

# What Makes a Secondary School Science and/or Mathematics Teacher “Highly Qualified?”

The authors examine the impact of the “highly qualified” teacher aspect of the NCLB legislation. They conclude that a highly qualified teacher requires much more than just content knowledge.

## Introduction

Issues facing schools abound from NCLB legislation. In science and mathematics teacher pre-service and in-service preparation, these issues are paramount for institutions of higher education, especially in terms of the definition of “highly qualified” teacher. Within this paper we will discuss the science and mathematics issues facing our state and nation. Specifically we will examine the literature supporting the major / minor teaching certification and NCLB’s effect on a rural western state.

The No Child Left Behind (NCLB) act has, without a doubt, been the most controversial federal law of the century. As public schools set about abiding by this law, universities are faced with the task of preparing teachers that are deemed “highly qualified” according to federal definition. While the law specifically evaluates and assesses the public education sector, ramifications of the law thread their way into higher education. Colleges of Education focused heavily on the preparation of the nation’s teachers are remiss if they continue to operate as before NCLB guidelines on preparation of “highly qualified” teachers. Specifically in science and mathematics teacher

preservice and inservice preparation, these issues are paramount for institutions of higher education, especially in terms of the definition of “highly qualified” teacher.

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 science and mathematics instruction. Educational analysts, together with calls for reform from the public, have proposed several solutions to the problems (see below). In essence, universities are faced with the daunting task of preparing secondary teachers with a certifiable major in all teaching fields, a task specifically problematic at the middle and high school levels.

**These findings suggest that increased content knowledge, while important, will not of itself guarantee that a teacher will be better able to increase student performance.**

Where a teaching minor was once a certifiable option, NCLB legislation now requires states to individualize their certification requirements with a HOUSSE (High Objective State Standard of Evaluation) plan that all but eliminates transferability across state borders.

Whether or not a teacher is “highly qualified” as defined by the NCLB federal education law is not an easy question to answer. To confound the guidelines, each state is asked to further clarify the meaning of several of these requirements, particularly the HOUSSE. Without exception, all states must prepare to meet the 2005-2006 “highly qualified” mandate. There is, however, new flexibility for rural states. Accordingly, the U.S. Department of Education (USDOE) suggests that, “Under this new policy, teachers in eligible, rural districts who are highly qualified in at least one subject will have three years to become highly qualified in the additional subjects they teach. They must also be provided professional development, intense supervision or structured mentoring to become highly qualified in those additional subjects” (2005, p 3). The USDOE also suggests that science teachers need more

flexibility in the interpretation of the law. While there is no ambivalence regarding the highly qualified status for mathematics teachers, science teachers must have a major in each science discipline or have a broadfield major. The USDOE suggests, “Now, states may determine—based on their current certification requirements—to allow science teachers to demonstrate that they are highly qualified either in “broad field” science or individual fields of science (such as physics, biology or chemistry)” (p. 3). However, the USDOE must approve the state’s recommendation.

The USDOE is quite specific regarding the definition of “highly qualified”. Teachers must have an academic major in the subject that they are teaching; coursework equivalent to an undergraduate academic major; a graduate degree in the subject being taught; a professional license in the subject being taught; or National Board Certification in the subject being taught. The No Child Left Behind law does not require current teachers to return to school or get a degree in every subject they teach to demonstrate that they are “highly qualified”. The law allows them to provide an alternative method (HOUSSE) for experienced teachers to demonstrate subject-matter competency that recognizes, among other things, the experience, expertise, and professional training garnered over time in the teaching profession. However, without a HOUSSE in action, practicing teachers who are qualified in one subject; e.g., biology, and are also teaching in a minor area like chemistry, have until June 30, 2007 to become highly qualified in these additional subject areas.

Individual HOUSSE plans are as

unique as are the individual states. However, one example might serve to help in our understanding of the nature of HOUSSE. Consider a HOUSSE plan that consists of a measurement of content knowledge through the PRAXIS II (4.0 points) added to a GPA measurement (4.0 points) added to an assessment of teaching (4.0 points) for 12 total possible points. States could determine in their HOUSSE plan a cut-off score, for example 9.0 and teachers scoring at or above that score would be deemed highly qualified. Additional scoring component criteria might include a score for professional development and/or teaching experience. Essentially, the formula might look like Figure 1.

Thus, this example of a HOUSSE formula could determine the state’s definition of a highly qualified teacher. But, is it just a means to an end? That is, does even this adjusted definition of “highly qualified teacher” guarantee that our nation’s students will be better served?

### Are highly qualified teachers better teachers?

It is clear from the pronouncements from the USDOE discussed above that it can be assumed as unarguable that highly qualified teachers are superior to those who are less well qualified. However, the research on

teachers had only a cursory understanding of the concepts underlying elementary mathematics. In general, there appears to be no association between the number of advanced mathematics courses a teacher takes and how well his/her students achieve in mathematics (Monk, 1994). This is not a recent revelation. Begle (1979) concluded

It is widely believed that the more a teacher knows about his subject matter, the more effective he will be as a teacher. The empirical literature suggests that this belief needs drastic modification and in fact suggests that once a teacher reaches a certain level of understanding of the subject matter, then further understanding contributes nothing to student achievement. (p. 51)

Notwithstanding the lack of clear evidence supporting the posited relationship between teachers’ mathematical knowledge and student achievement, there is strong intuitive support for the notion that student achievement is influenced by teachers’ background knowledge. One issue of concern here is the relevance of the science and mathematics courses taken by teacher candidates for increasing understanding of the nature of science and mathematics. In both disciplines,

Figure 1

Content Knowledge (i.e., Praxis II) 4.0	+	Content GPA (i.e., transcripts) 4.0	+	Assessment of Teaching (i.e. Student Teaching) 4.0	=	Highly Qualified >9.0
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this link between teachers’ background knowledge and their students’ achievement is at best only mildly positive. For example, Ball (1990) found that prospective secondary mathematics

the study of advanced courses takes a prospective teacher to a greater depth in the discipline without ensuring that he/she has a strong conceptual grasp of the foundational ideas and is able

to articulate them. This problem was highlighted by Liping Ma (1999) in her comparison of Chinese and U.S. teachers in their handling of routine topics in elementary mathematics. She concluded that the Chinese teachers, even though they had less formal instruction in mathematics, had more profound knowledge of basic mathematics and worked harder at developing effective ways to teach skills. Ma found that U.S. teachers have completed more coursework in mathematics but have less in-depth knowledge of mathematical procedures as evidenced by their responses to fundamental mathematical questions. This result raises the issue of whether a teacher who lacks a deep understanding of mathematics can teach for understanding.

These findings suggest that increased content knowledge, while important, will not of itself guarantee that a teacher will be better able to increase student performance. What is needed for prospective teachers is coursework that focuses on the foundations of the disciplines rather than on studying them to greater depths. The question posed at the beginning of the section “Are highly qualified teachers better teachers?” may thus be answered: Not necessarily. What is called for is a determination of those attributes that do enhance student performance. That is, what are the factors that contribute to teacher quality?

### **Teacher Effectiveness and Student Learning**

The framers of the NCLB legislation have a simple answer to the \$64 question: A highly qualified teacher is a more effective teacher. The discussion above suggests that the answer to the question is not so simple. As indicated in the previous section, merely having content knowledge is not enough.

Darling-Hammond and Sykes (2003), in endorsing the assertions above, claim that if effective teaching cannot be associated with improved student learning, then policy attention should be turned to other factors thought to exert greater influence on learning. Further, in their review of the research they find that student achievement is affected more by the teacher than by other factors such as class size or composition.

**Thus educational researchers have found that teacher dispositions like collegiality, self-reflection, collaborative and interactive skills, and the ability to adjust personal and professional practice based on reflection are important characteristics of good teachers.**

With so much confounding of the significant variables, it is extremely difficult to offer a clear recommendation regarding the most effective way to raise student performance. Since the enactment of NCLB, educational researchers have been addressing this issue, partly in an effort to counter the USDOE assertion that higher content credentials make for a better teacher.

Weiss and associates (2001) at Horizon Research observed many classrooms, rating 59% of them as low in quality, while only 15% were of high quality. They found that teaching strategy—traditional or constructivist—had no influence on whether or not a classroom was high quality, nor did the number of science and/or

mathematics classes taken, but that the teacher’s preparedness, commitment, and enthusiasm were critical variables.

Emerick, Hirsch, and Berry (2003) of the Southeast Center for Teaching Quality found that NCLB’s narrow emphasis on content knowledge has led to lower standards for teachers. They concluded that content knowledge alone does not justify the designation of highly qualified teacher, but that the successful teacher demonstrates understanding of the nature of student learning, the use of multiple forms of assessment, and the ability to differentiate instruction. In short, the high quality teacher will possess appropriate content knowledge, and will also possess considerable background in communicating effectively to students.

Thus educational researchers have found that teacher dispositions like collegiality, self-reflection, collaborative and interactive skills, and the ability to adjust personal and professional practice based on reflection are important characteristics of good teachers. There is little evidence that scores on teacher licensure tests or emergency provisional certification have any impact at all on student learning or measured achievement (Rice, 2003). Still, policy-makers fail to deal with the benefit of existing research or, in this case, lack of research on teacher quality. Certainly research should play a role in policy making decisions.

Administrators and teacher evaluators have long known that simple mastery of the content in science and mathematics by a teacher is not enough. Consequently, teacher evaluation instruments have typically included multiple measures that have been shown to improve student achievement. Teacher quality is not just the number of sci-

ence courses or mathematics courses a teacher possesses. 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 on teachers" (p. 20). Accordingly, administrators budget for the professional development of teachers with a focus on a strong pedagogical base. It is in this way that they believe they can enhance student learning and achievement.

### Where do we go from here?

Throughout the nation many current middle school teachers of science and mathematics will fail to meet the "highly qualified" test by spring 2006. While there has been a reprieve of one year for teachers presently in those positions, that is of little help to the many elementary certified teachers whose academic preparation may consist of no more than a concentration in science and/or mathematics. Those states which offer middle level certification do have an appropriate path for their teachers to follow, and those that have developed HOUSSE plans can provide their teachers with alternative routes to becoming "highly qualified". In states like Montana, where the Office of Public Instruction (OPI) deems a teacher to be highly qualified if teaching in one's area of certification (grades 7 and 8 are regarded as 'elementary'), a head-on collision with the federal mandate is in process. To this point, deans and faculty of the Colleges of Education have lobbied, without success, for compliance with the federal mandate. Efforts to develop alternative routes

to the completion of the equivalent of a major in a science or mathematics discipline have run aground where faculty see themselves expected to do more with ever diminishing resources. In our judgment, disaster can be averted only if the state pursues the HOUSSE route.

At the same time, there needs to be a significant body of research on the effects of a teacher's academic preparation on the achievement of his/her students. To suggest that students learn more from a "highly qualified" teacher begs the question posed by this paper. We would all agree that students will do less successful when a teacher is inadequately qualified, but the issue of "how much is enough" in terms of a teacher's science and mathematics credentials is not settled. The position of the USDOE has been made clear in the NCLB law and subsequent implementation statements, but the evidence presented in this paper disputes that conclusion. Our goal is to have every classroom staffed by a teacher with sufficient command of science and/or mathematics to help his/her students to achieve the intended levels of success. We need solid research evidence, not political jockeying or hortatory assertions, to help us determine the most appropriate academic background for the teachers of our nation's science and mathematics students.

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