

MATH ANXIETY AND THE “MATH GAP”: HOW ATTITUDES TOWARD MATHEMATICS DISADVANTAGES STUDENTS AS EARLY AS PRESCHOOL

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This study was conducted to examine the attitudes of Head Start teachers toward mathematics and how it may influence how and what they teach in the classroom. In general, the findings of this study can be summarized as this:

- 1) Math anxiety affects how teachers assess their ability at mathematics. The more math anxiety they report, the lower they rate their ability at mathematics.
- 2) The more mathematics a teacher feels that they know the more confident they are in their ability at mathematics and the better they like mathematics.
- 3) The more confident they are in their mathematic ability, the more important they feel mathematics is in the preschool classroom.
- 4) If a teacher is confident that they know enough mathematics to teach preschoolers, they plan to teach mathematics in their classroom more.
- 5) The more confident a teacher is in their ability at mathematics and that they know enough mathematics content, the more likely they are to use developmentally appropriate methods of teaching mathematics in the classroom.

The findings from this present study suggest two future actions to enhance the mathematics outcomes for Head Start children and their future ability and enjoyment of mathematics. First, in-service trainings for Head Start teachers need to add a focus on the teachers' confidence in mathematics. A second suggest is that teachers be encouraged and trained on reflective techniques so that they can reflect upon their own feelings toward mathematics and its effects that it has on their curricular decisions.

Introduction

Achievement in the STEM (Science, Technology, Engineering and Mathematics) disciplines is receiving a great deal of attention in research, politics and education recently (Latnerell, 2005; NAEYC, 2004; National Council for Teachers of Mathematics, 2006; Sarama & Clements, 2004). There is a general consensus on the importance of the STEM disciplines to a person's future employment possibilities, higher education potential and for improving our national economy. According to the National Research Councils report *Adding It Up* (Kilpatrick, Swafford, & Findell, 2001):

... Today's students ... will face new demands for mathematical proficiency that school mathematics should attempt to anticipate. Moreover, mathematics is a realm no longer restricted to a select few. All young Americans must learn to think mathematically, and they must think mathematically to learn (p.1).

Other emerging research is demonstrating that early experiences and education both at home and at school greatly impact on later achievement (Duncan, Ludwig, & Magnusson, 2007; Hoekstra, Brekelmans, Beijaard, & Korthagen, 2009). The experiences of children even before they enter Kindergarten can effect their achievement in mathematics (Roberts, Vukovic, & Society for Research on, Educational Effectiveness, 2011).

Head Start programs were designed to give children from lower socioeconomic status families a more stimulating early childhood environment, which they were likely not receiving in the home environment (Ludwig & Phillips, 2007). The general aim was provide stimulating preschool experiences to allow for children from ages 3-5 to enter Kindergarten on a more equal footing to their more economically advantaged peers (Ludwig & Phillips, 2007). However, with regards to mathematics achievement, attitudes towards

mathematics can have a huge impact on their ability to offer stimulating environments that can help children to succeed in mathematics (Sloan, 2010).

In this current study, 31 head start teachers were surveyed about their attitudes toward mathematics and their classroom practices to see how their attitude toward mathematics effected their decisions to teach mathematics to their students.

Beginnings of Math Anxiety

Math anxiety begins early and it caused by a number of intertwining influences (Lyons & Beilock, 2012a; Mattarella-Micke, Mateo, Kozak, Foster, & Beilock, 2011). Wu, Barth, Amin, Malcarne, & Menon (2012) demonstrated that math anxiety in primary grade children was not only present as early as 2nd grade, but that it had a marked detrimental effect on the subjects achievement in mathematics. Additionally, the study showed that math anxiety has a more pronounced effect on tasks that require complex verbal reasoning and problem solving rather than numerical operations that require basic fact retrieval. Krinzinger, Kaufmann, & Willmes (2009) also found a close relationship between math anxiety and math ability in 1st through 3rd graders and postulated that this is the time when Math anxiety seems to first occur.

Maloney & Beilock(2012) put the problem very clearly when they stated:

Not only is math anxiety present at the beginning of formal schooling, which is much younger than was previously assumed, but its development is also probably tied to both social factors (e.g. a teacher's anxiety about her own math ability) and a student's own basic numerical and spatial competencies – where deficiencies may predispose students to pick up on negative environmental cues about math.

If these Head Start teachers are, as the parents seem to be, math anxious and less comfortable with mathematics, this could effect their students' achievement. It can also affect teachers' classroom planning and amount of mathematics content that they include in their curriculum (Maloney & Beilock 2012). Parents and teachers may have developed mathematics anxiety because of previous failure in mathematics and negative experiences (Uusimaki & Nason, 2004). Parents and teachers can pass on their feelings about mathematics to their children and students. Higher level of math anxiety and lower levels of mathematical ability will result in less mathematics in the classroom (Sloan, 2010).

If math anxiety can be identified as early as 1st grade, this suggests that experiences before formal schooling can have an effect on the development of math anxiety. With children who come from less advantaged homes, such as those students who are eligible for Head Start, this relationship can take on an additional dimension.

The Influence of Teachers' Math Anxiety

Lyons & Beilock (2012b) found that math anxiety is a very real phenomenon with wide ranging consequences. They found that math anxious people had the same reaction to the anticipation to doing mathematics as they did to the anticipation of a concrete, visceral sensation such as pain. Interestingly, this relation was not seen while actually doing math problems, but rather just in the anticipation of doing mathematics suggesting that it is not the math itself that hurts but rather, the anticipation of the math that caused the reaction. Since we tend to avoid pain, it is likely that math anxious individuals will work very hard to avoid mathematics.

Peker & Ertekin, (2011) found that there was a link between math anxiety and anxiety about teaching mathematics. Teachers who were afraid of doing mathematics were

more likely to be afraid of teaching mathematics. This could lead to an avoidance of math in the planning process, especially at the younger ages.

It can also lead to behaviors in the teacher that can be detrimental to the mathematics achievement in students. Jackson & Leffingwell (1999) investigated the types of instructor behavior that created or exacerbated mathematics anxiety in students. It also tried to find the grade level at which mathematics anxiety first occurred in these students. The most significant finding was that teacher behavior was a prime determinant of math anxiety and that it is usually evident early in the primary grades.

Teachers who do not feel comfortable with mathematics or who have math anxiety may be less likely to incorporate math into their daily plans. According to Sloan (2010), teachers who report a dislike of mathematics spend 50 percent less time teaching the and teachers with negative attitudes toward mathematics frequently rely more on teaching skills and facts while neglecting cognitive thought processes and mathematical reasoning which in-turn fosters feelings of anxiety in students. In the discussion of the research study, Sloan (2010) writes:

The analysis of data revealed a number of antecedents of math anxiety, including parental influences, negative school experiences, methodology, low math achievement, test anxiety, lack of confidence, negative attitudes, mathematics avoidance, and mathematics background. Thus, as a preventative measure, another implication is that in-service, as well as pre-service, teachers should receive training regarding the causes of math anxiety.

Math anxiety also seems to be especially prevalent among early childhood teachers. Research suggests that many pre-service

teachers of young children report higher levels of math anxiety than those in other college majors. This leads to their poor academic performance in mathematics as well as to their effectiveness in teaching mathematics in their early childhood classrooms (Bush, 1989; Mahigir & Karimi, 2012; Maloney & Beilock, 2012; Peker & Ertekin, 2011; Roberts, Vukovic, & Society for Research on, Educational Effectiveness, 2011).

So why do so many teachers develop math anxiety and why does it seem to be so prevalent in early childhood teachers? Part of the answer has to do with socioeconomic backgrounds. As has been indicated earlier, parental influences tend to have a large impact on achievement in mathematics and the development of math anxiety (Arnold, Fisher, Doctoroff, & Dobbs, 2002; Barbarin et al., 2006). Parents and teachers from lower socio-economic statuses tend to have more negative attitudes toward mathematics or lower educational attainment (Mahigir & Karimi, 2012).

Many Head Start teachers tend to have lower educational attainment and they tend to be from lower socioeconomic backgrounds (Kim, Chang, & Kim, 2011; Ludwig & Phillips, 2007). This makes it much more likely that they will be more susceptible to math anxiety and be less apt to provide a stimulating mathematical environment for their young students.

The other part of the answer has to do with gender. Over 90% of early childhood and elementary teachers are female and for a number of reasons, math anxiety is more prevalent among females (Beilock, Gunderson, Ramirez, & Levine, 2010). In many classrooms, the classroom climate, learning style, instructional style, and experiences offered to students tend to favor the way that boys learn mathematics (Geist & King, 2008).

Devine, Fawcett, Szucs, & Dowker (2012) found that middle school and high school girls

showed higher levels of math anxiety than. As well as potentially having a detrimental effect on mathematics performance, the research study reported that high levels of math anxiety could have negative consequences for later mathematics education. The study also suggested evidence that math anxiety develops during the primary school years as was reported in studies previously cited in this review (Krinzinger, Kaufmann, & Willmes, 2009; Wu, Barth, Amin, Malcarne, & Menon, 2012). Furthermore, their study showed no gender difference in mathematics performance, despite girls reporting higher levels of math anxiety suggesting that girls may have had the potential to perform better than boys in mathematics however their performance may have been attenuated by their higher levels of math anxiety.

Beilock, Gunderson Ramirez & Levine (2010) studied female elementary school teachers to see what the effect of their level of math anxiety would be on their students, especially the female students. They suggest that math-anxious female elementary school teachers negatively effected the math achievement of their female students. At the beginning of the school year, there was no relation between a teacher's math anxiety and her students' math achievement but by the school year's end, the more anxious teachers were about math, the more likely girls (but not boys) were to endorse the commonly held stereotype that “boys are good at math, and girls are good at reading” and the lower these girls' math achievement. Also, girls who endorsed this stereotype had significantly worse math achievement than girls who did not and than boys overall. In early elementary school, where the teachers are almost all female, teachers' math anxiety carries consequences for girls' math achievement by influencing girls' beliefs about who is good at math.

These studies in this review indicate that students from low SES backgrounds are more

at risk for lower achievement in mathematics, math anxiety starts early in life for a child, and that their attitudes toward mathematics can be influenced by the adults around them. The current study focuses on female Head Start teachers who teach children from low socioeconomic backgrounds. Survey questions asked them to rate their personal attitude about mathematics and other aspects of teaching mathematics to young children in order to examine how their comfort level with mathematics effects their beliefs and practices in planning mathematics for young children.

Research Questions

This study was conducted to examine the attitudes of Head Start teachers toward mathematics and how it may influence how and what they teach in the classroom. The following foreshadowed questions were proposed:

1. Does a teacher's attitude toward mathematics effect decisions about curricular planning with regards to mathematics in the Head Start preschool classroom?
2. Does a teacher's attitude toward mathematics change the way that teachers approach mathematics in the Head Start preschool classroom?
3. Does the teacher's assessment of their own level of proficiency with mathematics effect decisions about curricular planning with regards to mathematics in the Head Start preschool classroom?
4. Do the teachers' assessment of their own level of proficiency with mathematics change the way that teachers approach mathematics in the classroom?

Materials and Methods

31 Head Start teachers from a rural Appalachian region of the United States were surveyed. The sample was 100% female, 100 % Caucasian and ages ranged from 25 to 57. The teachers were administered an open ended survey at the beginning of an in-service training meeting about their comfort level with mathematics and about how they teach math in their classroom. The questionnaire consisted of 9 questions. The questions asked were:

1. How do you feel when doing a math problem?
2. What do you like about math? What do you dislike?
3. What do you need to know about math to teach young children?
4. Do you like mathematics? Why or why not?
5. Why do you think math is important to learn in preschool
6. Tell me how you think about math when planning activities for children
7. Tell me how you would teach math to a preschool child?
8. What is important to remember when teaching math to young children?
9. Is it important for preschool children to learn math skills? Why?

Questions 1-4 were designed to gauge the teachers' attitudes toward mathematics, questions 5 and 6 were designed to gauge the teachers' beliefs about the importance of teaching mathematics in the preschool classroom and questions 7-9 were designed to investigate teachers' beliefs about how mathematics is taught in the classroom. The results of the surveys were then coded and analyzed using a grounded theory approach to qualitative research (Glaser & Strauss, 1967).

Results and Discussion

The findings of this study seem to support findings from other studies that indicate that math anxiety and negative attitudes toward mathematics in teachers are related to each other and also have an effect on the children they teach. In particular, the findings of this study suggest that these feelings effect their curricular planning choices as well as their ability to teach mathematics to young children. Similar to the findings of Peker & Ertekin, (2011), the this study's findings suggest that math anxiety and a negative self assessments of mathematical ability effects the choices a teacher makes about teaching mathematics in the classroom. It also supports the findings of Beilock, Gunderson Ramirez & Levine (2010) that math anxiety is not only an impediment to math achievement for the individual suffering from math anxiety, but to the children that they teach and Jackson & Leffingwell's (1999) finding that instructor behaviors in the classroom could exacerbated mathematics anxiety in students or effect the students mathematics achievement outcomes.

However more significantly, this study suggests that it is not just math anxiety that impacts the students of affected teachers, but also a teacher's self-assessment of their ability at mathematics and their confidence in how much math they know. These factors don't just effect children's level of anxiety toward mathematics as was shown in Beilock, Gunderson Ramirez & Levine (2010) and Jackson & Leffingwell (1999), but it effects the decisions teachers make about how they teach math in the preschool classroom and how often. In general, the findings of this study can be summarized as this:

1. Math anxiety affects how teachers assess their ability at mathematics. The more math anxiety they report, the lower they rate their ability at mathematics.

2. The more mathematics a teacher feels that they know the more confident they are in their ability at mathematics and the better they like mathematics.
3. The more confident they are in their mathematic ability, the more important they feel mathematics is in the preschool classroom.
4. If a teacher is confident that they know enough mathematics to teach preschoolers, they plan to teach mathematics in their classroom more.
5. The more confident a teacher is in their ability at mathematics and that they know enough mathematics content, the more likely they are to use developmentally appropriate methods of teaching mathematics in the classroom.

In these findings, one theme that repeats is confidence. These findings did not address examine how much mathematics education a teacher had in their education or their achievement in those classes. A suggestion for further research may examine a teachers' mathematics education background to see if that has an effect on their choices regarding teaching mathematics to preschool children. Tooke & Lindstrom (1998), Harper & Daane (1998), Godbey (1997) all found that most pre-service teachers come to their college mathematics methods classes with high levels of math anxiety. Methods classes seemed to mitigate these anxieties at least short term, but our goal as teachers should be to find ways not to pass on our math anxiety to our students in the first place. This study does suggest that a feeling of confidence in mathematics can make a difference in their curricular choices when teaching Head Start students.

Conclusions

The findings from this present study suggest two future actions to enhance the mathematics outcomes for Head Start children and their future ability and enjoyment of mathematics. First, in-service trainings for Head Start teachers need to add a focus on the teachers' confidence in mathematics. Most in-service trainings tend to focus on curricular methodologies and classroom practice. These foci are also vitally important to develop a teacher's knowledge base about appropriate methods of teaching mathematics to young children. However, the findings reported here suggest that activities that are specifically designed to make a teacher more comfortable with their ability at mathematics and also to increase their confidence in their mathematics ability will also have a beneficial impact. Head Start teachers, who do not feel confident in their ability or feel that they do not know enough mathematics to teach it to preschoolers, also tend not to plan for mathematics in their classroom. Additionally, when they do, they see math as a "skill" to be taught.

A combination of increasing mathematical confidence through subject matter training and training on developmentally appropriate mathematics practices, Head Start teachers may lead to better outcomes for children than simply curricular training alone. An avenue for future research on this topic is a MANOVA study of the interaction of the two independent variables (curricular training and content knowledge training) on the dependent variable of students' mathematics achievement in kindergarten.

A second suggestion is that teachers be encouraged and trained on reflective techniques so that they can reflect upon their own feelings toward mathematics and its effects that it has on their curricular decisions. A reflective process can help teachers to recognize their strengths and weaknesses and how it affects the children in their classrooms.

Many early childhood teachers feel uncomfortable teaching mathematics because they did not and do not like mathematics. Many also feel that they are not good at mathematics and therefore feel uncomfortable teaching it to their students. Math anxiety is a well-researched topic (Altermatt & Kim, 2004; Burns, 1998; Levine, Suriyakham, Rowe, Huttenlocher, & Gunderson, 2010; Stuart, 2000) and current practices tend to perpetuate the problem. Many teachers who have math anxiety themselves inadvertently pass it on to their students. Through a reflective process and targeted in-service training, these obstacles can be overcome to improve long-term mathematics outcomes for children.

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