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Pre-service elementary teachers' achievement goals and their relationship to math anxiety

Alyssa R. Gonzalez-DeHass*, Joseph M. Furner, María D. Vásquez-Colina, John D. Morris

Florida Atlantic University, United States

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ABSTRACT

Math anxiety remains a critical issue affecting student performance and confidence across grade levels, including pre-service elementary teacher education. Given the potential impact teachers' math anxiety might have on their learning as well as that of their future students, one unique purpose of this research is to investigate how achievement goals relate to math anxiety among 182 pre-service teachers enrolled in undergraduate elementary education math methods courses. While low self-efficacy is a significant predictor of math anxiety, our results indicate that taking into account pre-service teachers' achievement goals increases our ability to predict math anxiety over that afforded by their level of self-efficacy alone. In particular, students adopting either mastery-avoidance or performance-avoidance goals while learning mathematics, may be particularly susceptible to math anxiety. Further, self-efficacy does not moderate the relationship between achievement goals and math anxiety, so the relationship between achievement goals and math anxiety is consistent across levels of self-efficacy.

Negative attitudes toward mathematics and math anxiety are serious obstacles for students at all levels of schooling today (Geist, 2010). Of particular interest to this investigation is examining the predictors of pre-service elementary teachers' math anxiety given the potential impact it may have on not only their own learning, but also that of their future K12 students' mathematical learning. Specifically, this study investigates how achievement goals relate to math anxiety among students enrolled in an undergraduate elementary education math methods class. Because achievement emotions shape students' learning behaviors, knowledge of their origins would be of benefit to classroom practices, and achievement goals are a potentially relevant antecedent of these emotions (Goetz, Sticca, Pekrun, Murayama, & Elliot, 2016). Our review of the literature did not locate any research looking at the specific dynamics we have outlined in our investigation examining the relationships between achievement goals and math anxiety among pre-service elementary teachers.

1. Math anxiety

Math anxiety is defined as a negative emotional response that arises when confronted with a mathematical task (Beilock, Gunderson, Ramirez, & Levine, 2010). Anxiety is the most widely researched emotion in learning and achievement situations, and it has been found that the study of mathematics elicits anxiety in particular (Frenzel, Pekrun, & Goetz, 2007). It can result in a feeling of panic, helplessness, paralysis, and mental disorganization (Núñez-Peña, Suárez-Pellicioni, & Bono, 2013). Test anxiety by far is the most extensively investigated emotion (Boehme, Goetz, & Preckel, 2017). When considering older high school and college age populations, math test anxiety is identified as a major component of math anxiety, potentially because of failure experiences in past coursework (Alexander & Martray, 1989).

Among various college majors, pre-service elementary teachers have some of the highest rates of math anxiety while coupled with below average math proficiency (Novak & Tassell, 2017), and many report having poor experiences with math courses in K-12 (Bekdemir, 2010). Many elementary educators are female, and females report higher levels of 'traitlike' (or habitual) math anxiety and lower levels of perceived math competence (Goetz, Bieg, Lüdtke, Pekrun, & Hall, 2013). Unfortunately, teachers may pass on math anxiety to the next generation by modeling behaviors of their discomfort with the subject (Geist, 2010; Reys, Lindquist, Lambdin, Smith, & Suydam, 2015). Johnson and vanderSandt (2011) explain how teachers might pass on this anxiety to their own students, or negatively impact their own students' math achievement, as a result of teachers' discomfort with the subject, decreased time spent in math lesson preparation, or ineffective use of math instructional time. Math anxiety of elementary school teachers, who are predominantly female, may even impact their female students' math achievement by influencing girls' gender-related belief about who is good at math (Beilock et al., 2010; Maloney & Beilock,

* Corresponding at: Department of Teaching and Learning, Florida Atlantic University, 5353 Parkside Road, Jupiter, FL 33458, United States.
E-mail address: agonzale@fau.edu (A.R. Gonzalez-DeHass).

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2012). Their female students may be more vulnerable to falling victim to the stereotype that only 'boys are good at math'.

Given the impact a teacher's math anxiety may have on their own students' learning, studies addressing the roots of math anxiety in pre-service elementary teachers is important before teachers graduate and enter classroom teaching. Achievement goals are one potentially relevant antecedent of achievement emotions like anxiety (Goetz et al., 2016). Therefore, investigation into how achievement goals relate to math anxiety may prove an important avenue for understanding predictors of pre-service teachers' math anxiety.

2. Achievement goals

Achievement goal research examines how the types of achievement goals students adopt relate to important academic outcomes (Ames & Archer, 1988; Dweck & Leggett, 1988; Elliot, 2005; Elliot & McGregor, 2001). The most prevalent achievement goal model identifies four achievement goals (Elliot & McGregor, 2001): where individuals adopting mastery goals are motivated to master a task and advance their learning (mastery-approach) or are focused on avoiding misunderstandings and leaving tasks un-mastered (mastery-avoidance), and those adopting performance goals may be motivated to outperform others (performance-approach) or to avoid performing worse than others (performance-avoidance). Individuals adopting different goals will be engaged for different reasons. A student with a mastery-approach goal will seek out challenge and pursue opportunities to extend their mathematical learning whereas a student with a mastery-avoidance goal is more concerned with not being able to master the assigned task. A student with a performance-approach goal will strive to do better in comparison to others in front of the class on a given math task, while the student with a performance-avoidance goal just wants to avoid being judged unfavorably by classmates.

In particular, achievement goal theory links achievement emotions with achievement goals (Huang, 2011). Elliot and McGregor (2001) found both avoidance goals were related to test anxiety and undergraduate psychology students worrying about making mistakes. In contrast, research across diverse student ages and academic subjects has shown mastery-approach goals linked to positive emotions like enjoyment and lower anxiety, while performance-avoidance goals have predicted more negative emotions including anxiety and shame (Goetz et al., 2016; Huang, 2011; Ranellucci, Hall, & Goetz, 2015). Huang's (2011) meta-analytic review suggested that mastery-avoidance goals tended to correlate more highly with negative achievement emotions, but conclusions required further investigation.

3. Achievement goals related to math anxiety

Published studies have not yet investigated the relationships between achievement goals and math anxiety among pre-service elementary teachers. However, research has begun to investigate these relationships in other student populations. These studies predominantly utilize self-report surveys of students' adopted achievement goals. Results with college students enrolled in a statistics course revealed that while both avoidance goals were significant predictors of negative affectivity and anxiety, mastery-avoidance goals were a more salient predictor of anxiety and negative affect than any other goal type (Sideridis, 2008). It was concluded that mastery-avoidance goals, and a focus on failing to meet internal standards, can have a particularly harmful impact on student's regulation of their emotions in stressful academic situations. In contrast, mastery-approach goals significantly predicted lower negative affect. Luo et al. (2014) investigated achievement motivation among secondary students in Singapore and also found both of the avoidance goals to be predictive of math anxiety (particularly mastery-avoidant goals), while mastery-approach goals were a predictor of lower anxiety. However, Korean elementary and middle- school students who reported having performance-approach, and either avoidance goal showed evidence of more math anxiety (Bong, 2009). In contrast to other research, investigators concluded that students with stronger performance-avoidance goals felt more anxious and tended to avoid seeking out help than in comparison to those with mastery-avoidance goals who were more likely to report greater use of cognitive and self-regulatory strategies in math. This research also showed that mastery-approach goals appear to be particularly favorable, providing a stronger 'psychological armor' or protective shield, in warding off harmful thoughts and combating adolescents' test anxiety in math classes.

Additional studies have examined the relationship between math anxiety and achievement goals using the earlier trichotomous framework (with a mastery goal, conceptually similar to a mastery-approach goal, and the two performance goals). Research with undergraduate students found performance-avoidance goals related to higher levels of anxiety surrounding mathematics tasks, while both approach goals had positive outcomes for task enjoyment and competence perceptions for mathematical tasks (Zusho, Pintrich, & Cortina, 2005). Unlike performance-avoidance goals, the fear of failure channeled through performance-approach goals can still have indirect positive achievement outcomes, underscoring the complexity of performance-approach goals and the idea that there is not one specific pathway to academic success. However, in earlier research, the adoption of either performance goal predicted young adolescent students' nervousness and test anxiety felt during math (Middleton & Midgley, 1997; Skaalvik, 1997).

Therefore, it appears that both avoidance goals may be predictors of math anxiety. This may be due to the mastery-avoidance link to fear of being faced with one's inability to master math tasks, and the performance-avoidance goal's link to avoid seeking out help possibly to escape poor evaluations of their performance. In contrast, an individual with a mastery-approach goal may not be as concerned with negative effects of a failure experience, as they may interpret any initial failure as a springboard for further learning and better understanding. However, the impact of the performance-approach goal is more inconsistent. For some, the desire to be seen as outperforming others may not necessarily lead to math anxiety like it might for some learners. It may be that this depends on their level of self-efficacy for mathematical tasks.

4. Self-efficacy

Judgments of self-efficacy (defined as a personal set of beliefs about one's competence in a specific area) affect one's choice of activities and effort and persistence in those activities (Bandura, 1986, 2006; Usher & Pajares, 2008). Most importantly, judgments of self-efficacy may affect the emotional reactions to those activities (Bandura, 1986, 2006; Usher & Pajares, 2008). Many studies have found self-efficacy to be negatively correlated with math anxiety among students of various ages (Bong, 2009; Kesici & Erdogan, 2009; Pajares & Kranzler, 1995). In fact, beliefs about one's competence may be one of the strongest significant predictors of math anxiety (Ahmed, Minnaert, Kuyper, & van der Werf, 2012; Meece, Wigfield, & Eccles, 1990). The more they lack self-confidence in their mathematical ability, whether because of experiencing past failure or receiving negative persuasory feedback from significant others concerning math tasks, the more likely they would be to experience anxiety for executing mathematical tasks. People with low self-efficacy may dwell upon personal deficiencies, and their misgivings can create stress and divert attention from more productive problem-solving (Bandura, 1986). Therefore, while self-efficacy is a known predictor of anxiety in some research with K12 students, it would be of interest to examine if pre-service teachers' achievement goals serve as another predictor of math anxiety.

One final note is that some researchers have treated self-efficacy as a moderator between goals and outcomes. Where perceived competence moderates the relationship between performance goals and outcomes (with only those with low self-efficacy and performance goals