Working together: A cross-cultural study addressing mathematics anxiety in K-8 preservice teachers.

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Working Together: A Cross-cultural Study Addressing Mathematics Anxiety in K-8 Pre-service Teachers

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Abstract
This study will present data from research on K-8 pre-service teachers’ math anxiety across three universities: one public, one private and one non-U.S. The article discusses background rationale, literature, tools used and results of this study. The results of the study indicated that similar math anxiety levels exist in students in all three types of academic institutions. The paper also incorporates discussion of the importance of including the topic in pre-service teacher training, and possible interventions for alleviating math anxiety.

Introduction
Math anxiety as a construct was first introduced in the U.S. in the 1970s (Tobias, 1978) and since then has been studied across a variety of groups, from K-12 through college students. While elementary and secondary students were originally a major focus of research, further study indicated practicing and pre-service elementary teachers are not immune to having anxiety about math (Malinsky, Ross, Pannells, & McJunkin, 2006; Wenner, 2010; Widmer & Chavez 1982). Brown, Westenkow, and Moyer-Packenham, (2011) looked specifically at parsing the difference between pre-service teachers’ own math anxiety and their anxiety about teaching mathematics, while Mizala, Martinez, and Martinez (2015) examined how preservice teacher anxiety correlates with their expectations of students while Hadley and Dorward (2011) explored the relationship between teacher math anxiety, teaching practices and student achievement. It is clear that if math anxiety is related to how teachers teach and what their students learn, then this construct remains important to study and address in the preparation of pre-service teachers.

Significant research on math anxiety in pre-service teachers has taken place in the United States. While there have been a variety of studies in other countries (Lee, 2009), I wondered how different students might compare at different locations in the same study. To answer this question, I and my colleagues crossed the boundaries of one educational system and examined this phenomenon with a focus on pre-service teachers in three different venues using the same instruments. Specifically, this exploratory study examined and compared levels of math anxiety among groups of K-8 pre-service teachers in a U.S. public and a U.S. private institution, and in a public university in a Scandinavian country. The rest of this article will review some of the literature on math anxiety, discuss the research questions and method for the study and results, then end with some possible interventions for reducing math anxiety in pre-service teachers.
What the Literature Says About Math Anxiety
Math anxiety has been defined as “a feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in ... ordinary life and academic situations” (Richardson & Suinn, 1972, p. 551). The construct has been measured in numerous ways: by tools such as the Mathematics Anxiety Rating Scale (Richardson & Suinn, 1972) and its abbreviated versions (Hopko et al., 2003; Plake & Parker, 1982), and by physiological measures such as EEGs and MRIs. Math anxiety, it appears, is related to how students think and behave, as psychological measures indicate a relationship between inhibited working memory and math anxiety (Dowker, Sarkar & Looi, 2016), and researchers have found mathematical performance is negatively correlated with math anxiety (Baloglu and Koçak, 2006; Ma & Kishor, 1997). However, it appears there is a chicken and egg relationship between math anxiety and mathematics performance—it’s not clear if high anxiety leads to poor performance or poor past performance leads to high anxiety. Other studies indicate enjoyment of mathematics and self-efficacy both negatively correlate with math anxiety (Hoffman, 2010; Lee, 2009).

Factors such as gender and age may influence levels of math anxiety. Some studies (Devine et al., 2012; Ganley & Vasilyeva, 2014) show females have higher levels of math anxiety than males, as measured by both questionnaires and physiological measures. However, this may be partly due to social pressures to conform to stereotypes, stereotype threat (Beilock et al., 2007; Schmader, 2002), or higher levels of general anxiety in females (Devine et al., 2012). Other studies indicate no difference in anxiety between males and females (Wu et al., 2012). Age may also be a factor, as young children have less anxiety about math, but it appears to increase as students progress through school (Ma & Kishor, 1997).

Other people may influence a person with math anxiety. A recent study shows that highly math-anxious parents may unknowingly transmit their own fears and frustration with mathematics to their children (Maloney et al., 2015). It is interesting to note that math anxiety and culture might be related, but the relationship between math achievement and math anxiety in various cultures is not consistent (Lee, 2009; Ma, 1999). Possible influences might be high stakes testing, and high expectations or socioeconomic status in different cultures.

Studies on Preservice Teachers in Particular
Some research shows preservice teachers report high levels of mathematics anxiety (Brown, Westenkow, & Packenham, 2011; Gresham, 2007) and that anxiety about math and anxiety about teaching math are positively correlated (Hadley & Dorward, 2011). Anxiety about teaching math is also related to lower student mathematics achievement, while teacher math anxiety leads to lower expectations of students’ abilities (Hadley & Dorward, 2011; Mizala, Martinez & Martinez, 2015). Beilock (2010) even found female teachers with math anxiety may be influencing their female students to have increased
anxiety about mathematics. Since these elementary teachers are going to be teaching mathematics, this pressing problem needs to be addressed.

**Research Questions**
After examining the extant literature, the author determined three research questions to examine for her study:
1) To what extent do preservice teachers at public, private and foreign universities differ with respect to their levels of math anxiety?
2) To what extent does preservice teachers' math anxiety correlate with their skill levels in math, and is there a difference among the university types?
3) To what extent are the variables, age, gender, past math experience, and grade level teaching preference related to math anxiety across universities?

**Method**
To answer these research questions, it was necessary to find a measurement instrument for math anxiety, a skill test to determine differences in the skill levels of students, and a demographic analysis tool. Three tools were selected: an author-created demographic survey, the nine-question Abbreviated Math Anxiety Survey instrument (AMAS) by Hopko et al. (2003), and a 15-question skill quiz created by Johnson and Kuennen (2006) for assessing student skills across the various strands of mathematics. The demographic survey included questions about gender, age, current year in college, high school and college math background, and grade level teaching preference.

**Results**
The pre-service elementary education students surveyed across the three universities yielded N=97. The universities in the study were relatively small universities, with between 5,000 and 9,000 students. One U.S. university was private, one was public, both in the midwestern United States, with the public one located in a smaller city and the private in a large metropolis. The foreign university was located in a small Scandinavian city. All students were early in their education program, with no significant math pedagogy background. The gender makeup was 21 male and 76 female participants. Some students had taken a liberal arts math course or problem-solving course, but none had taken a course on teaching mathematics.

In order to answer the research questions, the data were analyzed using SPSS statistical analysis software and ANOVA. To answer the first research question, the author and her colleagues found no significant differences between university populations in math anxiety level as measured with the Abbreviated Mathematics Anxiety Scale (AMAS) in a series of pairwise comparisons.

Analyzing the skills test as a variable, one significant result showed there were higher mathematics skill scores at the private university, likely related to differences in admission requirements. In addition to that finding, there was a significant negative correlation between math anxiety and skill quiz scores. In particular, quiz scores were negatively correlated with the anxiety scores while controlling for high school math history, college math history, and teaching...
preference \((r = -0.329, p<0.05)\). In addition, skill quiz score negatively correlated with anxiety score while controlling for math background (this was a variable that averaged their high school and college mathematics experiences).

Other significant results showed that without controlling for any variable: Quiz score correlated with Anxiety score (Spearman Rho = -0.315, \(p = 0.02\)); Grade preference correlated with Anxiety score (Spearman Rho = -0.259, \(p = 0.010\)) and; Math background correlated with Grade preference (Spearman Rho = -0.228, \(p = 0.025\)).

Discussion
In this study, my colleagues and I found higher anxiety was related to lower skill scores in all of the universities studied. We also found no standouts with less anxiety among the three types of universities. In addition, neither gender nor age were significant in the study. In terms of surprises, math background had an interesting correlation with teaching preference; it was the opposite of what might be expected. Teachers with higher math background wanted to teach lower grades. At the same time, the results also showed students with high math anxiety tended to desire teaching lower grades. Including interviews of students in futures studies might illuminate this apparent contradiction.

Where Do We Go from Here?
The study described here, while small in scale, shows math anxiety is a problem for pre-service teachers both in the U.S. and the participating Scandinavian universities. Students who have high anxiety in this study tended to want to teach lower grades. One could speculate that this may be because they have anxiety about teaching topics in which they lack confidence. Since we need teachers across the K-8 grades to teach mathematics, seeking a solution is vital. One solution may be to implement known strategies for alleviating math anxiety in the curriculum for future teachers. If teachers have less anxiety about mathematics themselves, they may do an improved job of teaching their students mathematics.

A number of such strategies for treating math anxiety have been published in the literature surrounding math anxiety. Clinical treatments for math anxiety include treatment similar to other anxieties, such as cognitive behavior therapy (Dowker, Sarkar & Looi, 2016). Other ways to treat math anxiety include: using self-appraisal; informing people that some anxiety can actually improve performance (Jamieson et al., 2010); desensitization by having intensive 1-1 tutoring focused on math (Fuchs et al., 2013), and having students “writing out” their fears, or use expressive writing just before an exam (Park et al., 2014; Ramirez & Beilock, 2011); or increased use of manipulatives in class (Vinson, 2001). Some of these are more practical than others for the classroom. In particular, use of manipulatives, tutoring, and expressive writing could easily be implemented. Future studies could further examine whether any of these methods are helpful in reducing math anxiety in pre-service elementary teachers.
References


