estimates of the attrition rate, a high estimate of 8%, an intermediate estimate of 6%, and a low estimate of 4.8%. These estimates have been in use since the mid-1970s and reflect a downward revision of the 8% attrition rate reported in a study conducted in 1970 (Metz & Fleischman, 1970).

[3]As we later explain, black teachers (who were 5% of the original sample) were not included for methodological reasons.

[4]The demographic characteristics of teachers entering teaching in 1982, 1983, or 1984 that are reported in the text refer only to new entrants, not to teachers returning to the classroom after a career interruption. A recent report on newly certified teachers in Connecticut (Prowda & Beaudin, 1987) shows an age distribution similar to the distribution reported in the text for Michigan in the 1980s.

[5]The estimated median length of interruption between first and second teaching spells for all teachers in our sample was 1 year. It is likely, however, that this is an underestimate of the true median length of interruption because our dataset does not include teachers who return to teaching in any year beyond the 12th year after initial entry.

[6]Information taken from Connecticut State Department of Education, 1987.

[7]Information taken from New York State Education Department (1987) (unpublished table provided by John Stiglmeier, Director of Information Center on Education).

[8]In a paper describing related research using the same database, Murnane and Olsen (1988) show that starting salaries in business and industry for college graduates with different subject specialties do predict teachers' length of first spell.

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