

ATTENUATING TEACHERS' MATH ANXIETY AMELIORATES MATH CONTENT KNOWLEDGE

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ABSTRACT: *This feasibility study investigated the efficacy of the Multidimensional Content-Based Mathematics Professional Development Project in attenuating math anxiety while ameliorating mathematics' content knowledge. Data from 28 racially diverse female mathematics teachers from low-performing middle and high schools were analyzed by conducting a 2 X 2 repeated measures analysis of variance and polynomial regression analyses. Results indicated a 45.46% reduction in anxiety and a 45.61% increase in math content knowledge.*

KEY WORDS: Math Content Knowledge, Anxiety Reduction, Partnerships, Professional Development, Attenuating teachers' math anxiety ameliorates math content knowledge

INTRODUCTION

The consensus of the research literature reports that myriad middle and high school teachers are deficient in their fundamental understanding of mathematics (Ball, Thames, & Phelps, 2008)). This is a troubling finding considering that current research documents that teachers' mathematical knowledge is significantly correlated with student achievement (Hill, Rowan & Ball, 2005). Consequently, this lack of requisite mathematics knowledge reflects the abysmal performance of students on standardized mathematics tests (Hill & Lubienski, 2007). To enhance student performance, it is necessary but not sufficient, to advance teachers' mathematical literacy. One impediment to this learning is math anxiety. Ashcraft & Kirk (2001, p. 224), defines math anxiety as "a feeling of tension, apprehension, or fear that interferes with math performance". Today's teachers had experienced math anxiety as students in their K-12 school settings (Scarpello, 2007). The math anxious student develops into the math anxious teacher perpetuating this anxiety cycle. The math anxious teacher experiences "feelings of tension and anxiety that occurs during teaching mathematical concepts, theories, and formulas or during problem solving" (Tobias, 1993, p17). Not surprisingly, math anxiety attenuates the effectiveness of the teacher's instructional strategies resulting with students' poor performance (Ma, 1999). However, effective mathematics instruction prevents the development of mathematics anxiety (Scarpello, 2007). Some middle and high schools form partnerships with a postsecondary institution. These postsecondary institutions provide professional development programs to advance teachers' content knowledge. The *Multidimensional Content-Based Mathematics Professional Development Project* is a professional development program design to attenuate math anxiety while ameliorating mathematics' content knowledge. The hypotheses for this study were that participants of the program would (a) report significant decreases in their math anxiety and (b) demonstrate significant increases in their mathematics' content knowledge.

Participants

The sample for this feasibility study was 28 racially diverse female mathematics teachers from low-performing middle and high schools. These teachers ranged in age from 19 to 56 with teaching experience ranging from 3 to 17 years.

Procedure

The *Multidimensional Content-Based Mathematics Professional Development Project* involves attending all day sessions for two-weeks in the summer with six all day Saturday sessions scheduled throughout the following fall semester. During these sessions, the teachers first observed the activity from the program mentor then performed the activity to the cohort allowing for meaningful dialogue concerning the strategies and how to effectively implement the lesson in their classrooms. To counteract student math anxiety, examples of how to (a) demonstrate the use of math in everyday life and in careers, (b) provide successful activities, and (c) model math enthusiasm. For content knowledge, activities included (a) cooperative learning groups, (b) concept maps, and (c) inquiry-based hands-on activities. These constructivist lessons met the standards described in *Principles and Standards for School Mathematics* (NCTM, 2000) as well as documented by evidence-based practice to promote in-depth learning (Marzano, Pickering & Pollock, 2001).

Instrumentation

To assess the participants' math anxiety, a modified version of the Beck Anxiety Inventory (BAI) (Beck, 1993) was administered. The BAI contains ten question rated on a four-point Likert-type (0 to 3) scale with higher scores indicating greater levels of math anxiety. Math knowledge was evaluated with a 20 item examination developed by the first author with each correct item worth one-point. Results of the math knowledge examination were reported in percent correct. These items were constructed to meet the *Principles and Standards for School Mathematics* (NCTM, 2000). Assessments from both instruments were recorded at baseline and at post intervention.

Statistical Analyses

IBM SPSS v20 was employed for the statistical analyses, which were, (a) 2(time: pre/post) X 2(assessment: math and anxiety) within-subjects analysis of variance, paired t-test, and polynomial regression analysis. To achieve adequate power, alpha was set at < 0.10 .

RESULTS

As hypothesized, the results of the two-way within-subjects analysis of variance indicated a statistically significant interaction effect, Wilks' Lambda = .38, $F(1, 27) = 44.13$, $p < .001$, $\eta^2 = .62$. Follow-up test reported a significant decrease in anxiety, Wilks' Lambda = .39, $F(1, 27) = 40.80$, $p < .001$, $\eta^2 = .60$ with baseline ($M = 16.28$, $SD = 4.61$) and post-intervention ($M = 8.89$, $SD = 5.44$). Math content knowledge significantly increase, Wilks' Lambda = .30, $F(1, 27) = 61.56$, $p < .001$, $\eta^2 = .69$ with baseline ($M = 57.86\%$, $SD = .17$) and post-intervention ($M = 86.89\%$, $SD = .14$). In other words, while there was a 45.46% reduction in anxiety, there was a 45.61% increase in math content knowledge. Polynomial regression analyses were conducted to determine the relationships between pre and post scores for

anxiety and math content knowledge with results detecting quadratic relationship for both. In other words, greater improvements occurred for those with lower pre scores, while smaller improvement occurred for those with higher pre-scores.

DISCUSSION

The significant amelioration of math content knowledge with the attenuation of math anxiety documents the efficacy of the *Multidimensional Content-Based Mathematics Professional Development Project*. Not only did the results of the post-tests indicate overall improvement by the participants, but the participants who scored the lower on the pre-test actually “caught up” with their peers who scored higher on the pre-test. Thus, at the completion of the intervention, the majority of the participants were at approximately the same level for both anxiety and math content knowledge. The results of this study add to existing findings in which reduction of anxiety enhances learning education (Ma, 1999). Moreover, this professional development program can be considered “effective” in that it was characterized by a focus on content, a strong connection to practice, active learners and its duration went beyond the summer experience by providing classroom support to the participants during the following school year (Heck, Banilower, Weiss & Rosenberg, 2008)

CONCLUSION

The results of this research supported the feasibility of the *Multidimensional Content-Based Mathematics Professional Development Project*. These findings provide convincing evidence that the program attenuates math anxiety as well as ameliorates mathematics content knowledge for middle and high school math teachers. Although further research is recommended to provide convergent validity, these initial findings justify implementing this professional development program as part of an evidence-based practice for math teachers, which would ultimately improve students’ mathematics performance.

REFERENCES

- Ashcraft, Mark H.; Kirk, Elizabeth P., "The Relationships Among Working Memory, Math Anxiety, and Performance", *Journal of Experimental Psychology: General* 2001 pp. 224-237
- Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, 59(5), 389-404.
- Beck AT, Steer RA (1993). *Beck Anxiety Inventory Manual*. San Antonio: Harcourt Brace and Company.
- Heck, D. J, Banilower, E. R., Weiss, I. R., & Rosenberg, S. L. (2008). Studying the effects of professional development: The case of the NSF’s local systemic change through teacher enhancement initiative. *Journal for Research in Mathematics Education*, 39(2), 113-152.
- Hill, H.C. & Lubienski, S.T. (2007). Teachers’ mathematics knowledge for teaching and school context. *Educational Policy*, 21(5), 747-768.

- Hill, H.C., Rowan, B., & Ball, D.L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Education Research Journal*, 42(2), 371-406.
- Ma, X. (1999) A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *Journal for Research in Mathematics Education*, 30(5), 520-540.
- Marzano, R., Pickering, D., & Pollock, J. (2001). *Classroom instruction that works: Research-based strategies for increasing student achievement*. Alexandria, VA.: ASCD.
- National Council of Teachers of Mathematics (NCTM). (2000). *Principles and standards for school mathematics*. Reston, VA: Author.
- Scarpello, G. (2007, September). *Helping Students Get Past Math Anxiety*. *Techniques*, 82(6), 34-35.
- Tobias, S. (1993). *Overcoming Math Anxiety*. New York: W. W. Norton & Company.