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Factors Influencing Retention of Mathematics and Science Teachers in Secondary Schools— A Study based on SASS/TFS

Using a sample of mathematics and science teachers extracted from the 1999-2001 SASS/TFS surveys, connections between teacher and school district characteristics regarding retention are investigated to offer insight into how mathematics/science teacher recruitment might be focused.

Introduction

Shortages of qualified science and mathematics teachers are a ubiquitous problem in the United States. Many schools face both sides of the problem: recruitment and retention of those teachers. Since bringing new teachers in and keeping them are equally important, where should school districts look for teachers that are most likely to stay? While many school districts cannot afford to be too choosy in where they look, their limited resources also mean that they cannot look everywhere. Therefore, information on who are more likely to stay may be valuable for districts to focus their resources for maximum impact.

Background

While recruitment and retention are clearly linked, these topics represent very different aspects of school staffing. With respect to recruitment, mathematics and science education research appears to be focused on attracting individuals with mathematics and science backgrounds into teaching as a profession (e.g. Moin, Dorfield, & Schunn, 2005; Tomanek & Cummings, 2000; Wang, 2004). With respect to retention, the focus appears to be on issues of work environment and new teacher induction (Ingersoll, 2001; Ingersoll, 2003; Luft & Patterson, 2002; Luft, Roehrig, & Patterson, 2003; Patterson, Luft, & Roehrig, 2003; Smith & Ingersoll, 2005). Others suggested that professional preparation prior to recruitment may play a more important role (Kirby & Grissmer, 1993; Murnane, 1987; Reynolds, Ross, & Rakow, 2002; Rhoton & Bowers, 2002; Weld, 1998).

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With the proliferation of alternative teacher certification programs, the backgrounds of individuals entering teaching have shifted. Teacher certification has evolved from the familiar college and university-based teacher education programs to a multitude of different forms and formats. Many programs have structures designed to attract particular groups of young college graduates or working professionals. Other programs have been designed specifically to dovetail with the life demands faced by individuals who have science backgrounds and an interest in teaching. For example, *Teach for America* tends to attract recent college graduates with little or no teaching experience, while community-based alternative certification programs offering evening and weekend classes tend to attract people who hold full-time jobs, but wish to transition into teaching. Some mid-career programs are more time intensive and require full-time enrollment, while still others place pre-service teacher in

schools with limited teaching loads and mentors (e.g. *New York City Teaching Fellows Program*).

Given our focus, a comparison of traditional and alternative certification programs was not our purpose. Rather, we have chosen to analyze various teacher and school characteristics to provide a snapshot of the interactions among these factors and their association with the likelihood of teachers to remain in their original schools. We expect that the current study will offer some insight to those seeking to maximize their recruitment efforts by effectively keeping the mathematics and science teachers.

For this analysis, we have selected to study the influence of the following teacher characteristics: age, educational background, salary satisfaction, teacher experience; along with the following school characteristics: school-related earnings, sector (public or private), and urbanicity (urban, suburban, or rural). We have also controlled for the demographic background variables, gender and race/ethnicity. Our analysis included both mathematics and science teachers.

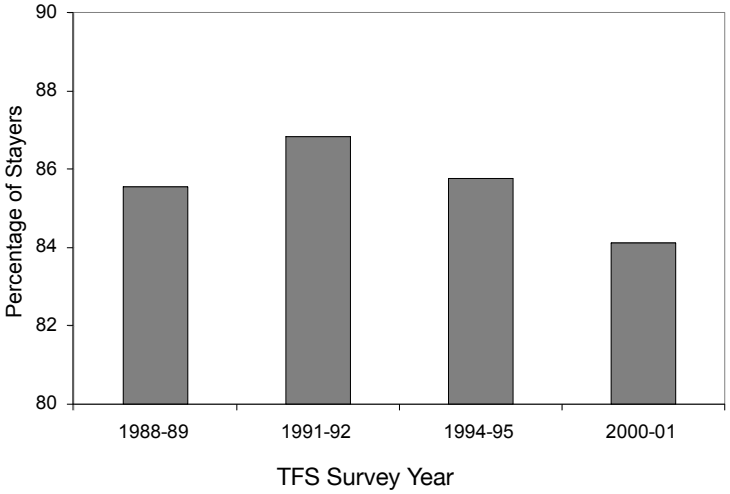
Methods

Data Source

The data from our study was obtained by linking two large-scale educational surveys from the *National Center for Educational Statistics* (NCES), the *Schools and Staffing Survey (SASS) of 1999-2000* and the *Teacher Follow-up Survey of 2000-2001*. The fourth in this series, the *SASS* data, collected by U.S. Census Bureau for *NCES* from a random sample of schools, were stratified by state, public/private sector, and school level (NCES, 2004). After one year, the same schools were again contacted and a representative sample of teachers was asked to complete the *Teacher Follow-up Survey (TFS)*, including those in the original sample who had left their teaching jobs. The survey also obtained information relevant to their departures. In earlier studies by Ingersoll et al. (2001; 2003; Smith & Ingersoll, 2005), teachers were placed into three categories: "leavers" for those who left the teaching profession; "movers" for those who moved to other schools; and "stayers" for those who remained at their original schools. However, for the purpose of this study, teachers not remaining in their original institutions are the primary concern, so we have chosen to group "leavers" and "movers" together into a single group "non-stayers", and compare them to the "stayers". Figure 1 shows a graph of the percentage of stayers over the four SASS/TFS surveys.[1] The most recently available *SASS* 1999-2000 collected data from approximately 52,000 teachers in 12,000 schools. *TFS* 2000-2001 obtained information on 5788 teachers, among them 3473 non-stayers and 2315 stayers.

The results suggest that overall, rural districts struggle most in retaining teachers, both new and experienced.

Figure 1: Percentage of stayers, teachers remaining in their original schools, from the four SASS/TFS surveys*



* Data obtained from Luekens, Lyter, & Fox (2004), p. 8.
These are percentages of stayers regardless of subject areas.
** SASS/TFS Surveys were not performed in 1997-98.

Analyses

The selected sample for analysis included 916 mathematics/science teachers who completed both *SASS* and *TFS* in 1999 – 2001. Excluding teachers who retired (n = 137) and 34 others who were not regular teachers (i.e. substitutes, administrators, staff), the final sample included 745 regular mathematics and science teachers. The sample included 304 stayers and 441 non-stayers, with 327 male and 418 female, 394 in mathematics and 351 in science.

The independent variables used in this analysis came from the 1999-2000 SASS teacher questionnaires. As a measure for educational background differences, we included variables identifying teachers who held Advanced Degrees in science/math-

1.Note that the spacing of the first three SASS/TFS surveys was carried out in 3 year intervals; however, no SASS/TFS surveys were carried during the interval beginning in 1997.

ematics and those who held Advanced Degrees in education in general. For Salary Satisfaction, we included teachers' response to a question asking them to rate their degree of satisfaction in salary on a 4-point Likert-type scale. For teacher experience, we compared teachers with 3 or fewer years of experience (New Teacher) to those with more than three years of experience (Experienced Teacher). Four teacher age groups were used: less than 30 years old; 30 – 39; 40 – 49; 50 years and older. The teacher-reported school-related earnings (School Earnings) were grouped into 4 categories: 1) less than 20,000; 2) 20,000 – 29,999; 3) 30,000 – 39,000; and 4) 40,000 or more. Sector accounted for differences between Public and Private schools. Finally, Urbanicity classified by Federal Information Processing Standards as used by the U.S. Census (NCES, 2004) was included to account for differences in the geographical locations of schools in proximity to population centers ranging from rural to suburban to urban. The analysis also included tests for interactions among these predictors. The binary format of the outcome comparing Stayers to Non-stayers indicated that logistic regression was most appropriate for this analysis. We used the logistic regression module available in SPSS 14.0.

Table 1: Binary logistic regression model with interactions (N = 745)

	B	S.E.	Odds Ratio
Constant	-0.72	0.76	0.49
Demographic Background			
Male	0.05	0.16	1.05
Asian	-0.95*	0.47	0.39
Black	0.49	0.40	1.64
Hispanic	-0.07	0.43	0.93
Native American/Am. Indian	-1.06	0.83	0.35
Educational Background			
Advanced Math/Science Deg.	-0.62**	0.24	0.54
Advanced Education Deg.	-0.32	0.23	0.73
School Characteristics			
School Earnings	0.38***	0.10	1.46
Private	0.24	0.18	1.28
Urbanicity	-0.89*	0.35	0.41
Teacher Characteristics			
Salary Satisfaction	0.31***	0.08	1.37
New Teacher	-1.20*	0.57	0.30
Age	-0.31	0.25	0.74
Interactions			
New Teacher * Urbanicity	0.63*	0.26	1.88
Age * Urbanicity	0.31**	0.12	1.37
Nagelkerke Pseudo R^2	0.15		

***: $p < 0.001$; **: $p < 0.01$; *: $p < 0.05$.
B: regression coefficient; S.E.: standard error; odds ratio: odds ratio of independent variables = e^B.
School sector is a dichotomous variable with private school = 1 and public school = 0.
Urbanicity is an ordinal variable with higher values indicate more urban areas.
Teacher earning from school (an ordinal variable with higher values indicate higher salary), year at the current school, whether they have an advanced degree in math/science (yes = 1), whether they have an advanced degree in education (yes = 1), whether they are new teachers with less than 3 year experience (yes = 1). An advanced degree was defined as a degree beyond a baccalaureate.
Satisfaction in the salary (higher value indicates higher satisfaction), satisfaction in general (higher value indicates higher satisfaction), and self-rated intention to remain in teaching (higher value indicates more inclined to stay in teaching).

Results and Discussion

Through our analysis we arrived at the regression model shown in Table 1. The model with a Nagelkerke R^2 of 0.15 included the main effects variables we listed in the previous section and two significant interactions: *New Teacher* by *Urbanicity* and *Age* by *Urbanicity*.

We approach the discussion in two parts, beginning with a discussion of the significant main effects and then proceeding to a discussion of the interactions. Applying this approach separates the significant effects accordingly, main effects only:[2] *Advanced Math/Science Degree*, *School Earnings*, and *Salary Satisfaction*; and interactions: *New Teacher by Urbanity*, *Age* by *Urbanicity*. Here, school earnings and salary satisfaction have a very low correlation of 0.12 which allowed them to be entered into the logit model together.

2.The *Asian* Race/Ethnicity grouping included only 27 teachers. Given the size of all non-white Race/Ethnicity groupings, the inclusion of these variables were as controls, rather than as robust means of uncovering differences. As a result, we caution against the direct interpretation of the significance of the *Asian* Race/Ethnicity main effect.

We begin by considering educational background of teachers. The logit model coefficient for *Advanced Math/Science Degree* is negative, indicating that those who held advanced mathematics/science degrees are less likely to stay in their original schools than those who did not hold these degrees. Calculating the reciprocal of the odds ratio reported in Table 1 yields a value of 1.85, indicating that advanced mathematics/science degree holders were 1.85 times more likely not to stay (i.e. move to another school or leave teaching all together) than those who did not hold these degrees. The odds ratio result for *Advanced Education Degree*, however, was not significant.

School Earnings account for the dollar amounts teachers were paid by schools in the logit model and were found to be the most statistically significant factor in the model. The findings indicate that after controlled for other variables including teacher experience, teachers in a higher earning bracket were 1.46 times more likely to stay than a lower one (e.g. teachers earning $30,000 - $39,000 compared to teachers earning $20,000 - $29,000). While this result is certainly not surprising, arguments continue to be made for why teacher salaries should not be increased.

Salary Satisfaction is a rating of teachers' satisfaction with their current earnings. To some degree, this variable offers some insight into teacher pay and local area cost of living. For example, earning $50,000 in Ruckersville, VA, is very different from earning the same amount in Brooklyn, NY. In addition, this variable reflects an individual's psychological perception, which can be different from the actual salary level. Here the results indicate that teachers who reported a higher salary satisfaction are 1.37 times more likely to stay in the same school than teachers who reported lower satisfaction (e.g. teachers who were "strongly satisfied" compared to "somewhat satisfied").

… the findings suggest that for urban and suburban school districts, after teacher experience has been taken into account, recruitment might best be focused on mid-career pre-service teachers.

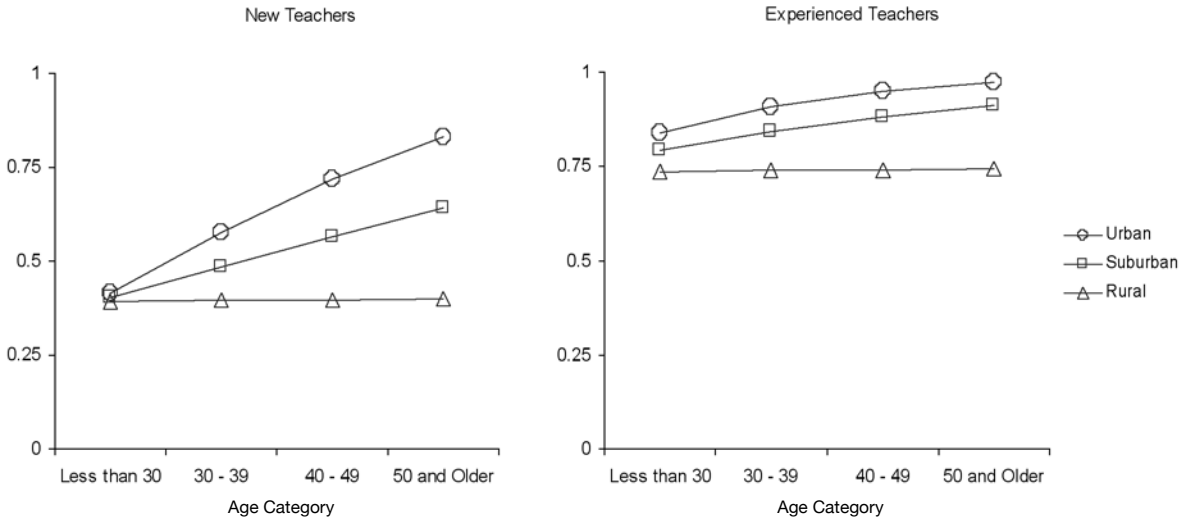
Given the complexity introduced by the interactions, a graphical display (Figure 2) of the estimated probabilities offers a clearer picture of the results. The interactions involve three variables: teacher experience, teacher maturity, and proximity to urban population centers. Figure 2 shows two panels for comparisons between *New Teachers* and *Experienced Teachers*. The x-axis of the graphs displays differences across *Age*. The y-axis represents the estimated probability of teachers staying in their original schools, with values ranging from 0 to 1. Finally, the three trajectories juxtapose the differences across *Urbanicity*. Here, we can see that the estimated probabilities for teachers to stay in their original schools varied across the three different predictors involved in the interactions. For rural schools, the estimated probabilities appear to be fairly flat, indicating little variation across *Age*, for both *New Teacher* and *Experienced Teacher* groups. The results suggest that overall, rural districts struggle most in retaining teachers, both new and experienced. For suburban and urban schools, the findings suggest that among *New Teachers*, the highest estimated retention rates appear to be for teachers in the older cohorts. Here the estimated probabilities indicate that older teachers are predicted to have greater likelihoods of remaining in the same school.3 Among *New Teachers* in suburban schools, teachers in the "Less than 30" group have an estimated probability of 40% of staying, while those in the "50 years and older" group stand at 64%. For urban schools, the difference is even greater, 42% compared to 83% for "Less than 30" versus "50 years and older", respectively. A similar outcome was also found among *Experienced Teachers*, where the estimated probabilities for rural districts remain at about 74% across *Age*. While estimated probabilities of staying for teacher in the "Less than 30" group are 79% and 84%, suburban and urban, respectively; the probabilities for *Experienced Teachers* in the "50 years and older" age groups are above 90%.

Conclusions

Much of the existing research on recruitment has focused on bringing new teachers with science and mathematics backgrounds into teaching. Much of the existing research on retention has focused on work environment and induction as a means of keeping these new teachers in the schools. However, we cannot ignore the economic and social realities that these teachers are faced with when they continue to make the choice of teaching as a profession.

3.Recall that we combined movers and leavers for this analysis and therefore do not distinguish between these groups of non-stayers.

Figure 2: Comparison of the estimated probabilities for teachers to stay in their original schools across Age Categories, Urbanicity, and Teaching Experience, where New Teachers are defined as those with 3 or fewer years of experience



The findings from this study confirmed some commonly understood connections with some new revelations. The connections between earnings *or* salary satisfaction and teacher retention are not new to teaching. Yet here earnings and salary satisfaction were found to be barely correlated and seemed to contribute independently to teacher retention. Another interesting finding was that the results with respect to *Urbanicity* show that while rural districts were consistently below suburban and urban districts in estimated probabilities to retain teachers, urban districts were actually predicted to have higher retention rates when other teacher characteristics and school characteristics are controlled for.

Older teachers are found to be more likely to stay in both urban and suburban districts in this study. Therefore, the findings suggest that for urban and suburban school districts, after teacher experience has been taken into account, recruitment might best be focused on mid-career pre-service teachers. However, for rural districts, the predictions are flat across *Age* for both *New Teachers* and *Experienced Teachers*. The results suggest that while *New Teachers* are predicted to have a roughly 40% likelihood to stay in their original schools, *Experienced Teachers* are predicted to have a 74% likelihood. This differential between rural school teachers with less-than-3-years of teaching experience versus more-than-3-years is very impressive. But does this result suggest that these districts should seek to fill their classrooms with practicing teachers from other districts? In the corporate world, this practice is called "poaching" and in the end, while beneficial for individual teachers, districts and the students they serve suffer. While most high profile efforts have concentrated on large urban districts, these results suggest that for rural districts recruitment faces problems of a different nature.

Should teachers who have accumulated a wealth of knowledge and experience leave teaching, it would be a loss not only to the students and the school, but also to the profession.

The finding that teachers with advanced mathematics/science degrees were more likely to leave the profession or move to another school should not be taken casually. This certainly does not suggest that school districts should stay away from these advanced degree holders. Actually, this result may be partly due to school districts' efforts to get the "cream of the crop": advanced mathematics/science degree holders are more likely to be approached by another school or industry with higher pay or better work environment and thus more likely to leave or move. While higher credentials do not necessarily translate into more knowledgeable about the subject matter or better pedagogy, it is at least equally important for schools to keep these teachers as to recruit them.

The existing literature (e.g. Ingersoll, 2001, Luft, et al. 2004) is

very clear on good practices to retain new mathematics and science teachers. While school districts strive to provide better work environment for these teachers, it is beneficial for both teachers and schools to find a good compatibility between the two. Should teachers who have accumulated a wealth of knowledge and experience leave teaching, it would be a loss not only to the students and the school, but also to the profession.

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