

Utilizing a Constructivist Approach within a Methods Course to Reduce Preservice Teachers Mathematics Anxiety

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Abstract: Early childhood, elementary, exceptional education preservice teachers' levels of mathematics anxiety mathematics were investigated before and after a methods course. Data from informal discussions and questionnaire-guided narrative interviews revealed constructivist approaches within the methods course were instrumental in reducing preservice teachers' mathematics anxiety ($p < .001$) with elementary preservice teachers experiencing the highest mathematics anxiety reduction. These findings have implications regarding how approaches disseminated within a methods course can effectively and positively change preservice teachers' mathematics anxiety and how their mathematics anxiety levels can be interpreted and reduced.

Introduction: Mathematics Anxiety, Its Causes, and Contributions

Research reveals preservice teachers typically experience mathematics anxiety levels higher than most others within the general university population (Beilock & Maloney, 2015; Gresham, 2021; Sloan, 2010). Haciomeroglu (2014) posited that preservice teachers have prior negative mathematics experiences, unfavorable attitudes and feelings towards mathematics, and are involved in ineffective undergraduate teacher education programs which contribute to such high mathematics anxiety levels. Concern abounds with how preservice teachers are prepared particularly since a teacher's negativity towards mathematics may unintentionally pass on to students (Gresham, 2018; Vinson, 2010). Some K-6 educators lack the mathematics competence and skills needed to effectively teach with mathematical understanding. Research is needed as to why this occurs. Therefore, this study was conducted to examine early childhood, elementary, and exceptional education preservice teachers' levels of mathematics anxiety pre-post to determine if changes can or will be made after participation in a constructivist-based mathematics methods course. Research is limited illustrating how mathematics methods courses can assist with preservice teachers' mathematics anxiety reduction. This study will contribute to the body of knowledge.

Mathematics anxiety has been described as a fear of mathematics related tasks that produces a negative physiological, emotional reaction or response creating frustration and avoidance of the subject (Beilock & Maloney, 2015). Causes of mathematics anxiety derive from low mathematical self-confidence, the inability to handle frustrations, emphasis

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placed on mathematics drill and practices without focusing on deeper understanding of mathematics facts and mathematics concepts, and negative parental and teacher attitudes towards the subject (Lake & Kelly, 2014). Lake and Kelly concluded that cognitive resources are used differently in those with high mathematics anxiety versus those with low mathematics anxiety. Research cites past negative mathematics experiences, negative teacher attitudes towards mathematics, and excessive use of traditional teaching practices contribute to mathematics anxiety in students as early as first grade (Lee & Zeppelin, 2014). Geist (2010) and Gresham and Burleigh (2018) confirm that how mathematics is presented particularly with teaching practices that include rote memorization of facts, drill competition, lack of manipulative use contributes to higher mathematics anxiety levels.

Mathematics Methods Course, Instruction, and Preservice Teachers' Mathematics Anxiety

Limited research exists addressing how preservice teachers' involvement in a mathematics methods course may influence mathematics anxiety levels (Johnson & vanderSandt, 2011). Sloan (2010) and Vinson (2001) highlighted the effectiveness of a methods course that used a reform-based approach. Confirmation from both studies showed that preservice teachers exhibited more confidence in their mathematical ability after the witnessing introduction and implementation of effective teaching practices. However, Lake and Kelly's (2014) study revealed that even though similar teaching methods were used as those mentioned in previous studies, evidence concluded a lack of success within the methods course to reduce preservice teachers' mathematics anxiety. Study differences illustrate a lack of consensus regarding the methods and strategies used in methods courses to reduce mathematics anxiety. Therefore, the topic warrants further investigation.

Novak and Tassel (2017) contended that the preparation of educators belies the shaping of attitudes and expectations towards mathematics. This is notable since Furner and Duffy (2002) indicated that mathematics anxiety lies in how one is involved with and taught mathematics and in how educators teach the subject. This solution is supported by many researchers who have indicated that the very "nature of instruction itself seems a powerful source in shaping later attitudes, expectations, and concepts of learning in preservice teachers" (Novak & Tassel, 2017, p. 23).

The National Council of Teachers of Mathematics (NCTM, 2014) called attention to the mathematics curriculum. The focus was to direct attention to those who struggle with mathematical learning by promoting mathematics understanding and reasoning, confidence, and knowledge of the subject. Even though attention has been called preservice teachers still "lack confidence in their ability to learn more advanced mathematical skills, have lessened opportunities in identifying mathematics learning concerns, and often teach primarily through lecture and rote memorization of algorithms" (Haciomeroglu, 2014, p. 4).

The Study

The population consisted of ninety-nine preservice teachers: thirty-four Early Childhood Education preservice teachers (EC), thirty-four Elementary Education preservice teachers (EE), and thirty-one Exceptional Education preservice teachers (ExE). EC

preservice teachers were seeking a K-3 endorsement, EE preservice teachers were seeking a K-6 endorsement, and ExE preservice were seeking a K-6 endorsement for students needing special education services. Course enrollment consisted of both juniors and seniors and were overwhelmingly female (96 of 99) therefore, no attempt was made to differentiate results by gender. Prior to the methods course participants completed two university undergraduate mathematics courses and one elementary mathematics content course. Participation was voluntary with no interference or influence course grades. Course features included concrete manipulative use, representations, journal logs, and discussions which have been found in studies previously mentioned. However, this study differs because all participated in a 12-week K-6 teaching experience two days per week throughout the semester.

Data Collection

Data sources included Richardson and Suinn's (1972) Mathematics Anxiety Rating Scale (MARS) and interviews. Even though a newer more conducive mathematics rating scale exists, the MARS was used because those involved in this study are also participating in a longitudinal study and thus used for consistency. Interviews were analyzed for coded themes (see **Table 1** for interview questions). Bruner's model of instruction within the course included discourse sessions, presentations and activities with both small and large groups, literature activities integration, journaling, and hands-on manipulative engagement. Field experience requirements included planning and implementation of 4 lesson plans identifying state/national standards and objectives, English for Speakers of Other Languages (ESOL) and special needs modifications, assessment procedures, and use of manipulatives.

Table 1. *Interview Questions*

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1. What do you think when you hear the word mathematics?
 2. For me, mathematics is most like....?
 3. Do you perform well in mathematics?
 4. How confident do you feel when asked to perform mathematics problems?
 5. Describe your most memorable teaching moment while teaching mathematics in your internship. Why does this stand out in your mind?
 6. How do you feel about mathematics?
 7. How confident are you when teaching mathematics?
 8. Describe your feelings when teaching mathematics?
 9. What do you think contributed to your mathematics anxiety?
 10. Do you feel class discussions have helped you this semester? Why or why not?
 11. Did this course help you address your mathematics anxiety? How? Why or why not?
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Data Analysis

Paired sample t-tests considered pre-posttest differences in mathematics anxiety levels (See Table 2). Positive score differences indicated mathematics anxiety increases while a negative score meant decreases in mathematics anxiety. Interview and journal entries were analyzed and coded for reoccurring themes using cross-case synthesis, a

strategy recommended by Yin (2014). Participants reviewed their thoughts and statements for accuracy and correctness.

Findings

After comparing pre-posttest scores, ninety-three of ninety-nine participants had a reduction in mathematics anxiety. Two EC preservice teachers had no mathematics anxiety changes, and one slightly increased. Three ExE preservice teachers' mathematics anxiety slightly increased (see **Table 2** for raw score means and group comparisons). EE teachers scores illustrated a -47.45 gain. EC preservice teachers scores indicated a -39.12 gain while ExE preservice teachers had a -35.33 gain. This table also reveals that overall, EE preservice teachers had the largest decrease in mathematics anxiety from pre-post testing followed by EC preservice teachers, and then EXE preservice teachers. The difference from the largest mathematics anxiety decreases (EE preservice teachers) to the least mathematics decreases (EXE preservice teachers) was -12.12. Even though EC preservice teachers had a greater posttest decrease than ExE preservice teachers, EC still retained the highest degree of mathematics anxiety pre-and posttest.

Table 2. *Preservice Teachers Mathematics Anxiety Raw Score Means*

Group	Pretest	Posttest	Gain
Early Childhood Education	260.51	221.39	-39.12
Elementary Education	237.88	190.43	-47.45
Exceptional Education	234.69	199.36	-35.33
All Groups	244.69	203.73	-40.63

Note. * $p < .001$

Preservice teachers described the following as contributors to their mathematics anxiety decreases: (1) attitudes towards mathematics, (2) having a better understanding of effective mathematics teaching practices using manipulatives, (3) the personality, environment, and teaching style of the instructor, (4) prevalent classroom discourse, interactions, and presentations with peers, and (5) journaling.

Theme 1

Preservice teachers' negative attitudes towards mathematics surfaced immediately. Discourse involved personal mathematical stories of strong dislike and struggles with mathematics starting as early as the primary grades, and with having parents who also disliked the content which affected them. Feeling "stupid", "stressed", "ostracized", "embarrassed", "frustrated" and "discouraged" were words to describe themselves which were associated with failure and a direct copulation of ineffective mathematics teaching practices experienced throughout their education. They claimed other emotional and physical reactions including crying, nausea, and sickness were evident because they could not perform mathematical tasks successfully and feeling chastised by the teacher for not knowing the correct answer quickly. Others described avoidance of mathematics at all costs.

Each indicated a strong need to address their mathematics anxiety but did not know how to do so.

ExE preservice teachers had the least changes in pre-post scores. They expressed fear in teaching mathematics to all K-6 grade levels and were concerned with creating further deficits and/or difficulties in students mathematical learning because of their inadequacies and frustrations. The EC preservice teachers who had an increase and/or no changes in mathematics anxiety expressed much concern with having to teach second or third grade mathematics, believing they would not be successful teaching those grades. They placed emphasis on only wanting to teach kindergarten or first grade even though they were seeking K-3 certification.

Theme 2

Ninety-one participants had a better understanding of effective mathematics teaching practices including the use of manipulatives. Each expressed a strong desire to understand how mathematics was taught using manipulatives, particularly since the majority had very limited experience using them in prior mathematical learning. The majority (88 of 99) felt that the instructor's use of manipulatives (e.g., base 10 blocks, geoboards, fraction tiles, geometrical solids, algebra tiles, etc.) and representations to model the concepts using problem-solving situations was most effective. Many verbally expressed relief in finally having an understanding of the content when represented concretely rather than abstractly or when the instructor outlined multiple strategies and illustrations to teach the content. Each stated a need to immitate these same practices in their own classrooms.

Eight preservice teachers felt the use and selection of manipulatives within lessons and learning how to introduce content using manipulatives increased their mathematics anxiety even though test scores showed a decrease. In the beginning, these teachers found it difficult and intimidating to teach a lesson with manipulatives and in knowing which ones to select. However, by the courses end they felt better prepared and confident in introducing manipulatives to students.

Theme 3

All 99 preservice teachers described how the instructor was instrumental in reducing their mathematics anxiety through the creation of a relaxed, open, and trusting learning environment. Because of this each felt comfortable with discourse during a class they once feared. Nervousness and dread in having to take a mathematics course was evident early in the semester. However, those feelings disappeared as they felt a sense of repose with how the professor recognized her own past feelings of frustration with mathematics. Others looked forward to coming to class because they felt welcome, valued as a learner, and never felt belittled over lack of content knowledge. They believed expectations were presented early and were consistent throughout the semester and that the instructor believed in them, motivated and helped, and wanted to see them improve their mathematical understanding. Many identified the class as fun and interesting, and the comradery each felt throughout the course contributed to their mathematical learning.

Thoughts of the instructor's personality and enthusiasm which espoused a sense of calm, assurance, and acceptance surfaced quickly. Each wanted to immitate the instructor's

teaching style and felt they were learning how to identify and redirect their negative emotions towards mathematics based on the instructor's comments and presentations. The instructor's sense of humor, honesty, firmness, fairness, consistency and personal stories of her own experiences with mathematics anxiety made them feel connected to her. Some expressed a feeling of humiliation and embarrassment from other instructors when they did not understand. However, each posited that the instructor's positivity and enthusiasm for teaching mathematics, and the many different ways the content was presented helped them address their negative feelings towards mathematics.

Theme 4

Preservice teachers (97 of 99) postulated that experiences with discourse in class, peer presentations, and interactions lessened their mathematics anxiety. Each articulated an openness to freely express their thoughts without repercussions. The realization that others experienced frustration and/or embarrassment and struggled with mathematical content was enlightening to them. Discourse contextualized interactions and drew differing thoughts and viewpoints in the continuum, even in face-to-face communication. Some approached conversations to connect mathematical ideas to explanations, explorations, and strategies to successfully learn the content. Each were strategies they wanted to implement in their future classrooms. Of the two that did not find discourse effective one indicated that she was not much of a talker while the other said she was very shy and did not like to engage in conversation. Both felt they were good listeners.

Theme 5

Eighty-nine preservice teachers found that journaling (writing) about their thinking, thoughts about learning difficulties, incorrect assumptions, and overall mathematical progress helped decrease their mathematics anxiety. Each articulated that journaling helped to clarify, organize, and consolidate their thinking. Reflection eventually led to the utilization of more concise language to express their thoughts which facilitated mathematics growth. Encouragement enabled mathematics confidence and enhancement of mathematical abilities. Most saw journaling as an effective practice that helped fill in the missing mathematical learning gaps and a practice to implement in their own classrooms. Interestingly, though the ten preservice teachers who did not express a significance in journaling were all future EC educators. Each indicated writing as low priority in the early grades and would not be approached as high priority once inservice. NCTM (2014) posited that journaling promoted mathematics understanding and a sense of involvement with the content as journaling's importance is realized when students begin developing their confidence as problem solvers and in understanding the mathematical processes even in the primary grades.

Discussion

This pre-post study examined mathematics anxiety levels of EC, EE, and EXE preservice teachers. Findings suggest significant pre-post mathematics anxiety differences after participation in a constructivist-based mathematics methods course. Thus, it could be

reasonably concluded the mathematics methods course was a fruitful intervention strategy for reducing mathematics anxiety. Results agreed with Bahr, Shala, and Monroe (2013) and Novak and Tassel (2017) which reported that the mathematics anxiety levels of preservice teachers can be reduced through mathematics methods course participation. Zemelman, Daniels, and Hyde (1998) and Sloan (2010) posited that a variety of best practices employed during a methods course reduce mathematics anxiety. A variety of best practices were implemented throughout the study which preservice teachers perceived as most effective in reducing their mathematics anxiety.

Preservice teachers' negative attitude towards mathematics surfaced early particularly through discourse of personal non-positive experiences with mathematics and how it created a sense of isolation in their feelings towards the subject. Negative attitudes were situated towards ineffective teaching practices and/or lack of instruction, or teacher/parent dislike. From this study, we are reminded that disdain, frustration, and fear towards mathematics is detrimental in how teachers present mathematics (Lake & Kelly, 2014). It serves to reason teachers affect students' mathematics anxiety particularly since research suggests that teacher attitudes and the classroom environment affect such (Beilock & Maloney, 2015; Gresham, 2018).

Preservice teachers concrete experiences with manipulatives created a better understanding of methodology, particularly with how to utilize and implement within lessons for understanding concepts, and with procedural practices to meet all students' needs. It is important that our teaching is organized through sound instruction that supports and enables *all* individuals to learn mathematics while improving mathematical skills and knowledge. Providing effective instruction is exigent particularly for preservice teachers, but knowing why one struggles with mathematics is critical (Sloan, 2010). We want instruction to celebrate both small and great advances and for it to be non-threatening and risk-free with opportunities to empower, especially since mathematics can be challenging (Haciomeroglu, 2014).

The finding of the instructor's enthusiasm and classroom atmosphere was expected and consistent with previous literature. Sloan (2010) and Lake and Kelly (2014) found that the creation of a positive classroom atmosphere is the direct result of the instructor's disposition to help students feel at ease thus contributing toward mathematics anxiety reduction. In addition, teacher discourse and presentations were identified as effective practices in reducing preservice teachers' mathematics anxiety. These findings are not explicitly referenced in the literature. This study openly allowed preservice teachers to freely express their thoughts and reflect on their mathematical experiences and learning which attributed to their success or failures. These factors provided a self-awareness that facilitated positive change.

The usefulness and positivity of journaling was a salient finding. NCTM (2014) reported that writing within the learning environment promotes mathematical thinking, reasoning, and sense making that strengthens mathematical understanding and confidence. Specifically, journaling creates stronger preservice teachers (Gresham, 2009; Hurst & Cooke, 2014). However, ten EC teachers did not completely recognize its importance and struggled with identifying clear and concise expectations for journaling due to time restraints within its implementation. They posited that since primary students were just learning to write, students' mathematics frustrations would be more evident. Education programs must advocate for ones that include the most effective contexts and experiences for mathematics

learning and how mathematics anxiety affects these contexts at all grade levels (NCTM, 2014). Simply having knowledge of these findings is not enough.

Implications, Recommendations, and Limitations

This study has implications for teacher education programs, particularly mathematics methods courses. It has been suggested that to overcome mathematics anxiety initiative in one's learning must take place (Geist, 2010). Research illustrates that teacher preparation programs should offer quality instruction with a variety of methods to develop confident mathematics thinkers (Hurst & Cooke, 2014). We want teachers to move from traditional teaching methods to incorporating a variety of effective strategies to meet students' needs grounded in in-depth understandings, inquiry, and problem-solving that strengthens how mathematics is delivered and learned (Geist, 2010; Gresham, 2008). Findings from this study show lack of mathematics confidence which negatively affected mathematics anxiety. Due to lack of confidence preservice teachers must resist and discard false beliefs and become knowledgeable of mathematics anxiety and factors that contribute to it. Support for preservice teachers is critical to produce such change (Sloan 2010).

Study limitations do exist based on the smaller sample size. However, the argument exists that demonstrates mathematics anxiety complexities as a universal concern across EC, EE, and EXE education programs. Even though a determination is not made that changes in mathematics anxiety will persist or will continue to change, examination of methods courses is recommended as are further longitudinal studies across time. This study supports methods courses that build conceptual mathematical understanding, are student-centered, and cognitively demanding. Modeling constructivist pedagogy and greater depth examination of the topic can help bridge the gap between past negative mathematical experiences and positive future ones and better preparation of future educators.

Conclusion

Researchers and educators are working together to learn why individuals struggle mathematically and determination to identify best instructional practices within curricula is important if we want to eradicate mathematics anxiety altogether. Knowledge is needed in knowing why some strategies are effective while other approaches are not. Understanding gives rise to offering preservice teachers non-threatening, risk-free opportunities to learn and practice mathematics skills as this plays a role in competence and mathematics abilities (Vinson, 2001). Mathematics anxiety increases when educational backgrounds become a barrier to learning and training and therefore, must not be overlooked. Considering this study is important in developing effective methods course that highlight and address preservice teacher mathematical needs and teacher training. Effective programs that offer such will highlight the teachers' voice and will create opportunities for mathematics success. The key now is to extend and improve teacher growth within education preparation programs.

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Note

This study received approval from the Institutional Review Board at the University of Central Florida.

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