Does Teacher Certification Matter? Teacher Certification and Middle School Mathematics Achievement in Texas

By

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Paper presented at the Annual Meeting
of the American Educational Research Association
San Diego, CA, April 12, 2004

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Introduction

In a study of the Tennessee Assessment System, William Sanders (1998) found that the "single largest factor affecting academic growth of populations of students is differences in effectiveness of individual classroom teachers" (p. 27). This finding is reflected in the newly reauthorized Elementary and Secondary Act, No Child Left Behind, which requires states to have a "highly qualified" teacher in every classroom by the end of the 2005–06 academic year. However, many states, faced with an inadequate supply of qualified teachers and an increasing number of teachers reaching retirement age, will struggle to meet this mandate. In 1994, for example, 25 percent of the nation's 2.5 million public school teachers were nearing retirement age. Many states, Texas included, are challenged to find educators willing and capable to teach in public schools. In a recent noteworthy development in Texas, a temporary teacher certificate was proposed by the State Board for Educator Certification (SBEC) in November 2003. This new temporary teacher certificate will allow anyone with an academic degree or advanced degree in the content area to teaching after they have passed the Texas pedagogy and content area certification exam for grades 8–12. The applicant would then be eligible for the two-year temporary teacher certificate. After two years, the hiring district can recommend the teacher for the Texas standard teaching certificate. This rule was approved by SBEC at its February, 2004 meeting and went through final approval in April, 2004.

This new development puts into question the importance of teacher training and the significance of a teacher certificate. Interestingly, the current study presented below on teacher certification was in response to a Texas legislative request. In the June 18, 2002 hearing of the

Joint Committee on the Shortage of Educational Professionals, legislative committee members requested that the State Board for Education Certification (SBEC) examine the connection between teacher characteristics and student achievement.

Teacher characteristics such as certification, years of education, content knowledge, and years of teaching experience have been investigated to determine their effect on student outcomes (Sanders and Rivers, 1996; Wright, Horn et al., 1997). However, no previous study has used data from a system aligned around one set of standards, such as that implemented in Texas in recent years. "Student academic achievement is the ultimate yardstick used to measure the quality and effectiveness of state, regional, district, and campus education management and organization" (Texas State Board of Education, 2000). Texas is unique in the data available for analysis.

Texas student achievement data was collected that linked students with their individual teachers and employs a value added approach by calculating changes in middle school student achievement on the mathematics Texas Assessment of Academic Skills (TAAS) for each teacher from 1997-98 to 1998-99 academic years.

Review of the Literature

The research on teacher certification and quality and their effect on student achievement is still inconclusive and debated. Some scholars declare the research does not support specific rigorous teacher preparation and licensing standards. Two recent works state that teacher certification requirements do not effect student achievement, but do raise barriers that prevent qualified applicants from entering the profession. (Ballou and Podgursky, 2000b; Ballou and Podgursky, 2000a). On the other side of the debate, the proponents of teacher licensing and certification

standards purport that specific teacher characteristics such as certification and academic major are associated with increased gains in student achievement. (Darling-Hammond, 2000).

The following literature review is divided into three sections: subject-matter knowledge, pedagogical knowledge, and specific studies of teacher certification and student achievement.

Subject-Matter Preparation. While many assume the literature base establishing a positive relationship between a teacher's subject-matter knowledge and increased student achievement is both voluminous and consistent, Wilson, Floden, and Ferrini-Mundy (2001) found that the research base in this area is, in fact, relatively small and certainly not consistent. Indeed, Wilson, et al (2001) state, "The conclusions of these few studies (on the connection between subject-matter preparation and student achievement) are provocative because they undermine the certainty often expressed about the strong link between college study of a subject matter and teacher quality" (p. 6-parentheses added by authors). In their study, Wilson, et al (2001) found only a few studies that examined teacher preparation, subject matter knowledge, and student achievement that met their rigorous criteria for inclusion in their review. For a more thorough review of this literature, see *Teacher Preparation Research: Current Knowledge, Gaps, and Recommendations* by Wilson, Floden, and Ferrini-Mundy (http://depts.washington.edu/ctpmail/PDFs/TeacherPrep-WFFM-02-2001.pdf) which was commissioned by the United States Department of Education.

The overall findings from theses studies indicate that teacher subject-matter knowledge is important to student achievement. Darling-Hammond (2000) found that the percentage of teachers with both a subject matter major and full state certification is positively associated with a state's reading and mathematics scores on the National Assessment of Educational Progress (NAEP). A study, by Goldhaber and Brewer (2000), found that students with teachers possessing

degrees in mathematics had greater gains in achievement than students with teachers with non-mathematics degrees, but found no such results for science. Also investigating mathematics, by Hawk, Coble, and Swanson (1985), found that students with mathematics teacher's assigned in-field scored higher and had greater gains than students with mathematics teacher's assigned out-of-field. Again, looking at mathematics, Rowan, Chiang, and Miller (1997), found that students taught by teachers with a mathematics' major had greater gains in student achievement, although the effect on student achievement was rather small.

In a comprehensive study, Monk (1994), found that undergraduate coursework in mathematics was positively related to student improvement in mathematics, but that having a mathematics major had no effect on student performance. Interestingly, he found that after five mathematics courses, additional coursework in mathematics had smaller effects on student achievement. However, when examining the effect on students by their type of course, Monk found that additional undergraduate mathematics courses did positively impact student achievement for students in advanced courses, but had no effect on student achievement for students in remedial courses. With respect to the life sciences, Monk found that coursework had no effect on student achievement. However, with respect to undergraduate coursework in the physical sciences, he found a positive relationship between the number of courses and gains in student achievement. Interestingly, unlike with mathematics, having a science major was positively associated with gains in student achievement.

Another literature review study by Druva and Anderson (1983) completed a comprehensive review of the literature available at the time and concluded that there is a positive relationship between teachers' science coursework and student performance, especially for students in higher-level courses.

A more recent analysis by Wenglinsky (2000) used multilevel structural equation modeling to analyze data from the NAEP and found that teachers with a major or minor in the subject area that they are assigned to teach produce greater gains in student achievement in both mathematics and science. This remained true even after controlling for teacher professional development, teacher classroom practices, class size, and student demographics. Interestingly, Hawk, Coble, and Swanson (1985), found that students with mathematics teachers assigned in-field scored higher and had greater gains than students with mathematics teachers assigned out-of-field which indicates a connection of content-knowledge, but not necessarily applying pedagogical knowledge to other content areas.

Finally, in a very recent study that looks at the application process for The National Board for Professional Teacher Standards (NBPTS). Each applicant has to complete assessments on *both* pedagogical and content knowledge. Goldhaber and Anthony (2004) found that elementary student achievement gains were larger for student taught by NBPTS-certified teachers than students taught by noncertified teachers.

Pedagogical Preparation. Although, the NCLB Act emphasizes the importance of content area knowledge, many experts believe that pedagogy is just as important as content-knowledge. Monk (1994), found that, in many cases, undergraduate coursework in mathematics pedagogy contribute more to gains in student achievement than do undergraduate coursework in mathematics. He also found that *undergraduate coursework* in science pedagogy was positively associated with student achievement for students in grade eleven and that *graduate coursework* in science pedagogy was positively associated with student performance in grade ten.

A recent study by Nathan and Petrosino (2003), found that "educators who have advanced knowledge of a subject, but lack concomitant knowledge of how novices actually learn that subject tend toward views of student development that align more closely with the organization of the discipline than with the learning processes of student." (p. 906). The authors indicate that their findings call into question the policies that seek to streamline the licensure process of new teachers on the basis of their subject-matter expertise.

A study by Ferguson and Womack (1993), found that subject matter major and scores on the National Teacher Examination explained some of the differences in the ratings of the classroom performance by both supervisors and subject-matter specialists. However, they also found that subject matter major and scores on the National Teacher Examination were less powerful than education coursework in explaining the differences in the ratings of the classroom performance by both supervisors and subject-matter specialists.

Certification and Student Achievement. Darling-Hammond (2000) found that the percentage of teachers with both a subject matter major and full state certification is positively associated with a state's reading and mathematics scores on the National Assessment of Educational Progress (NAEP). She also found that a state's average NAEP scores in mathematics was negatively associated with : (1) the percentage of teachers less than fully certified, (2) the percentage of beginning teachers less than fully certified, and (3) the percentage of all newly hired teachers not certified.

Goldhaber and Brewer (2000) also found students taught by fully certified mathematics and science teachers had greater gains in student scores than students taught by teachers with emergency, probationary, or no certification. The results for mathematics were stronger than for science.

While the research in teacher preparation is certainly not large or consistent, the evidence does suggest that both subject-matter knowledge and pedagogical knowledge are positively related to student achievement. Indeed, as Monk (1994, p. 142) states, "it would appear that a good grasp of one's subject area is a necessary but not a sufficient condition for effective teaching."

The goal of this study is to look at patterns of teacher qualifications in association with student performance. By understanding more about which teacher qualifications are most strongly related to student performance, researchers will be able to inform educators and policymakers about the most effective ways to increase the capacity of schools and districts.

Methodology

Data Sources. This study relies on four different sets of data. The first set of data was obtained from four different school districts in Texas. Each data set linked individual students with individual teachers for the 1997-98 and 1998-99 academic years. The second data set, from the Texas State Board for Educator Certification (SBEC), includes the demographics of teachers (race/ethnicity, age, gender...), years of experience and areas of certification. The third data set, from the Texas Education Agency (TEA), includes individual student data that includes demographics (race/ethnicity, economic status, grade level), program participation (ESL, bilingual, special education), and tests scores on the Texas Assessment of Academic Skills (TAAS), a criterion-referenced test mandated by the state to be taken by all students in grades three through eight and grade ten.. The fourth data set, also obtained from TEA, includes school- and district-level information on student demographics and total enrollment.

This study focused on the teacher characteristic of holding a state teaching certificate. In this study the student performance measures are TAAS scores for the 1998 and 1999

administration in mathematics. The district data identified teachers that students received instruction from for a one year time period in mathematics. The sample of the districts that we received data from educated a total of 578,123 students in the year 2001-02. In all, the sample districts educated 14% of the total state student population in 2001-02. Characteristics of the teachers and students are taken into account in this analysis including the years of teaching experience. Adjustments (controls) are added for student demographics and program assignments such as gifted/talented, special education, and limited English proficiency. The data used were district classroom assignment, PEIMS assignment data; revised PEIMS experience data, certification data, and individual TAAS data.

The Texas Learning Index (TLI), which is derived from raw scores, was used as the measure of TAAS results. The TLI is an index of student achievement toward the goal of passing the exit level TAAS test. It allows for comparisons between administrations and between grades. The TLI is anchored at the exit level passing standard (a scale score of 1500) which was established to be 70 with a standard deviation of 15. This established level of passing performance—TLI of 70, is relative to the mean performance of the other students at a particular grade. The TLI defines typical progress as maintaining the same position relative to one's peers from grade to grade. The anchor, TLI of 70, is the passing score at all grades. The Texas Education Agency Technical Digest (2001-2002) indicates the TLI ranges "from approximately 0 to 100." The minimum expectation score of 70 represents the same amount of achievement at each grade tested and at each administration. This enables the use of the TLI to assess achievement, as tested by the TAAS, across grades. Because the TLI can be compared across grade levels, it can be used as a type of pre-test/post-test to determine maintenance, loss, or

growth in achievement. It should also be noted that any actual gain in TLI can be considered gain in grade plus some.

Description of Methodology. In this analysis, a value-added model is constructed by using each student's previous year TLI score as a proxy for each student's academic level. Using a previous score as a proxy for previous learning in multiple regression analysis has been used by many educational researchers (Rumberger and Willms, 1992; Sanders and Rivers, 1996). This allows for the value-added analysis from a baseline year (represented by the previous score) to the following year.

The statistical technique of multiple regression was used to analyze the data. Regression analysis was selected because it is a statistical tool that introduces as much control as possible into an observational study (e.g. compensates for nonrandomized data). Important indicator variables were used as well as variables that were used only for the ability to control or account for certain characteristics of the model (such as cubic curve). The final regression model was decided upon by investigating many models with different combinations of independent variables. For this analysis, the most important variable to examine was the certification variable describing whether a teacher held a valid Texas teaching certificate.

A standard multiple regression analysis employed TAAS scores for 1999 as the dependent variable and TAAS scores for 1998, student ethnicity, economically disadvantaged status, at risk status, student program indicator (e.g. Special Education, Limited English Proficient, Gifted/Talented), campus exemplary rating, campus percent economically disadvantaged, campus percent Limited English proficiency, controls for high and low scores, teacher years of experience, and finally whether a teacher is certified or not.

Analyses were made to assess the validity of the regression assumptions in the final model. The Durban-Watson statistic was used to measure the correlation among the errors to test the independence assumption. The examinations of residual plots and curve estimations lead to some adjustments to meet regression assumptions. A cubic adjustment of the dependent variable assisted in improving the model to meet the linearity and equal variance assumptions. Since interpreting coefficients in light of a cubic metric can be confusing it was decided to address the cubic curve estimate through the use of TAAS score adjustments for high and low scores. Since the TAAS is a Criterion Referenced Test (CRT) that has been administered for several years, there tends to be a ceiling effect as well as a basement effect (students not exempt, but refusing to respond). Finally a formal test of the assumption of equal variance was made which indicated that the final model output did not present a statistically significant departure from equal variance.

Findings

The major findings indicate that compared to students with non-certified teachers, the students with certified teachers, on average, perform better on the 1999 TAAS math assessment. These results include controlling for other important variables such as, student characteristics, teacher characteristics and the campus characteristics (See Table 1).

Table 1: Regression Results

	Unstandardized Coefficients		Standardized Coefficients		
Variables[1]	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
STUDENT					
1998 TLI-Mathematics	.210	.005	.211	43.984	.000
Hispanic	-.395	.139	-.014	-2.843	.004
African-American	-.546	.140	-.015	-3.899	.000
Asian	.206	.187	.003	1.104	.270
Native-American	-1.733	.938	-.005	-1.847	.065
Partic.in free/reduced meals	-.212	.104	-.008	-2.047	.041
Partic.in Special Education	-.850	.156	-.015	-5.450	.000
Partic.in Gifted/Talented	1.123	.108	.031	10.406	.000
Limited English Proficient (LEP)	-.148	.143	-.003	-1.032	.302
At Risk of Dropping Out	-1.271	.096	-.048	-13.259	.000
TEACHER					
Hold a Texas Certification	.672	.266	.007	2.522	.012
Teaching Experience 0-5 yrs	-.060	.096	-.002	-.629	.530
Teaching Experience 11-20 yrs	-.126	.106	-.004	-1.181	.238
Teaching Experience > 20 yrs	-.146	.103	-.005	-1.414	.157
CAMPUS					
Campus 98-% Econ. Disadv	-.002	.002	-.006	-1.208	.227
Campus 99-% LEP.	.004	.006	.002	.670	.503
Campus 99-Rating=EXEMPL	.591	.200	.009	2.955	.003
[1]additional high/low score adjustments were made to maintain linearity R^2 = .918 Durbin-Watson = 1.956					

As mentioned earlier, the TLI score defines typical progress as: maintaining the same position relative to one's peers from grade to grade. As a result, this model indicates that on average a student who has a certified teacher gain a grade level plus about one more TLI unit point.

Another teacher characteristic examined was teaching experience. Years of experience was separated into four ranges of experience. These categorical ranges are: 0-5 years, 6-10 years, 11-20 years, and greater than 20 years. The comparison category was the 6-10 years of experience. Compared to the 6-10 year teacher experience range, all the other ranges of experience produced a negative coefficient, but none were significant.

Student characteristics included in the model help hold constant individual differences that affect the students' scores. In general minority status, participation in free and reduced lunch

program, participation in special education, and being at-risk of dropping out means that a students scores tend to be significant in the negative direction. This means that these students, compared to their counterparts, tend to have lower TAAS mathematics exam scores. Students that participate in the Gifted and Talented program tend to have significantly higher scores.

Conclusion

The analysis indicated that the estimates for the 1999 TLI scores for students who had certified teachers compared to non-certified teachers were statistically significant. This indicates that, on average, students who had a certified teacher had greater gains on the TAAS mathematics exam than students having non-certified teachers, after controlling for several variables.

The findings of this study indicate that certified teachers are associated with increased student achievement on the state-mandated TAAS mathematics test. Moreover, this conclusion holds after controlling for a host of other factors, including student demographics, school demographics, teacher years of experience, and prior student achievement.

By understanding how teacher qualifications are most strongly related to student performance, researchers can inform educators and policymakers about the most effective ways to increase the capacity of schools and districts.

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