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Closing the Gender Gap: Increasing Confidence for Teaching Mathematics

Gavrielle Levine
LIU Post, glevine@liu.edu

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Gavrielle Levine, Ph.D.

LIU Post

glevine@liu.edu

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Abstract

National emphasis on STEM education highlights the need to reduce mathematics anxiety and increase confidence for teaching mathematics among elementary level teachers. Most elementary school teachers are female, and are responsible for introducing foundational mathematics concepts and attitudes to developing minds. Female teachers' higher levels of mathematics anxiety (when compared with male teachers) have detrimental effects on student learning. In this study, pre-service elementary teachers enrolled in mathematics education courses increased their confidence for teaching mathematics and reduced their mathematics anxiety. At the beginning of the course, males were more confident than were females. At the conclusion of the course, while both males and females reported more confidence for teaching mathematics, females' gains were larger and no gender differences were found.

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National emphasis on science, technology, engineering, and mathematics (STEM) education (Kuenzi, 2008) highlights the importance of developing high-quality teachers to provide effective mathematics instruction (Ball & Evans, 2008). Elementary level mathematics, the crucial opportunity to introduce foundational concepts and enduring attitudes, is usually taught by female teachers (Podgursky, Monroe, & Watson, 2004). Despite academic preparation, female teachers who reported mathematics anxiety conveyed this attitude to their students resulting in decrements in student achievement (Beilock et al, 2010) and spent less classroom time teaching mathematics (Wilkins, 2008). One opportunity to intervene in the mathematics anxiety cycle is during the teacher preparation process when adult learners revisit content they have previously learned from the perspective of teaching it. This study examines changes in levels of confidence for teaching mathematics as well as of mathematics anxiety among pre-service elementary school teachers.

Method

Participants

Pre-service teachers enrolled in a one-semester elementary level mathematics education course participated in this study. Most of the pre-service teachers included in this study (graduate students, N = 436, undergraduate students, N = 108) were female (N=483), which was consistent

at both the graduate (93% female) and undergraduate (81% female) levels. These data were collected over several semesters in the entry-level mathematics education courses taught by the same instructor. The essential components of this course did not change across those semesters included in this study.

Description of course

The course preparing students to teach mathematics in elementary school was based on guidelines developed by the National Council of Teachers of Mathematics (NCTM, 2000) and New York State (2005) that emphasized instructional principles to teach mathematics content. Concept development, challenging questions and solution hints coupled with structured, hands-on activities modeled strategies for constructivist mathematics instruction. During the semester students completed three major assignments: textbook analysis, lesson plan, and construction of a material to teach mathematics (See Appendix A for assignment descriptions.). A ten-hour field experience was required. Initial and final activities of the course were completion of the reflective surveys described below.

Reflective Survey

Three Likert-type questions measured pre-service teachers' attitude for mathematics (AFM), confidence for teaching mathematics (CTM), and self-reported knowledge of mathematics (KM). Written responses to the questions were collected during the first and the final class meetings. The questions are included in Appendix B.

Results

All questions were scored on five-point-Likert-type scales with higher scores indicating more positive attitudes than lower scores. T tests comparing mean pre- and post-test scores (See Table 1) found positive gains in Attitude for Mathematics, $t(543) = -20.15$, $p<.00$; Confidence for Teaching Mathematics, $t(542) = -26.16$, $p<.00$; and Knowledge of Mathematics, $t(541) = -20.64$, $p<.00$.

Table 1

Mean Scores

	Pre-test(SD)	Post-test(SD)	N
AFM	3.27(.93)	3.95(.65)	544
CTM	3.00(.85)	3.94(.61)	543
KM	3.03(.62)	3.63(.62)	542

Analyses of variance were conducted using gender, course level (undergraduate vs. graduate), and pre-test scores as predictors of Confidence for Teaching Mathematics at the end of the course. There were no main effects for gender or course level, and no interaction effect. The most significant predictor of final Confidence for Teaching Mathematics scores was initial Confidence for Teaching Mathematics scores, $F(1,539) = 29.61$, $p < .00$. Initial (pre-test) self-

reported Knowledge of Mathematics was also a strong predictor of final confidence, $F(1,539) = 6.44$, $p < .01$. Initial Attitude toward Mathematics was a less strong but still significant predictor of final confidence, $F(1,539) = 3.89$, $p < .05$.

Change scores were constructed by subtracting the pre-test score from the post-test score for each measure. Then changes scores of males and females were compared using T tests. These tests revealed significant gender differences in CTM. A comparison of male and female CTM pre-test scores show that males began the semester higher in Confidence for Teaching Mathematics (M=3.31, SD=.87) than did females (M=2.98, SD=.83), t (603)= 3.09, p= .00. Both males and females showed significant gains in confidence by the end of the semester, with females (M=3.91, SD= .62) demonstrating greater improvement than did males (M=4.06, SD=.53). At the conclusion of the semester, there was no difference between male and female Confidence for Teaching Mathematics $t(560) = 1.83$, $p = .07$(NS). The gender gap in Confidence for Teaching Mathematics which pre-service teachers displayed at the beginning of the semester disappeared by the end of the semester.

Conclusion and Discussion

The purpose of this study was to measure the extent to which elementary school pre-service teacher attitudes changed during a one-semester mathematics education course. Pre-service teachers reported an increase in their knowledge of mathematics, more confidence for teaching mathematics, and a more positive attitude for mathematics.

One valued finding of the study is that for this sample of pre-service elementary teachers both their attitude for mathematics and self-appraisal of their mathematics knowledge increased while they developed strategies to deliver mathematics instruction.

A surprising result was the elimination of gender differences in Confidence for Teaching Mathematics at the conclusion of the semester despite significant gender differences at the beginning of the semester. At the beginning of the semester, female pre-service teachers reported lower Confidence for Teaching Mathematics than did males. Since most elementary teachers are female (Podgursky, Monroe, & Watson, 2004), increasing female Confidence for Teaching Mathematics can contribute to improving the quality of mathematics instruction at the elementary level (Beilock et al, 2010). Meaningful concept development that engages students and provides a model of effective instruction for future teachers may contribute to increasing their confidence for teaching mathematics.

In conclusion, increasing the confidence that elementary teachers have for teaching mathematics contributes to improving mathematics instruction and student learning. Our national and global efforts to improve mathematics knowledge demand that elementary teachers, who introduce students to mathematical learning, are confident in their ability to teach mathematics.

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Appendix A

Course Assignments

Textbook Analysis

The textbook analysis first required pre-service teachers to explain each of the National Council of Teachers of Mathematics (NCTM, 2000) content standards and instructional principles in their own words, then asked them to identify a meaningful example of each standard or principle in an elementary level (grades 1-6) mathematics textbook. Thus, the focus of this assignment was developing mastery of the foundational concepts in mathematics education through applying these best practices in mathematics instruction to current textbooks.

Lesson Plan

For the lesson plan assignment, each pre-service teacher selected an elementary grade and curriculum-appropriate topic and wrote one lesson in the form of a teacher/student dialogue. Specific guidelines were provided so that key components of the lesson (i.e. motivation, assessment) were included. Also, the mathematics content was to be delivered through a hands-on activity supported with a Socratic-style dialogue. Thus, pre-service teachers were encouraged to implement the approach introduced during the university course in their own lesson construction. In addition, the lesson plan was developed in two phases. Initial submission of the plan was reviewed by the professor and returned with comments and suggestions, and (usually) no grade. The final submission of the plan was graded, and comments were provided as

appropriate. Meetings with the professor were encouraged to clarify comments and support completion of the assignment.

Mathematics Material Construction

The construction of a material to teach mathematics is intended to encourage pre-service teachers to imagine their future classroom and how they plan to teach mathematics. They were encouraged to construct a material that they would like to have in their future elementary classroom. Often this was related to their lesson plan, or a modification of a material that they saw during their field experience. Once constructed, pre-service teachers tried out the material with grade-appropriate students, wrote a brief paper describing the project and their try-out session, and presented the project in the university class.

Appendix B

Reflective Survey Questions

1. Circle the best description of your attitude TODAY toward mathematics.

   The five choices were: love, like, tolerate/neutral, dislike, hate.

   This question measured self-reported attitude for mathematics (AFM).

2. Circle the best description of your attitude TODAY toward teaching mathematics.

   The five choices were: very confident, confident, neutral, not confident, very not confident.

   This question measured self-reported confidence for teaching mathematics (CTM).

3. How would you rate your knowledge of mathematics TODAY?

   The five choices were: very above average, above average, average, below average, and very below average.

   This question measured self-reported knowledge of mathematics (KM).