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Do teacher characteristics matter? New results on the effects of teacher preparation on student achievement

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ABSTRACT

Research fairly consistently demonstrates that teachers are an important measurable factor in student learning, yet few teacher characteristics are shown to be consistently related to student achievement. Using a state administrative dataset that matches individual students to their teachers over time, I find that math teachers' undergraduate performance, as measured by GPA (overall, math, and math education) and course hours (math and math education), is predictive of 5th grade math achievement. The effects of the teacher characteristics are mediated by years of experience and vary according to student types.

1. Introduction

Economists and policy researchers are now demonstrating that teachers "matter." After many years of research that failed to find systematic relationships between policy variables and student outcomes, recent research illustrates that individual teachers generate differential effects on students' test scores and other outcomes. Many of these studies are based on empirical results that estimate teacher fixed effects. Rather than identifying measurable and observable characteristics of teachers, the studies use fixed effects to control for teachers and find that the fixed effects are significant in explaining student achievement (Rivkin, Hanushek, & Kain, 2005; Rockoff, 2004). Scholars and policymakers now face the challenge of identifying observable characteristics of teachers that signal quality teaching. The work in this area is extensive and varied, employing a mix of methodology, data, and units of analyses. Despite this variation, the literature is suggestive of some teacher characteristics that are important for student learning.

Recent studies generally report that teacher experience has a positive effect on student test scores (Clotfelter, Ladd, & Vigdor, 2006; Goldhaber & Anthony, 2007; Goldhaber & Brewer, 1997; Jepsen, 2005; Krueger, 1999; Noell, 2005, 2001; Rivkin et al., 2005; Rockoff, 2004; Sanders, Ashton & Wright, 2005). The positive effect also appears to be non-linear in nature as demonstrated by substantial improvements in teaching skill during the first 3–5 years in the classroom with the effects generally tapering off around the fifth year (Rivkin et al., 2005). Despite this fairly consistent result, not all studies find an association between experience and student achievement (Cooper & Cohn, 1997; Ehrenberg & Brewer, 1994; Ferguson & Ladd, 1996). While not specifically acknowledged by the authors, the methodologies employed in these studies provide one possible explanation for the lack of finding. Ehrenberg and Brewer (1994) and Cooper and Cohn (1997) use OLS estimation without fixed effects, making the estimates vulnerable to omitted variables bias. Ferguson and Ladd (1996) use Hierarchical Linear Modeling (HLM), a technique that is becoming increasingly popular in education research because its error structure accounts for the nested nature of the data. However, as noted in Jepsen (2005), it assumes that the variance in achievement is due to class-

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room specific factors rather than attributing it to omitted student-level factors such as motivation. Studies that use HLM typically report smaller effect sizes than studies that employ OLS and fixed effects methods.

All of these studies make the implicit assumption that experience operates similarly for all teachers. However, it is likely that the effect of experience varies with teachers' qualities or abilities. Rather than estimate the effect of this variable independently of other teacher attributes, this paper looks at the joint relationship between teacher experience and teacher qualifications to determine whether experience has a consistently positive effect on student achievement.

There is tenuous evidence that teachers' content area preparation affects student learning. Using a strong value-added design that includes teacher fixed effects, Goldhaber and Brewer (1997) find that holding either a BA or MA in math has a statistically significant, positive relationship with student math achievement. Monk (1994) presents a nuanced relationship between teacher content preparation and student achievement. He finds that teacher preparation predicts student performance, but the magnitude of the positive effect varies according to subject matter and grade level. Neither of the datasets used in these papers has the capacity to link individual students to teachers, forcing the authors to aggregate to the classroom level. This prevents the authors from exploring the non-random sorting of teachers and students within and across schools, so the results could be biased in unknown ways. Using student–teacher matched data from the San Diego Unified School District, Betts, Zau, and Rice (2003) improves upon the design of these prior studies by including student fixed effects to mitigate omitted variables bias. The study fails to detect a systematic relationship between content area preparation and student achievement, but the generalizability of these findings must be considered since the data represent only one school district in the U.S. No nationally representative dataset contains measures of teacher content preparation and matches students to their teachers over time, so it is important to explore the role of content area preparation in another geographic region of the county.

There are other reasons to examine content area preparation further. Teachers' skill and knowledge are important factors to consider when measuring the impact of teacher inputs on student achievement, but data limitations typically force researchers to use proxies like number of college courses taken and degree attainment to capture these dimensions. While these proxies should be positively correlated with content knowledge, they may not reflect teachers' ability to transfer knowledge in the classroom. This paper improves upon past research by including several variables that indicate teacher performance during pre-service training—overall GPA, math GPA, and math education GPA. All else equal, a high achieving college student is likely to be a high achieving teacher.

2. Data and measures

This paper uses unique data from a school district in Kentucky that matched individual teachers to 5th grade math students. They were compiled with the cooperation of the district and the Kentucky Education Professional Standards Board (EPSB). EPSB compiles annual data on all teachers in the Commonwealth and also maintains detailed records of the teachers' pre-service training. The agency provided 5th grade data for the 2000–2001, 2001–2002 and 2002–2003 academic years. After accounting for missing information, the dataset contains 3812 students, 46 schools, and 120 teachers.

The outcome measure is the standardized 5th grade math test score from the state testing program, Kentucky Core Content Test (KCCT). The KCCT is a criterion-referenced test that assesses individual student performance against a specified set of state educational goals and consists of both multiple-choice and open-response questions. The test scores are converted to statewide grade-by-year *Z*-scores with a mean of 0 and standard deviation of 1. Kentucky does not test the same subject in subsequent years, therefore, the students' KCCT reading score is used as a measure of prior achievement in the analyses.[1] The average math score is 0.08 with a standard deviation of 1.07, suggesting that this sample of students performs slightly higher than other 5th grade math students in the state.

Demographic information on the students, including gender and race, is included in the models. Indicator variables specify whether the student is female, African American, Latino/a, Asian American, or other. Male and European American students provide the reference categories. Students also report on subsidized lunch status, allowing the creation of three variables that indicate whether a student receives federally subsidized lunch, partially subsidized lunch, or does not qualify for subsidized lunch. Table 1 provides means and standard deviations for the student and teacher characteristics. The table indicates a racially diverse district with 62.4% European American students and 32.6% African American students. Asian American and Latino/a students combined constitute roughly 3%, but these are both growing segments of the population in this district. Female students make up 50.8% of the population, 48.9% receive some form of subsidized lunch.

The dataset contains detailed information on the teachers' college coursework and GPAs. The numbers of math content and math education hours taken during pre-service training are included as distinct variables in the models. GPA is separated into overall, math content, and math education categories in order to model different dimensions of teachers' pre-service performance. Experience is a continuous variable that measures the number of years the individual has been teaching and experience squared is included in order to account for the non-linear effect of experience on student achievement. To consider the joint

[1] The use of a reading test score as a measure of prior achievement for a math outcome is fairly unconventional. However, Eberts and Hollenbeck (2001) look at the properties of different subject area tests and determine that this is a feasible option in value-added models, such as those employed in this paper. Additional sensitivity analyses are conducted to determine whether the effects of content area preparation and pre-service performance are robust to alternative specifications.