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A STUDY OF INTIAL STEPSUSED IN STUDYING TEACHING COMPETENCY AND STUDENT'S ACHIVEMENT

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Abstract

This study explored whether and how teachers' teaching competency for teaching contributes to gains in students' mathematics achievement. We used linear mixed model methodology in which first (n=1190) and third (n=1773) graders' mathematical achievement gains over a year were nested within teachers (n=334 and n=365), who in turn were nested within schools (n=115). We found teachers' teaching competency was significantly related to student achievement gains in both first and third grades, controlling for key student and teacher-level covariates. While this result is consonant with findings from the educational production function literature, our result was obtained using a measure of the specialized teaching competency and skills used in teaching mathematics. This result provides support for policy initiatives designed to improve students' mathematics achievement by improving teachers' teaching competency.

Introduction

Educational policy; mathematics; student achievement; teacher knowledge. In recent years, teachers' knowledge of the subject matter they teach has attracted increasing attention from policymakers. To provide students with "highly qualified teachers," No Child Left Behind requires teachers to demonstrate subject-matter competency through subject matter majors, certification, or other means.

Programs such as California's Professional Development Institutes and the National Science Foundation's Math-Science Partnerships are aimed at providing content-focused professional development intended to improve teachers' content knowledge. This focus on subject matter knowledge has arisen, at least in part, because of evidence suggesting that U.S. teachers lack essential knowledge for teaching mathematics, and because evidence from the educational production function literature suggests those teachers' intellectual resources significantly affect student learning.

Despite this widespread interest and concern, what counts as "subject matter knowledge for teaching" and how it relates to student achievement has remained inadequately specified in past research. A closer look at the educational production function literature, for example, reveals that researchers working in this tradition have typically measured teachers' knowledge using proxy variables, such as courses taken, degrees attained, or results from basic skills tests. This stands in ssharp contrast to another group of education scholars who have begun to conceptualize teachers' knowledge for teaching differently, arguing that teacher effects on student achievement are driven by teachers' ability to understand and use subject matter knowledge to carry out the tasks of teaching (Ball 1990; Shulman, 1986; Wilson, Shulman, Richert & 1987).

In this view, teaching competency for teaching goes beyond that captured in measures of mathematics courses taken or basic mathematical skills. For example, teachers of mathematics not only need to

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calculate correctly, but also know how to use pictures or diagrams to represent mathematics concepts and procedures to students, provide students with explanations for common rules and mathematical procedures, and analyze students' solutions and explanations. By inadequately measuring teachers' knowledge, existing educational production function research could be limited in its conclusions, not only about the magnitude of effects that teachers' knowledge has on student learning, but also about the kinds of teacher knowledge that matter most in producing student learning. As we discuss below, only a few educational production function studies have measured teachers' teaching competency directly and used this as a predictor of student achievement (Harbison & Hanushek, 1992; Mullens, Murnane & Willett, 1996; Rowan, Chiang & Miller, 1997). Most other production function studies used tests of teacher verbal ability to predict achievement outcomes. As a result, despite conventional wisdom that elementary U.S. teachers' subject matter knowledge influences student achievement, no large-scale studies have demonstrated this empirically (Wayne & Youngs, 2003). Nor is the situation ameliorated by examining process-product research on teaching, in which both the measurement of subject-specific teaching behaviors and the direct measurement of teachers' subject matter knowledge were notably absent.

To remedy this situation, this study analyzes teachers' scores on a measure of teaching competency for teaching. By "teaching competency for teaching," we mean the teaching competency used to carry out the work of teaching mathematics.

Examples of this "work of teaching" include explaining terms and concepts to students, interpreting students' statements and solutions, judging and correcting textbook treatments of particular topics, using representations accurately in the classroom, and providing students with examples of mathematical concepts, algorithms, or proofs.

Our previous work has shown that a measure composed of several multiple choice items representing these teaching-specific mathematical skills can both reliably discriminate among teachers and meet basic validity requirements for measuring teachers' teaching competency for teaching (Hill, Schilling, and Ball, 2004). Here, we use teachers' scores on such a measure as a predictor of students' gains in mathematics achievement. An important purpose of the study is to demonstrate the independent contribution of teachers' teaching competency for teaching to student achievement, net of other possible measures of teacher quality, such as teacher certification, educational coursework, and experience.

Framing the Problem

Since the 1960s, scholars and policymakers have explored the relationship between teacher characteristics, behaviors, and student achievement. Yet measures of teacher characteristics have varied widely, as have results from these investigations.

Below, we outline how different research programs have measured characteristics of teachers and teaching and briefly summarize results from investigations using these measures.

Teachers in the Process-Product Literature

In classroom-level education research, attempts to predict student achievement from teacher characteristics have their origins in what has been called the process-product literature on teaching, that is, the large set of studies describing the relationship between teacher behaviors and student achievement. Moving beyond using affective factors such as teacher appearance and enthusiasm to predict student achievement, scholars in this tradition took the view that what teachers did in their classrooms might affect student achievement.

By the late 1970s, these scholars had accumulated substantial evidence that certain teaching behaviors did affect students' achievement gains. For example, focusing class time on active academic instruction rather than classroom management, student choice/ game time, personal adjustment, or non-academic subjects was found to be one consistent correlate of student achievement gains; so was presenting materials in a structured format via advance organizers, making salient linkages explicit, and calling attention to main ideas. Brophy & Good (1986), Gage (1978), Doyle (1977) and others provide excellent reviews of these findings. As this research progressed, scholars also designed experiments, training teachers in the behaviors indicated by previous research and comparing the academic performance of students in trained teachers'

classrooms to that of students in untrained teachers' classrooms. Notably, Good, Grouws, & Ebmeier (1983) conducted such an experiment in mathematics and found that teachers who employed active teaching practices had students who performed better in basic skills but not problem-solving.

Critiques of process-product studies studies ranged from methodological - e.g., an excessive reliance on correlational data - to conceptual. Chief among the conceptual critiques was the lack of attention given in these studies to subject matter, and to how the subject being taught conditioned the findings described above (Shulman, 1986). What worked well to increase student achievement in mathematics, for instance, often did not work well to produce achievement gains in reading. Critics also pointed to the lack of attention to teachers' subject matter knowledge as a predictor of effective teaching and learning in this work.

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