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What Does the Term "High Quality" Mathematics Teacher Mean?

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ABSTRACT

The term "highly qualified teacher" occurs frequently in discussions on educational issues today, but there is no agreement about the meaning of this term. There is agreement that "teacher quality" should be expected of our teachers, but this term also lacks precise definition. Some educators believe that mastery of content knowledge is not only important, but is all that is important. Others suggest that failure to recognize the importance of teaching skills limits the definition of teacher quality. Nevertheless, most educators agree that student achievement is the necessary outcome and that teaching strategies must conform to this outcome. Future research needs to identify those teacher qualities which enhance student performance and advocate their inclusion in teacher education program revisions.

In recent years we have seen the terms "teacher quality" and "highly qualified teacher" occur frequently in educational reports and in the professional literature. There has also been general recognition, stimulated in large measure by the Third International Mathematics and Science Study (TIMSS), that the United States has fallen behind other countries in the effectiveness of its mathematics instruction. Educational pundits, together with the public at large, have proposed a variety of solutions to this dilemma. Some say we should teach more mathematics, and others that we should teach the mathematics that is currently taught more effectively. How to teach mathematics more effectively has been the subject of the "math wars" in California, and is a topic of serious debate throughout the country. Some educators suggest that instruction should focus on the basic skills of math while others believe that a problem solving focus will help students learn math more effectively. The government of the United States weighed into this controversy with the passage of the No Child Left Behind (NCLB) law in 2001, asserting that by the 2005-06 school year, all children in the country would be taught by a highly qualified teacher.

HIGHLY QUALIFIED TEACHER

In the context of this legislation, what does the term "highly qualified" mean? Across the United States, the term "highly qualified" is generally taken to mean that a teacher has a major in his/her area of expertise and/or has passed a rigorous test in this area. Except for gray areas, such as broadfield science and broadfield social studies, there is little quarrel with this expectation at the high school level. But nationwide there is considerable ambiguity as to what constitutes a "highly qualified" teacher at the middle school level. In the state of Montana, for ex-

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ample, approximately two in three of all middle school teachers are certified at the elementary (K-8) level and the Montana Office of Public Instruction (OPI) deems them to be highly qualified so long as they are teaching within their area of certification. At the middle school level nationally, 69 per cent of math students have teachers who lack certification in math (Gewertz, 2002).

That this issue is one of major concern at the national level is evidenced by the Requests for Proposals (RFP) issued by both the National Science Foundation and the U.S. Department of Education. These RFPs are focusing on the enhancement of teacher preparation in science and math at the middle school level. For example, three of the six math/science partnerships currently funded in Montana through OPI address the enhancement of middle school math teachers. The "64 dollar question" is whether we can make these teachers highly qualified according to the provisions of NCLB and, if we can, will they become more effective math teachers?

The framers of the NCLB legislation believed that a highly qualified teacher would be a more effective teacher. Research on teacher effectiveness, as cited below, is clear that teaching quality is the key to raising student achievement. What is not clear is whether there is a link between highly qualified teachers and high quality teaching (which would include teacher dispositions). The legislation indicates that highly qualified teachers will both know their subject and know how to teach it effectively. However, spokespersons for the U.S. Department of Education have emphasized mastery of content knowledge while downplaying teaching emphasis. In fact, former Education Secretary Paige (Keller & Galley, 2002; USDE, 2002) believes that the existing system for preparing and certifying teachers is "broken", and that there needs to be higher standards for content knowledge and less preparation in teaching methods: it is enough for teachers to pass a standardized test of content knowledge as a condition for becoming a teacher. He claimed that subject-matter mastery is the only "measurable" quality of a first-rate teacher.

Teacher quality is extremely difficult to measure. Most studies measure more direct teacher variables such as certification, academic credentials, and years of teaching experience. There is much research that supports Secretary Paige's contention regarding the effects of subject-matter mastery. Studies that correlated teachers' test scores with the scores of their students on standardized tests have found that high-scoring teachers elicit stronger gains in student achievement than do lower-scoring teachers. In particular, teachers' deep content-area knowledge seems to have a positive impact on student achievement (Ferguson & Ladd, 1996; Monk, 1994; Strauss & Sawyer, 1986). Wayne and Youngs (2003) found, in a review of research on teacher effectiveness, that certification in mathematics may be a significant variable. Darling-Hammond (2000) also reviewed many such studies and found that fully certified teachers having a major in the field correlated strongly with student achievement.

In a related comprehensive study, Wilson, Floden, and Ferrini-Mundy (2001) addressed the question of how much subject matter preparation is needed. They found the results of the studies to be contradictory. Some studies found, as we observed above, a major in mathematics to be a strong correlate, while others found that mathematics education courses yielded the best results. From the various studies the common thread appears to be that mathematics teachers must have completed enough courses in mathematics and be sufficiently versed in sound instructional methodology if gains in student achievement are to be expected.

From a different perspective, the Southeast Center for Teaching Quality conducted a study (Emerick, Hirsch, & Berry, 2003) which found that NCLB's narrow emphasis on content knowledge has led to lower standards for teachers. The study concluded that content knowledge alone does not justify the designation of highly qualified teacher. Interviewees (teachers and administrators) indicated that highly qualified teachers must also demonstrate understanding of the nature of student learning, the use of multiple forms of assessment, and the ability to differentiate instruction. The study also found that, in the states surveyed, passing scores for demon-

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strating content knowledge varied from state to state. Above all, the multiple-choice content tests were deemed to have little relevance to classroom teaching. One interviewee (a human resources administrator) commented: "I have never seen a teacher get into difficulty because they didn't have the content. It has always been they didn't have the mastery of teaching strategies" (p. 8). He was not implying that content knowledge is unimportant, but that content knowledge is not enough. In its concluding statement, the study recommended that NCLB be amended to focus not only on teachers' content knowledge but also on their ability to teach it and to use multiple forms of assessment.

This position is endorsed by Rich (2004) who drew from her own experience to conclude that teachers must know how to teach. She suggests that teaching is a "messy" process, interconnecting many factors, all of which go to make up the "highly qualified" designation. Elaboration of this perspective is provided by the National Board for Professional Teaching Standards (2004) which holds five core propositions for accomplished teaching. One of the five is that board certified teachers demonstrate that they know the subjects they teach and how to teach those subjects to students and that they have a rich understanding of the subjects they teach and appreciate how knowledge in their subject is created, organized, and linked to other disciplines and applied to real world settings.

The No Child Left Behind law places considerable emphasis on teacher quality; every teacher is to be "highly qualified" by the 2005-06 school year. But there really is no evidence that the kinds of qualifications required by NCLB guarantee a good teacher. Certainly the intention of the requirements is that a teacher know the subject he or she is teaching. But many people with impeccable content credentials are unable to teach effectively. The standards for "highly qualified" are really a rather crude proxy for trying to figure out which teachers are effective and which are not. The latest accountability imperative focuses on student learning as a direct measure of how effective a student's teacher is.

EFFECTIVE TEACHING

Borsuk (2003) devoted a series of articles in the Milwaukee Journal Sentinel to issues involved with mathematics instruction. He reported that a national commission on how to teach mathematics in school reached this conclusion: "The greater part of the failure of mathematics is due to poor teaching. Good teachers have in the past succeeded, and will continue to succeed, in achieving highly satisfactory results with the traditional material; poor teachers will not succeed even with the newer and better material" (para. 2). That report was presented in 1923. Through multiple waves of math reform, and changes in the culture of schools, what was true in 1923 is true in 2003. Borsuk cites Diana Kasbaum as saying, "You can give a great program to a lousy teacher, and it won't go anywhere" (para. 6).

A recent study conducted by researchers at Horizon Research (Weiss, Banilower, McMahon, & Smith, 2001) rated 59% of the classroom sessions they observed as low in quality, while only 15% were high-quality. Researchers concluded that teachers can use either constructivist or traditionalist approaches to teach math effectively–or ineffectively–and there was no correlation between that choice and whether a class was of high quality. The constructivist approach focuses on teaching kids to solve problems on their own; the traditionalist approach focuses on teaching them basic math fundamentals. According to Weiss et al. the best thing might be to use elements of both.

John Glenn (2001) claimed: "The basic teaching style in too many mathematics and science classrooms today remains essentially what it was two generations ago. By contrast, teaching innovation and higher student performances are well documented in other countries, where students' improvements are anchored to an insistence on strong professional development of teachers (p. 20)." The Glenn Commission said, "We are of one mind in our belief that the way to interest children in mathematics and science is through teachers who are not only enthusiastic about their subjects, but who are also steeped in their disciplines and who have the training -

as teachers - to teach these subjects well" (p. 5). The writers of this report assert that too many math teachers do not have a strong grasp of the basics of what they are aiming to teach.

Liping Ma (1999) compared how teachers in China and in the U.S. handled routine topics in grade school math. Her conclusion was that the Chinese teachers, who had much less advanced formal education, had much more profound knowledge of basic math and had worked much harder on developing effective ways to teach skills. According to Ma, U.S. teachers have completed more coursework in math but have less in-depth knowledge of mathematical processes as evidenced by their responses to basic math questions. Ma wonders whether teachers who lack profound understanding of mathematics themselves can be responsible for teaching for understanding.

APPLICATION TO PROFESSIONAL DEVELOPMENT PROJECT

As a math teacher educator who has been working with pre-service and in-service math teachers for many years, the author acknowledges the desirability of all math teachers being as well qualified in mathematics as possible. Does this mean that all middle school math teachers should have completed a math major or minor? This question arose last year when the author, as co-director of one of Montana's MSP projects identified above, discussed the highest priorities for these middle school teachers with the project team. The decision was that, in the spirit of the OPI designation of "highly qualified", these teachers would be best served by a program of math enrichment related to the middle school math curriculum, rather than by pursuing courses leading to math certification (that is, a math major). While this decision did not meet the expectations of four of the participants, it was deemed the correct path for most of them. Participants took a test of content knowledge appropriate for middle school probability and data analysis. Preliminary results indicated that these teachers did not demonstrate a desired level of competence in probability and statistics. Disaggregation of these results suggest that higher scores were associated with teachers working at the eighth rather than the sixth and seventh grade levels. The number of math courses taken and the number of years of teaching experience were not significant factors. This finding suggests that professional development should focus on helping teachers become more effective in dealing with their teaching assignment, including the provision of activities to strengthen their understanding of the mathematics for that grade level. Accordingly, the materials designed for the two-week teacher institute focused on an in-depth treatment of topics that they would be responsible for teaching. Also, seminars held during the school year have focused on areas of weakness identified in the pre-tests. A post-test will be administered prior to the close of the school year.

How do we know if a teacher is effective? No matter what teaching strategies we support, the test of a teacher's effectiveness is in how much the students learn. In the MSP project directed by the author, it is planned to investigate student achievement and to compare that achievement with such teacher variables as teacher math knowledge, teacher pedagogical knowledge, and teacher certification.

CONCLUSION

Controversy about the implementation of NCLB will continue. The "math wars" and their variants have been ongoing for decades and will likely continue for many years to come. The issue of what constitutes a highly qualified teacher and what are the components of teacher quality are still to be answered. The tenets of NCLB make it clear that all students are to show evidence of improved learning.

The case for superior content knowledge as evidence of "quality teaching" has not been convincingly made. This writer contends that teacher quality is demonstrated only when students learn as evidenced by accepted testing measures. Significant ongoing research is needed to establish which teacher variables will enhance student achievement and under what conditions. Finally, it is the task of teacher educators to adjust teacher education programs to focus on those teacher

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attributes that enhance student performance. Quality teaching that leads to improved student outcomes must become the focus of teacher education programs.

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