THE COST OF TEACHER TURNOVER IN K-12 SCIENCE AND MATHEMATICS: WHAT WE KNOW AND WHAT WE NEED TO KNOW

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THE COST OF TEACHER TURNOVER IN K-12 SCIENCE AND MATHEMATICS: WHAT WE KNOW AND WHAT WE NEED TO KNOW

This paper recaps current literature about the incidence and financial costs of teacher turnover, identifies gaps in knowledge, and suggests areas where future research can make important contributions. Little work has been done thus far on the incidence or the costs of turnover in the science, technology, engineering, and mathematics (STEM) disciplines. This represents a large gap in knowledge, impeding the ability of policy makers and school leaders to take effective steps to improve the quality of STEM teaching and learning in American schools.

This paper also describes a current study of turnover costs in five school districts. The National Commission on Teaching and America's Future (NCTAF) is conducting research on the cost of teacher turnover in five school districts through grants from the Joyce and Spencer Foundations. The authors of this paper are leading the study for NCTAF. Because this paper is written for distribution and discussion at the October 3-5, 2006 Wingspread Symposium, study findings are not yet available. Nonetheless, we describe the study methodology, identify the cost elements for which school and district data are now being analyzed, and discuss the basis for our research questions. We conclude by suggesting key areas where high quality research on the costs of STEM teacher turnover is needed.

Teacher turnover

In recent years compelling evidence has emerged that teacher turnover has become a significant problem affecting school performance and student achievement (Grissmer and Kirby, 1987 and 1997; Ingersoll, 2001). Drawing on the Schools and Staffing Survey (SASS) from the National Center on Education Statistics (NCES), NCTAF reported in 2003 that approximately a third of America's new teachers leave teaching sometime during their first three years of teaching; almost half leave during the first five years. In many cases, keeping our schools supplied with qualified teachers is comparable to trying to fill a bucket with a huge hole in the bottom. Teaching is increasingly an "occupation with relatively high flows in, through, and out of schools" (NCTAF, 2003, 21-40).

Equally evident from the data is the differential impact of teacher turnover on schools (CFTL, 2001; NCTAF, 2003). NCTAF's analysis of the SASS data found that teacher turnover is almost a third higher in low-income urban school districts (NCTAF, p. 28). Further confirmation of the relationship between teacher turnover and school characteristics comes from the largest analysis of school-level turnover conducted to date. The Southeast Center for Teaching Quality (SECTQ) found that "the highest rate of teacher turnover occurs in schools where 75% or more of the student body is eligible" for free and reduced price meals (SECTQ, 2003). The same multi-state analysis of 7,000 schools found teacher turnover rates higher at low-performing schools than in other schools. SECTQ used employment and teacher turnover data for 270,000 teachers in over 7,000 schools across five states - *every* school and *every* classroom teacher in those states.

The SECTQ study shows that the scope of the turnover problem is significant: annual statewide turnover rates ranged from a low of 19% in Georgia to 25% in Arkansas; the five-state average was 21%. For high poverty school districts, the ***one-year*** teacher turnover rate is 20%. The problem of teacher turnover appears to apply to STEM and nearly all other subject areas, although few studies break down the rate of turnover by subject area.

Teacher turnover and pupil achievement

The consequences of high teacher turnover for student achievement are clear. In a study of Texas students and teachers in grades 4-8, Hanushek et al. (2005) report that the pupils of movers and leavers have lower achievement rates than the pupils of teachers who stay in the same school (31). While Hanushek and his colleagues show the impact of turnover on student achievement, other studies measure the impact of student achievement on a teacher's decision to leave the classroom. Another Texas study with hundreds of thousands of teachers and more than fifty thousand pupils found that "teaching lower achieving students is a strong factor in decisions to leave Texas public schools, and the magnitude of the effect holds across the full range of teacher experience" (Hanushek, Kain, and Rivkin, 2004). Their analysis noted that 7% of all Texas teachers left the profession altogether from one year to the next, while 11.5% changed schools within the state. A large-scale study of teacher turnover in Norway reported that teachers of lower performing students are more likely to move or leave teaching (Falch and Ronning, 2005, 14). In a vicious cycle, teacher turnover lowers student achievement, and lower student achievement leads to teacher turnover.

Another line of research corroborates the impact of teacher turnover on student achievement. Studies of "teacher effects" demonstrate a strong relationship between teaching and student achievement gains (Sanders and Rivers, 1996; Wright, Horn and Sanders, 1997; Mendro, Jordan, Gomez, Anderson, and Bembry, 1998; Rivkin, Hanushek and Kain, 2000). These studies also argue that, "teacher effectiveness improves with experience during the early years of a teacher's career" (McCaffrey, Koretz, Lockwood, and Hamilton, 2003; Rivkin et al., 2000; Shkolnik et al., 2002). Villar's study of costs and benefits associated with a very high quality induction program reported that the pupils of new teachers who experienced strong induction "in general, achieve in patterns that mirror the achievement rates of students assigned to more experienced mid-career teachers" (Villar, 2004). Based on this research, it stands to reason that student achievement will suffer when students are continually faced with a parade of inexperienced teachers.

Turnover costs

In addition to affecting student achievement, teacher turnover forces school districts and states to spend money on recruiting, hiring, and training replacements. While it makes intuitive sense that high teacher turnover has significant financial consequences for school districts, there are few studies of what it costs to lose teachers. From the standpoint of resource equity and adequacy, Roza and Hill (2004) show that *per-student* funding at the school level is far lower within the same district at high-turnover schools than in schools with a stable teaching force. We also know that concern over teacher shortages has led many districts and states to invest financial resources in programs that give bonuses and other incentives to people willing to enter the teacher workforce. However, because many teachers leave before they have had time to mature into accomplished teachers, these programs drain resources without producing the intended benefits.

A key question is whether these costs associated with teacher turnover can, in fact, be identified and measured in a consistent manner. Previous efforts have fallen short. No school district or state currently has the tools to track their teacher attrition or control their turnover costs. As a result, the data and tools needed to understand how a school district's financial resources could be *saved* through reductions in the incidence and costs of teacher turnover, and *redirected* to investments in teacher support systems, simply do not exist.

CURRENT LITERATURE ON THE COSTS OF TEACHER TURNOVER

Most studies of teacher turnover costs have produced estimates that are quite large, ranging from 20 percent to 200 percent of the leaving teacher's salary. However, because these estimates are based on incomplete methodologies, and because the estimates vary so widely, they have had little practical utility for policy makers. A recent—and welcome exception—is a 2006 paper by Shockley and his colleagues on the costs of teacher turnover in two Florida school districts. For the most part, though, teacher turnover costs have only recently been a focus of education researchers.

A Texas analysis is the first large scale study to have addressed the topic of teacher turnover costs by using actual data on the rate of teacher turnover in public schools (Texas Center for Educational Research, 2000). The study was flawed, however, because it used an industrial model to estimate costs in schools, and because it failed to account fully for costs in its more in-depth study of three school districts. A Chicago study used three models for estimating teacher turnover costs, where the actual teacher turnover data was available for sixty-four elementary schools (ACORN, 2004). None of the models used actual costs, however, and the assumptions for estimating costs under each model produced widely varying results. A third study of turnover costs – based on a formula and not actual cost calculations – was produced by Breaux and Long (2003). The study drew on the work of human resource specialists in industry and concluded that the loss of a teacher costs nearly 2.5 times the teacher's initial salary in recruitment, personnel expenditures and lost productivity. In 2005, the Alliance for Excellent Education tapped a US Department of Labor estimate "that attrition costs an employer 30% of the leaving employee's salary" in a report on turnover and induction. The Alliance estimated national teacher turnover costs at $4.9 billion, only about twice as high as the upper bound for the Texas report of annual costs *for Texas alone*.

The most recent study of turnover costs identified in this literature review is the only one that appears to make use of real cost data (instead of estimates derived from other fields). Shockley and his colleagues (2006) conducted a study of teacher turnover in two countywide Florida school districts. Broward County, where Fort Lauderdale is located, has about 270,000 students and employed 16,648 teachers in 2003-04. The district-wide one-year turnover rate was 7.25%, with an average cost of turnover per teacher pegged at $12,652. St. Lucie, on the other hand, enrolled about 30,000 students, employed 1,952 teachers, and had annual one-year turnover of 16.4%. The cost per teacher in this school system was $4,631. The authors explain the differential turnover costs this way: "A possible explanation … is the infrastructure investment that the Broward County School System is making in their teacher/induction support system" (Shockley et al., 2006, 6). This is a plausible and highly interesting association of induction, lower turnover, and higher costs per teacher. The paper does not discuss directly the cost of induction, but the authors did collect detailed expenditure information from the two districts (personal communication, Sept. 14, 2006).

SUMMARY RESULTS FROM EARLIER REPORTS AND STUDIES

Study	**Area**	**Number of Teachers**	**Reported Turnover Rate**	**Claimed Cost of Teacher Turnover**	**Claimed Cost Per Turnover**
Texas Center for Educational Research (2000)	Texas Public Schools	258,000	15.5%	Model 1: $329m Model 2: $2.1b	Model 1: $8,227 Model 2: $52,513
Chicago ACORN (2003)	64 Chicago Public Schools	2377	22.9%	Model 1: $ 5.6m Model 2: $42.2m Model 3: $34.7m	Model 1: $10,294 Model 2: $77,574 Model 3: $63,787
Breaux & Wong (2003)	Nation			Model 1: 2.5 x initial salary Model 2: 1.75 x initial salary	
Alliance for Excellent Education (2005)	Nation	2,998,795	13.1%	$4.9b	$12,546
Shockley et al., 2006	2 Florida districts	Broward: 1206 St. Lucie: 320	Broward: 7.25% St. Lucie: 16.4%	Broward: $15.3m St. Lucie: $1.48m	Broward: $12,652 St. Lucie: $4,631

These studies have made contributions by establishing the possible scope and scale of teacher turnover costs, but important empirical work remains to be done. Since all of the approaches estimate teacher turnover costs using either borrowed, but untested, formulas, or calculate turnover costs from incomplete data on actual costs, work on the cost of teacher turnover must move to the next level by implementing a protocol for collecting actual turnover cost data. Shockley and his Florida colleagues have made an important contribution here. It seems reasonable to think that accurate data on the true magnitude of turnover costs will provide district and state policymakers with a strong basis for data-based decisions that help them to cope with the costs of turnover.

These earlier reports do not target turnover costs for specific disciplines or subjects. But given the evidence that STEM (science, technology, engineering, and mathematics) teacher turnover occurs at rates equal to or greater than turnover in other subject areas, it is also likely that costs associated with STEM turnover will comprise a significant proportion of the overall cost of teacher turnover. It may be, in fact, that STEM turnover costs are disproportionately high in the aggregate and on a per-unit basis because states and districts often target recruitment incentives on prospective STEM teachers. Further studies, in which turnover rates and costs are disaggregated by subject area, are necessary to test this hypothesis.

NCTAF'S COST OF TEACHER TURNOVER STUDY

To strengthen the existing knowledge base, NCTAF is conducting a cost of teacher turnover study in five school districts. The study will determine how several variables impact teacher turnover and attempt to determine actual district costs associated with teacher turnover.

Defining teacher turnover

The starting point for this and other research on teacher turnover is a clear definition of what we mean by the term. In 2003-04, NCTAF worked with a national research panel through a project funded by the Rockefeller Foundation to develop a working definition of teacher turnover. This definition builds on the work of Richard Ingersoll (Ingersoll, 2001 and 2003; Ingersoll and Smith, 2003) and on the analyses and policy recommendations made by NCTAF in its 2003 report, *No Dream Denied: A Pledge to America's Children*. Teacher turnover has three dimensions:

- ***Within-District Movers:*** Teachers employed in a classroom teaching role in a school in Year 1 (e.g., 2003-04) who are employed as classroom teachers at a different school *in the same district* in Year 2 (e.g., 2004-05), constitute a group defined as "cross-school, within-district movers";

- ***Cross-District Movers:*** Teachers employed in a classroom teaching role in a school in Year 1 who are employed as classroom teachers at a different school *and a different district* in Year 2, are described by NCTAF as "cross-school, cross-district movers";

- ***Leavers:*** Teachers employed in a classroom-teaching role in a school in Year 1 and not employed as classroom teachers *in any district* in Year 2 are described as "leavers".

Different researchers utilize different combinations of these three groups. Krieg's (2004) analysis of teacher turnover and pupil achievement in Washington State focuses only on teachers who leave the profession. Feng's study of public school teachers in Florida describes the same kinds of teacher turnover employed by this paper (Feng, 2005, 2), but concentrates on leavers because "migration does not represent a net loss in the total supply of public school teachers" (Feng, 3). Scafidi and his colleagues make the same choice in their Georgia study of whether teachers leave the classroom for higher paying jobs (Scafidi et al., 2003). Like Ingersoll (2003), we define teacher turnover as the combined total of those who ***move*** and those who ***leave***. The reasoning is that movers and leavers have the same impact on the specific school whose employment they depart from, whether or not they exit the profession.

Cost categories

In initial work with the national research panel, NCTAF identified eight cost elements. Some costs are direct expenditures (e.g., advertising, recruiting, and hiring incentives). Others derive from the proportional value of time spent by school or district administrators interviewing teacher candidates, doing outplacement, and so on. Similarly, the locus of costs varies by the nature of the activity. Some costs occur at the building level, others at the district level (Hertert, 1995; Miles and Roza, 2002). These eight clusters of cost elements will be refined through experience from the study now underway. The eight cost elements are:

1. ***Recruitment and Advertising,*** including the cost of advertising space, the cost of travel to job fairs and interview sites, the design of advertising formats, website design and development costs, posting information on recruitment websites, responding to inquiries from prospective candidates, coordination of recruitment activities with state programs, working with teacher preparation programs to identify strong candidates, training student teachers, special costs associated with overseas recruiting, etc.

2. ***Special Incentives*** such as signing bonuses, payment of moving expenses, salary supplements, housing allowances and rent subsidies, relocation bonuses, day care subsidies, reduced teaching loads, etc.

3. ***Administrative Processing*** of new hires and costs associated with separation, including criminal background checks, health record checks, checking references, meeting with candidates and members of search committees, completing affirmative action paperwork, corresponding with applicants, drafting letters of acceptance/rejection, setting up interview and visitation schedules, purchasing equipment for digital fingerprinting and archiving teacher records, adding new teachers to payroll and benefit programs, exit surveys, paperwork to remove the teacher from payroll and health plans, processing refunds of retirement contributions that may be due, etc.

4. ***Training for New Hires***, including introducing new hires and teacher transfers to school goals and governance procedures; integrating new hires into the community of other teachers and staff, parents, students and residents; explaining benefit programs; conducting tours of facilities and school resources; etc.

5. ***Training for First-Time Teachers,*** including mentoring and related forms of structured induction.

6. ***Training for All Teachers***, including introduction to the state's testing programs, induction programs for newly trained teachers, costs of mentor teachers, workshops and professional development activities, salaries for substitutes used to cover for teachers at training activities, etc.

7. ***Learning Curve Loss***, including the loss of student learning at the school that results from having new teachers each year, and from having a teaching staff with little experience.

8. ***Transfer Costs***, including paperwork to change a teacher's school sites, time and effort spent matching a teacher with a new school, salaries for substitutes used to cover for teachers who transfer during the school year, etc.

Recap of influences on turnover and its costs

A critical issue is the extent to which teacher turnover costs vary by teacher and school characteristics. The Texas study suggests that these costs in the aggregate, and in several key cost categories, vary significantly across districts. It found, for example, that one district had aggregate turnover costs that were 14.6 times higher than those of the lowest-cost district. The higher-cost district also spent 17.6 times more on teacher recruitment than did the lower-cost district (p.15). The differences in costs could be due to differences in the turnover rate of STEM teachers. The higher-cost district may be spending 17.6 times more on recruitment because their STEM teachers keep leaving. The district could then invest in intervention strategies focused on retaining STEM teachers. However, the Texas study, and other studies like it, does not disaggregate turnover rates by subject area. Greater understanding of where STEM turnover occurs and why it appears to happen will permit design of effective interventions.

This means that it is crucial to have more empirical data on STEM turnover rates in general, and on STEM turnover controlling for district and school characteristics. The current NCTAF study, where cost is the pre-eminent dependent variable, will also be able to report turnover rates by subject area for each participating district. Other possible influences on turnover, such as compensation levels, the quality of school leadership, the existence of teacher induction and retention programs, the strength of the curriculum, or the academic performance of its students, are factors that are amenable to policy interventions.

Hypotheses

The current literature on teacher turnover supports the view that **turnover costs can be identified, measured and aggregated**. In addition to testing this view, the NCTAF study tests the following hypotheses:

1. ***Turnover costs vary by school type*** (urban/suburban/rural, rich/poor, high achieving/low achieving). This hypothesis drives the selection of school and district sites for the data collection and analysis—explained in the next section of this paper. We expect to find that turnover costs will be lowest in suburban schools, but it is not entirely clear whether to expect urban turnover costs to be higher or lower than those in rural schools and districts. At the school level, the study will test the argument that turnover costs are higher in urban schools, higher in poor schools (as measured by student and family financial characteristics), and higher in low-achieving schools.

2. ***Higher performing schools have lower levels of teacher turnover***, suggesting that they also will have lower teacher turnover costs. To control for school and district size, the project will calculate costs per teacher as well as overall turnover costs for the school and for the district. At the school level, the literature on student performance and teacher

staffing supports the notion—to be tested in the study—that the costs of teacher turnover in high performing schools will be less than those incurred by low performing schools.

3. ***Low performing schools have higher levels of teacher turnover***, even after controlling for a wide variety of school, teacher, and context variables. Studies by Hanushek et al. and others find an association between turnover rates and pupil achievement: lower achievement rates are linked to higher rates of turnover, even after controlling for a wide variety of school, teacher, and context variables. The NCTAF study design includes low- and high-performing schools, calculates their respective turnover rates and measures the costs per teacher and per school.

NCTAF study sites and data collection

The five study sites include two urban school districts, one countywide suburban district, and two quite small rural districts. With the active participation of officials from each district, three databases have been created. The first contains information on individual teachers. This **Teacher Database** includes a teacher personal identifier to link with district and state databases. The second database, the **Schools Database**, holds information on each school in the study. We also have obtained the numerical school identification codes for each school in all five districts. This identifier will link each school to the federal Common Core of Data (CCD) at the National Center for Education Statistics (NCES). CCD will be the source of a wide range of information about each school. The third database, the **Annual Costs of Teacher Turnover Database**, contains the disaggregated components of turnover costs. Sorted by category of cost, the database permits project researchers to derive total annual costs of turnover at the school level and at district and state levels. It will enable us to make various other calculations important to the determination of turnover costs and the ability of study site schools and other schools across the country to make the same calculations.

Data on teaching assignments

Research studies on STEM teacher turnover need accurate data about the subjects taught by each teacher. Several variables are needed because of the complexity associated with recruitment, preparation, and classroom assignment of STEM teachers: highest degree earned (and, to be safe, second highest degree earned in case the STEM teacher has an undergraduate degree in the discipline but has also picked up a master's or specialist degree in education); the college major(s) for each teacher; and licensure and endorsement areas for each teacher. In NCTAF's study, each district was also asked to provide data on the subject(s) taught by every teacher in every school, as well as up to four licensure endorsement areas per teacher. Future studies should be able to collect more accurate information on subjects taught because of the requirements of the No Child Left Behind provisions relating to highly qualified teachers.

Although STEM teachers may have higher turnover because they are in higher demand and have more job opportunities that do non-STEM teachers, teaching assignments may influence teacher turnover in another way. When teachers are assigned to teach in fields outside their endorsement areas or their majors, they may choose to move to a position where they will be able to teach in their chosen field. Therefore, it is reasonable to assume that out-of-field teachers will have higher rates of moving and/or leaving than will others, independent of whether they are STEM teachers. The comparison of teaching assignments with endorsement areas allows us to define out-of-field teaching in the NCTAF study.

Geography

Studies on "hard-to-staff" schools report that urban and rural schools are the most difficult to staff (Education Commission of the States, 2000). Analyses of teacher turnover also find higher rates in urban or rural districts than in suburban locations (NCREL, 2000; NCTAF, 2003). This suggests that costs associated with turnover also will vary with school location.

Student Socio-economic status (SES)

Several studies find empirical connections between teacher turnover rates and the economic status of students enrolled in the schools (Ingersoll, 2001; 2003; SECTQ, 2003; ACORN, 2004). Schools with concentrations of poor students have higher rates of teacher turnover than those with more students that are affluent. Here, too, it will be helpful to access uniformly defined and widely used measures captured by NCES in its CCD data collection.

Student Achievement

Numerous studies find strong relationships between pupil achievement and teacher turnover, even when controlling for a host of other variables through multiple regression (Hanushek, Kain and Rivkin, 2004; Falch and Ronning, 2005; Hanushek et al., 2005). For student achievement indicators, one approach is to collect information about schools classified by their states as either high or low performing in terms of student outcomes. This means that studies of the relationship between turnover costs and student achievement would need to be based on *within-state* comparisons. Since most expenditures on public schools in the United States come from state or local revenue sources, testing a model of turnover costs that might generalize to a state will give that state's policymakers powerful new information about the allocation and use of scarce state education resources in the schools for which they are responsible.

The Texas and Norway studies mentioned earlier used individual-level data on students and teachers to map the relationship between achievement and turnover. Turnover cost studies target three "cost centers": the school, the district, and the state. Hence, school-level indicators of pupil achievement should be sufficient. Controlling costs by managing turnover is a different story. Just as teaching quality and student achievement vary widely within schools, so will the forces affecting individual teacher decisions about whether to stay or go. If the NCTAF project analysis supports the argument that low-achieving schools have higher rates of STEM and other teacher turnover (and higher costs), this will give impetus to other researchers, educators and policymakers to look carefully at the cost of turnover in low-performing schools across the nation.

Working conditions

It is clear that a teacher's working conditions may also influence the decision to stay or to leave. Although the NCTAF study will be able to account for the effect of salary and compensation, principal turnover and tenure (as a proxy for the stability of school leadership), and in-field and out-of-field teaching assignments, *it will not be able to account for many working condition factors that also affect career persistence decisions*. These include the state of physical assets, space assignments, non-teaching assignments, allocation of time for planning and interacting with colleagues, technology support, the quality of school leadership and a host of related conditions that have been identified by professional practice boards and teacher associations across the county. The nature, if any, of these relationships ought to be the subject of future research on STEM teacher turnover.

STRATEGIES TO CALCULATE THE COSTS OF TEACHER TURNOVER

Research efforts to calculate STEM teacher turnover costs make two contributions to the field, almost by necessity. First, they produce badly needed information about the *incidence* of STEM turnover. Since it is not possible to calculate accurate turnover costs without measuring turnover at the individual level, any well-designed study of costs will enlarge our knowledge base about turnover itself. The second important addition to the knowledge base will come from studies that identify, calculate, and analyze the components of turnover costs. Designs to conduct future research on the costs of STEM teacher turnover should include the following components:

1. Measurements of the annual turnover rate of full-time STEM teachers at each participating school and district, and measurement of the annual turnover rate of all full-time teachers.

2. Analysis of the impact on school-level STEM turnover of variables such as a teacher's age, race/ethnicity, gender, years of teaching experience (total and in the school), school setting (rural, urban), type of teacher preparation program (traditional, alternative, licensure only, none), license held, and total compensation, school grade level, school enrollment, participation in school lunch program and school academic performance level;

3. Measurements of the full costs of STEM (and all) turnover by cost category: recruitment, special incentives, administrative processing of applications, orientation, retention, training, learning curve loss, and separation;

4. Research designs that conduct multi-year (three or more) STEM turnover and total turnover cost analyses to generate trend data.

NCTAF's current study covers the first three steps, with findings expected by the end of the 2006 calendar year. NCTAF researchers will also use the turnover rate and cost data to explore creation of benchmarks that function as "***leading indicators***" of STEM teacher turnover and its impact on schools. We hope to produce easily understood summary measures that could be derived from trend data to chart progress as states, districts and schools implement strategies to reduce teacher turnover and lower its costs. Leading indicators might include:

- **Benchmarks of STEM and total teacher turnover rates and teacher turnover costs—**allows schools and districts to compare what they spend to cope with teacher turnover, which might create momentum for incremental change in cost control and resource reallocation;

- **Teaching Staff Stability Index** (school-level)—a calculation of year-to-year STEM (and all) teachers retained by the school as a proportion of all classroom teachers in the school (controlling for possible growth or shrinkage in teaching positions);

- **Teaching Staff Stability Cost Ratio Per Student** (annual total turnover costs per student enrolled in the school)—captures the impact of teacher turnover on the fiscal resources available to each school for the education and learning of students; and

- **Teaching Staff Stability Cost Ratio Per Teacher** (annual total turnover costs per teacher enrolled in the school) — captures the impact of teacher turnover on the fiscal resources available to each school for instructional staffing purposes.

STEM TURNOVER AND PUPIL LEARNING: LEARNING CURVE GAIN AND LOSS

Several large-scale studies of teacher turnover find that teachers of lower-performing students are more likely to move or leave teaching (Falch and Ronning, 2005, 14; Hanushek et al., 2005, 31; Hanushek, Kain, and Rivkin, 2004). Other studies find a positive relationship between years of teaching experience and positive teacher effects on pupil learning (Villar, 2004; Shkolnik et a., 2002). The 2004 Texas study by Hanushek and his colleagues concludes with discussion about possible policy responses to the twin problems of high turnover and lower achievement: "If exit rates increase when schools have larger concentrations of disadvantaged and low achieving populations, these schools are likely to have higher proportions of new teachers –thus magnifying their difficulties. Yet, inexperience is only one element of teacher quality, and the variation in teacher quality even within schools is generally significantly larger than just the impact of inexperience." This analysis suggests that it should be possible to determine how STEM turnover—and changes in rates of turnover—affects pupil-learning outcomes.

Kane, Rockoff, and Staiger (2006) argue that teaching quality is more important than teacher experience as an influence on pupil learning:

> "The impact of assigning a student to a bottom quarter teacher rather than a top quarter teacher is roughly three times the impact of being assigned to a novice teacher rather than an experienced teacher, and more than ten times the impact of being assigned to a teacher with a particular kind of certification or from a particular program" (39).

From their analysis of New York City teachers, the authors make the claim that "raising the effectiveness of novice teachers in New York by one standard deviation would have a similar impact on student achievement as the expected improvement of novices who spend 8 years teaching in the district! Thus, policies that enable districts to attract and retain high quality teachers (or screen-out less effective teachers) have potentially large benefits for student achievement" (42).

While Kane et al. (2006) do examine teacher effects by certification status, most studies do not disaggregate teachers by content area. This makes it difficult to talk confidently about STEM teachers as a group. Another problem in studies of STEM turnover and pupil achievement is that the analyses seldom are able to go above the middle school grades because of testing issues (many states and districts do not have high school level standardized tests in STEM fields), and teacher effects attribution problems (determining with certainty which teacher to associate with which students).

The contributions of the literature on turnover and pupil learning seem to be the following:

- Evidence supports the idea that turnover rates are linked to pupil achievement;
- High turnover schools are more likely to have larger numbers of novice teachers; and
- On average, novice teachers contribute less to pupil learning than do teachers with more experience.
- ***However***, studies reporting these findings generally have not been able to include high school STEM teachers in their analyses; and
- Positive teacher effects on pupil learning involve more than just increased teacher experience.

So these studies, their interesting findings, and the puzzles they leave us with suggest that exploring the links between STEM turnover and achievement is an area ripe for future research. The NCTAF study does not have sufficient data on pupil learning outcomes and trends to address learning curve loss and gain.

SUMMARY, RESEARCH QUESTIONS, AND NEXT STEPS

Current reports and studies, as well as the NCTAF study in progress, demonstrate that research into the costs of teacher turnover is an emerging field. As more scholars focus on turnover itself, the broader implications of teacher attrition deserve more thought and study. STEM turnover, its financial cost, and its consequences for students and schools have not received enough attention in the literature. As this picture begins to change for the better, there is a host of research questions, conjectures, and promising ideas with which to work.

For example, Shockley and his colleagues commented that "the district with the highest teacher retention rate was a school district that had a very strong and supported teacher induction and mentoring program." This raises an interesting question about the role that the variable ***time*** plays in our understanding of the relationship between turnover and its costs. A superintendent who wanted to address a high turnover problem would document that it was high and then would invest in the most cost effective strategies for stanching the turnover. Given the popularity of strong induction and mentoring programs, induction/mentoring would be one investment. The question is, "How long would it take to see some positive effects?" Our guess is at least two years (it takes time to get the program up and running well). In this situation, we would observe, at least for a while, a high rate of turnover and a high level of spending for induction and mentoring programs. As a result, the contemporary association would be positive (high turnover with high spending) while the lagged association (the one that was actually the causal relationship) would be negative. There are three implications for our study: 1) unrecognized lags could cause us to reach the wrong conclusions; 2) trend data are very important to the study design, and most studies do not have trend data, so they all suffer from this flaw; and 3) use of the term "leading indicator" may not be appropriate for the measures NCTAF has identified in our study.

Secondly, we have observed already that our discussion of ***learning curve gain and loss*** is very exploratory—not only because we do not have the data to test these ideas, but also because the ideas themselves need refinement and more measurement precision. But if, as Hanushek and others show in studies of teacher effects, teacher ability is three times more powerful as a determinant of student learning than teacher experience, and if high-ability teachers are more likely to leave bad teaching environments, particularly STEM teachers, these findings have important implications for how we respond to STEM teacher turnover. These empirical findings suggest that a cost effective strategy for retaining STEM teachers is to invest in retention bonuses for high ability teachers, perhaps even at the expense of investing more in teacher induction programs. Such a strategy might not only reduce turnover rates significantly, but it might also reduce learning curve loss significantly. Testing this idea requires accurate measures of teacher quality, a variable that is currently unmeasured in our database.

Thirdly, a related area of inquiry is ***whether high rates of STEM teacher turnover have school-wide pupil achievement implications***. Studies cited earlier note the relationship between particular teachers and their pupils, but a productive area of inquiry would be designs that broaden this perspective to the school as a whole. We suggest this approach would require time series data on STEM turnover and pupil achievement, as well as a school-pupil-teacher sample large enough to conduct sophisticated comparisons.

Fourth, we noted earlier that ***school working conditions*** might affect STEM teachers' decisions to stay or leave. The research of Ingersoll and his colleagues emphasizes working conditions as a key variable, drawing on extensive teacher survey data. As more states collect systematic information on school working conditions, it should be possible to test empirical relationships between these indicators, STEM turnover rates, and the cost of STEM teacher turnover.

Finally, there are ***the contributions of research*** into STEM turnover costs on school and district efforts to cope with these problems. Here, we believe there are at least three direct links between the research and its application:

- The research process itself reveals the need for specific data system and data collection improvements at the school and district level;

- Benchmarks derived from the cost of turnover categories can be employed as improvement indicators, especially when the cost of STEM turnover is calculated annually for many schools and school districts; and

- Precise data on STEM turnover and its costs will allow policy makers to test the efficacy of various “solutions” to these issues.

Results of STEM turnover and cost of turnover studies have many possible policy implications for schools and districts. Improved teacher retention should produce savings in recruitment, hiring, orientation, training, and separation costs. For instance, higher retention may decrease the number of district recruiters needed to fill teaching vacancies. In order to capitalize on this decrease, school districts must have the flexibility to alter staffing and budgets from year to year. Will school districts be able to make yearly adjustments in order to recoup the savings of improved teacher retention? A related policy question involves the information system infrastructure necessary to capture and make effective use of data on turnover and costs.

Most school districts do not know their rate of teacher turnover, let alone the costs associated with such turnover. In large school districts, these costs are distributed across multiple departments and are rarely tracked. As school systems (and states) update their data systems for reasons more directly related to the teaching and learning dimensions of No Child Left Behind, these issues need attention. We hope this paper, the work of colleagues cited in the paper, and the discussions by participants at the NCTAF Wingspread Symposium will enable the United States to make measurable progress along these lines.

REFERENCES

Alliance for Excellent Education (2005). Teacher Attrition: A Costly Loss to the Nation and to the States. Retrieved from http://www.all4ed.org/publications/TeacherAttrition.pdf#search=%22alliance%20for%20excellent%20education%20cost%20of%20turnover%22

Association of Community Organizations for Reform Now [ACORN] (2004). Where Have All the Teachers Gone? The Costs of Teacher Turnover in ACORN Neighborhood Schools in Chicago. Retrieved from www.acorn.org/index.php?id=315.

Breaux, A., and Wong, H. (2003). *How to Train, Support and Retain New Teachers*. Mountain View, CA: Harry Wong Publishing.

Falch, T. and Ronning, M. (2005). The Influence of Student Achievement on Teacher Turnover. CESifo Working Paper No. 1469. Retrieved from http://opus.zbw-kiel.de/volltexte/2005/3305/pdf/cesifo1_wp1469.pdf.

Feng, L. (2005). Hire Today, Gone Tomorrow: The Determinants of Attrition among Public School Teachers, Ph.D. dissertation, Florida State University Tallahassee, FL.

Hanushek, E., Kain, J., and Rivkin, S. (2004). Why Public Schools Lose Teachers. *Journal of Human Resources* 39(2), pp. 326-354.

Hertert, L. (1995). Does equal funding for districts mean equal funding for classroom students? Evidence from California. In Lawrence O. Picus and James L. Wattenbarger (Eds.), *Where Does the Money Go? Resource Allocation in Elementary and Secondary Schools*. Thousand Oaks, CA: Corwin Press, pp. 71-84.

Ingersoll, R. (2001). Teacher Turnover and Teacher Shortages: an Organizational Analysis. *American Educational Research Journal, 38(3),* 499-534.

Ingersoll, R. (2003). *Is There Really a Teacher Shortage?* Seattle, WA: Center for the Study of Teaching and Policy. Retrieved from http://www.ctpweb.org.

Ingersoll, R. and Smith, T. (2003). The Wrong Solution to the Teacher Shortage. *Educational Leadership, 60(8),* 30-33.

Kane, T., Rockoff, J., and Staiger, D. (2006). What Does Certification Tell Us about Teacher Effectiveness?: Evidence from New York City. Cambridge, MA: National Bureau of Economic Research.

Krieg, J. (2004). *Teacher Quality and Attrition*. Bellingham, WA: College of Business Economics. Retrieved from http://www.cbe.wwu.edu/Krieg/Econ.%20Documents/Teacher%20Quality%20Attrition%20EER%20Final.pdf.

McCaffrey, D.F., Lockwood, J.R., Koretz, D.L., and Hamilton, L.S. (2003). *Evaluating Value-Added Models for Teacher Accountability*. Santa Monica, CA: RAND.

Mendro, R., Jordan, H., Gomez, E., Anderson, M., and Bembry, K. (1998). An application of multiple linear regression in determining longitudinal teacher effectiveness. Paper presented at the 1998 Annual Meeting of the AERA, San Diego, CA.

National Commission on Teaching and America's Future [NCTAF]. (2003). *No Dream Denied: A Pledge to America's Children*. Washington, DC: Author. Available online at www.nctaf.org.

Rivkin, S. G., Hanushek, E. A., and Kain, J. F. (2005). Teachers, schools and academic achievement. *Econometrica*, 73(2), 417-458.

Roza, M., and Hill, P. (2004). How within district spending inequities help some schools to fail. In Dianne Ravitch (Ed.), *Brookings Papers on Education Policy: 2004*. Washington, DC: Brookings Institution Press.

Sanders, W.L. and Rivers, J.C. (1996). *Cumulative and residual effects of teachers on future student academic achievement*. Knoxville, TN: University of Tennessee Value-Added Research Center.

Scafidi, B., Sjoquist, D. and Stinebrickner, T. (2003). The Relationship between school characteristics and teacher mobility. Working paper.

Shkolnik, J., Hikawa, H., Suttorp, M., Lockwood, J.R., Stecher, B., and Bohrnstedt, G. (2002). Appendix D: The Relationship between teacher characteristics and student achievement in reduced-size classes: A study of 6 California districts. In G. Bohrnstedt & B. Stecher (Eds.), *What We Have Learned About Class Size Reduction in California: Technical Appendix*. Sacramento, CA: California Department of Education, pp. D1–D22.

Shockley, R., Guglielmino, P., and Watlington, E. (2006). The Costs of Teacher Attrition. Presented at the International Congress for School Effectiveness and Improvement, Fort Lauderdale, Florida. Retrieved from http://www.leadership.fau.edu/ICSEI2006/Papers/Shockley%20Guglielmino%20and%20Watlington.pdf.

Southeast Center for Teaching Quality [SECTQ]. (2003). "The Teaching Quality Indicators Project: Better Data for Better Teaching Quality." Retrieved from www.teachingquality.org.

Texas Center for Educational Research [TCER]. (2000). *The Cost of Teacher Turnover*. Austin, TX: Texas State Board for Educator Certification.

Villar, A. (2004). Measuring the Benefits and Costs of Mentor-Based Induction: A Value-Added Assessment of New Teacher Effectiveness Linked to Student Achievement. Paper presented at the 2004 Annual Meeting of the American Education Research Association.

Wright, S.P., Horn, S.P., and Sanders, W.L. (1997). Teacher and classroom context effects on student achievement: Implications for teacher evaluation. *Journal of Personnel Evaluation in Education*, *11*, 57–67.