Elementary Teachers: A Source of Math Anxiety

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For more than 50 years, mathematics anxiety in students and teachers has been a topic of interest (Baloğlu & Zelhart, 2007). Mid-20th century teachers initially identified the behavior, which was later called *mathematics anxiety* by Dreger and Aiken (1957, as cited in Baloğlu & Zelhart, 2007). Since then, numerous studies have attempted to quantify mathematics anxiety, beginning with primarily opinion-based studies and evolving to use a variety of survey instruments that were later standardized (Baloğlu & Zelhart, 2007). Many ways exist to measure math anxiety, due in part to the lack of agreement on its definition (Kazelskis et al., 2000).

A major discussion point is whether or not math anxiety is distinct from test anxiety. Kazelskis et al. (2000) studied the effects and indicate the two traits seem to be distinct, but say more work is required. It seems likely that math anxiety has many components (Bursal & Paznokas, 2006). It consists of negative emotional and physical reactions related to math use (Rule & Harrell, 2006), avoidance of situations in which mathematics may be needed (Rule & Harrell, 2006; Brady & Bowd, 2005), lack of confidence (Bursal & Paznokas, 2006; Brady & Bowd, 2005; Leung & Cohen, 2004) as well as low scores on tests (Brady & Bowd, 2005). The remainder of this paper will reflect on the concept of math anxiety as a fear of displaying a lack of mathematical knowledge, which is a different phenomenon from text anxiety.

Math anxiety for many students begins in elementary school (Rule & Harrell, 2006; Brady & Bowd, 2005) and is caused, in part, by elementary teachers who are themselves anxious as a result of their fundamental lack of mathematical knowledge (Rayner, Pitsolantis, & Osana, 2009; Rule & Harrell, 2006; Leung & Cohen, 2004). This lack of knowledge has been identified in several studies (as cited in Rayner et al., 2009; as cited in Bursal & Paznokas, 2006; Lias, Krivak-Fowler, Holdan, & Maxwell, 2005; Vinson, 2001) and has been shown to cause anxiety,

which in turn prevents the assimilation of additional knowledge and can lead to math avoidance (Rayner et al., 2009; Rule & Harrell, 2006). Furthermore, elementary teachers' anxiety that stems from their lack of mathematical knowledge can be passed on to their students (Kirtman, 2008; Leung & Cohen, 2004; Vinson, 2001), beginning the process again.

In 2001, the No Child Left Behind Act called for all core subject area teachers to be highly qualified (California Department of Education, 2010). Even with this impetus, the lack of what Liping Ma (1999) calls a "profound understanding of fundamental mathematics" (p. xxiv) in preservice elementary teachers appears again and again in the literature (Rayner et al., 2009; Kirtman, 2008; Bursal & Paznokis, 2006; Brady & Bowd, 2005; Lias et al., 2005; and others). Ma's (1999) study of Chinese and American elementary teachers found American teachers had more formal education but a much lower level of conceptual understanding than did their Chinese counterparts. Conceptual understanding is critical for extending knowledge and making connections between concepts. One reason for the lower level of conceptual understanding in American teachers may be that teacher education programs presume a competence in math and fail to address deficiencies in college graduates' mathematical content knowledge (Kirtman (2008). Lias et al. (2005) claim teacher education programs also fail to emphasize depth of mathematical knowledge. As a result, many new teachers present "mathematics as a set of unrelated procedures, skills, and facts" (Lias et al., 2005, p. 73).

This approach to teaching mathematics is the complete opposite of that suggested by Ma (1999). She insists teachers must have an excellent understanding of content knowledge before they can help their students construct a solid mathematical foundation (Ma, 1999). Specifically, Ma explains a *profound understanding of mathematics* is one in which deep connections are made between concepts and the underlying principles and broad connections are made between

laterally related concepts (Ma, 1999). An over-arching bond that ties these connections together is "thoroughness[,] which 'glues' knowledge of mathematics into a coherent whole" (Ma, 1999, p. 121).

Teachers who lack this deep understanding, particularly those who have been taught procedures for solving problems but not the underlying reasons behind the procedures, are more likely to suffer from math anxiety (Rayner et al., 2009). Kelly and Tomhave (1985) specifically implicated teachers' lack of knowledge as the cause of their math anxiety (as cited in Rayner et al, 2009). In a study of anxiety in preservice elementary teachers, Rayner et al. (2009) found that preservice teachers with a better mathematical understanding (both procedural and conceptual) were less anxious. These results are consistent with other studies cited by the authors that show anxiety is reduced when understanding is increased. Hill, Rowan, and Ball (2005) found a positive correlation between teachers' knowledge of how to teach math and elementary student achievement in grades one and three. The effect was significant even in first grade, in which students are learning very basic math concepts (Hill et al., 2005). Elementary teachers in primary grades still need a deep understanding of mathematics.

Math anxiety in preservice teachers affects what they choose to teach (Leung & Cohen, 2004). According to a study by Leung and Cohen (2004), teachers with a higher level of math anxiety will choose to teach grade levels in which the math is easier and they are less likely to be challenged by their students' questions. In fact, most mathematics anxiety studies focus on preservice elementary teachers because they have been determined to be relatively more math-anxious (Rayner, et al., 2009; Rule & Harrell, 2006; Kelly & Tomhave, 1985, as cited in Vinson, 2001). This position is supported by the work of Leung and Cohen (2004): Several participants

in their study admitted that math anxiety led them to teach a lower grade level than they would have preferred (Leung & Cohen, 2004).

Math-avoidance affects not only teachers like those in Leung and Cohen's (2004) study but also math-anxious students at all levels who avoid situations in which math plays a role (Rayner et al., 2009; Rule & Harrell, 2006). Anxious students may not attempt problems they perceive as too difficult and when they reach an impasse they are more likely to quit (Post, 1992, as cited in Vinson, 2001, p. 90). Anxiety may even be the cause of students' failure to understand math concepts (Rayner et al., 2009). According to Ashcroft and Kirk (2001, as cited in Rayner et al., 2009), anxiety may reduce the ability of the brain to process new information. The effect of anxiety cannot be overstated. Anxiety has been called "a greater block to math learning than supposed deficiencies in our school curricula" (Martinez, 1987, as cited in Vinson, 2001, p. 125).

Math-anxious teachers may transmit their anxiety to their students (Rule & Harrell, 2006). The exact mechanism for this potential transference is not confirmed: it may be how long they teach math, the types of lessons, or even their own behaviors. Confident teachers spend as much as twice as long teaching math as do less confident teachers (Schmidt & Buchmann, 1983, cited in Rule & Harrell, 2006, pp. 241-242.) Insecure teachers may choose strategies that emphasize following procedures, thus developing anxiety in their students who do not understand the math behind the procedures (Rule & Harrell, 2006). It has also been suggested that "students [can] learn math anxious behavior" from teachers (Cruikshank and Sheffield (1992), as cited in Vinson, 2001, p. 90). Many studies have found that students' mathematical performance is influenced both by teachers' attitudes and their mathematical knowledge (Hill et al., 2005; Scholfield, 1981, as cited in Vinson, 2001). Recently, Rayner et al. (2009) concluded

their study by "propos[ing] that a teacher's weaknesses in mathematical content knowledge may not only hinder student performance, but may also be a source of the students' own mathematics anxiety" (p. 81).

Mathematics anxiety has been shown to be a complex phenomenon closely related to low confidence and negative attitudes. This type of anxiety can result in avoidance behaviors that make the problem worse. Choosing to teach elementary school rather than middle or high school may be a way that math-anxious teachers avoid situations that make them uncomfortable. Unfortunately, math-anxious elementary teachers may inadvertently transmit their anxiety to their students. They tend to teach procedures rather leading students to develop a deep conceptual understanding, which the teachers themselves lack. Once the cycle of poor performance – anxiety – avoidance begins, it is difficult to stop, as the anxiety itself can prohibit the acquisition of new knowledge.

Leung and Cohen (2004) summarize this condition's cyclical nature very eloquently calling it a "perpetual cycle of knowledge gaps and lack of confidence" (p. 1). Elementary teachers are responsible for providing every student with a basic knowledge of mathematics, those who will become scientists as well as future non-scientists. That many students receive "an incomplete foundation for mathematical knowledge" (Leung & Cohen, 2004, p. 1) resulting from their teacher's personal relationship with mathematics is unwise for a country that wants to stay on top of the technological pyramid.

Mathematics is a vertical discipline as well as a horizontal one; advanced concepts rely on the existence of a structure built upon underlying principles. Students who lack this structure will find their mathematical understanding cannot stand up to more complex concepts and these students are likely to become anxious and avoid future math-related embarrassments. In

summary, "when some of these students re-enter the elementary education system as teachers, they restart the treacherous cycle that robbed them of an invaluable knowledge of mathematics and the balanced education they deserved" (Leung & Cohen, 2004, p. 1).

Hope exists for students and teachers who suffer from math anxiety. According to the California Mathematics Framework, student performance on recent standardized tests is better than in the past and more students are choosing to take higher level math courses (California Department of Education, 2005). Changing math instruction to include conceptual as well as procedural knowledge may reduce or eliminate math anxiety (Rayner et al., 2006; Vinson, 2001). If mathematics anxiety is indeed a learned behavior (Cruikshank & Sheffield, 1993, as cited in Vinson, 2001) then it can be "unlearned" (Smith, 1997, as cited in Vinson, 2001, p. 91). Lias et al. (2005) report on the success of a partnership between K-12 teachers and university professors in a teacher education program. This collaborative effort provides both groups with appropriate content-development support (Lias et al., 2005). Math anxiety can even be put to good use. Leung and Cohen (2004) report that some math-anxious teachers are determined to block the transmission cycle and that a focus on more individually oriented *mastery* goals rather than on more competitive *performance* goals may help these teachers succeed.

Although there are other reasons for math anxiety in students, such as poverty and math-anxious parents (Rule & Harrell, 2006), the math anxiety in elementary teachers must be addressed. *Teaching* math requires a deeper understanding than *using* math. A teacher must be competent *and* confident to keep up with 30 or more free-thinking students and facilitate their construction of a "profound understanding of fundamental mathematics" (Ma, 1999, p. xxiv).

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