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The Impacts of Preschool Teachers' Mathematics Anxiety and Beliefs on Children's Mathematics Achievement

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ABSTRACT: *This study was conducted to investigate the impacts of preschool teachers' mathematics anxiety and beliefs on children's mathematics achievement. Sample consisted of 400 preschool children. As data collection tools "Beliefs Survey", "Math Anxiety Scale", "Number and Operation Task" and "Geometric Shapes Sorting Task" were used. Results showed that teachers' mathematics anxiety did not lead to significant difference on children's mathematics achievement while their beliefs towards mathematics education made a significant difference on children's mathematics achievement.*

KEYWORDS: *Mathematics anxiety, beliefs towards mathematics education in preschool, teacher, children, mathematics achievement*

I. INTRODUCTION

The awareness of the importance of mathematics education for young children has been increasing in parallel with the increasing awareness of the importance of mathematics for our society and for children's development (Saracho & Spodek, 2008). Mathematics education is an important component of the curriculum for students worldwide. The foundation for understanding mathematical concepts related to number sense begins at early ages, and the basis of mathematical skills that will be needed later in life can be presented in early childhood settings. Mathematics surrounds around us and the children take part in the mathematical surroundings from the childhood with mathematical concepts and ideas (Stafford, 2010). Effective mathematics education for young children (approximately ages 3 to 5) establishes a ground for later achievement (Ginsburg, Lee & Stevenson, 2008). Clements (2001) suggested four reasons for teaching mathematics to preschool children. First of all, the situation that the content of preschool mathematics is restricted should be improved. Second, children who come from low-income and minority families have difficulty in mathematics at later schooling. The equity should be provided between these and other children. Third, the improvement of preschoolers' informal mathematical knowledge and abilities should be taken into consideration. Finally, preschoolers' brains grow significantly through age and experiences.

In preschool years, the role of teachers' attitudes towards mathematics in children's having a positive attitude towards mathematics and not feeling mathematical anxiety is incontrovertible (Beswick, Watson & Brown, 2006). Attitudes toward mathematics are significant due to the reciprocal relationship between attitudes toward mathematics and achievement in mathematics (Evans, 2007). Negative teacher attitudes toward mathematics often cause to avoidance of teaching strong mathematical content and influence students' attitudes and behaviors (Evans, 2011). Aiken (1970) can be acknowledged as guide while examining the relationship between mathematical achievement and attitudes toward mathematics. Aiken (1970) presented that attitudes and achievement in mathematics are reciprocal (cited in Evans, 2010). The multi-dimensional construct of the attitude to mathematics includes confidence or anxiety, liking or disliking mathematics, a tendency to engage in or to avoid mathematics, beliefs about whether one is good or bad at mathematics, and beliefs that mathematics is important or not, useful or useless, easy or difficult (Beswick, Watson & Brown, 2006).

Studies have indicated that mathematics anxiety has implications for teacher practice in mathematics (Bush, 1981; Hembree, 1990; Swetman, Munday & Windham, 1993). Richardson and Suinn (1972) have defined mathematics anxiety as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems". Mathematics anxiety is also defined as a state of discomfort that occurs in encountering with math-related situations (Zettle & Raines, 2002). It is an irrational hesitation from mathematics often causes to the avoidance of the subject (Bursal & Paznokas, 2006). Cemen (1987) presented mathematics anxiety as the response to the situations involving mathematical tasks perceived as a threat to self-esteem.Trujillo and Hadfield (1999, cited in Peker, 2009) investigated the underlying causes of mathematics anxiety into three categories: personality factors, environmental factors and intellectual factors. The personality

factors such as shyness, low self-esteem, and for female, viewing mathematics as a male domain can inhibit to ask questions. Negative experiences in the classroom and using memorization in taught of formulas are put into the categories of environmental factors. Intellectual factors include lack of confidence in mathematical activities and being taught with mismatched learning styles. Studies showed that teachers having high mathematics anxiety tend to use more traditional methods. To illustrate, they use lecture and concrete on teaching basic skills rather than concepts in mathematics. These teachers spend more time with seatwork and whole class instruction while they allocate less time to playing games, problem-solving, small group instruction, individualized instruction (Gresham, 2007; Swars, Daane and Giesen, 2010). Additionally, Schmidt and Buchmann (1983) found that math-anxious teachers spend 50 percent less time with mathematics activities than teachers who enjoy mathematics. Furthermore, previous studies have reported that teachers with mathematics anxiety may induce the early anxiety in their students and their mathematics anxiety has negative impact on math success of students (Martinez, 1987; Hembree, 1990).

According to Sovchik (1996), math anxiety passes from teachers to students. The instruction of mathematics has influence on the students' attitude towards mathematics (Jackson & Leffingwell, 1999). In previous research, it was reported that although there is no relation between female elementary teachers' math-anxiety and the female students' math achievement at the beginning of the school year, the level of teachers' anxiety are negatively related to female students' achievement in math at the end of the year (Beilock, Gunderson, Ramirez & Levine, 2010). Moreover, as a result of Hadley and Dorward (2011)'s study conducted with elementary teachers and students, it was found that teachers' anxiety about mathematics is positively related to their anxiety about teaching mathematics. In addition, there was a positive relationship between students' mathematics achievement and teachers' low anxiety about teaching math although it cannot be found a relation between students' achievement and teachers' anxiety about mathematics. Another factor related to teacher practice in mathematics is their beliefs toward mathematics. Kagan (1992) defined teachers' beliefs as "implicit assumptions about students, learning, classrooms, and the subject matter to be taught". Raymond (1997) identified mathematics beliefs as personal judgments about the nature of mathematics, learning mathematics and teaching mathematics inferred from the experiences. Beliefs towards the nature of mathematics can be investigated into three main philosophical conceptions of mathematics as instrumentalist, Platonist and problem solving. Instrumentalist view proposed that mathematics consist of particular operation, rules and skills. Platonist view suggested that 'mathematics is a static but unified body of certain rules'. And in the problem solving view, mathematics is a dynamic and cultural production that always improves with invention (Ernest, 1991).

The activities that teachers do in the classroom are products of their beliefs (Cooney & Lin, 2001; cited in Zakaria & Maat, 2012). There is a debate about the consistencies between teachers' beliefs and their practices. Although some studies identify that beliefs and classroom actions are consistent (Peterson, Fennema, Carpenter & Loef, 1989; Kupari, 2003), other researchers supported the inconsistencies between these variables (Brown, 1986; Beswick, 2005). This is a complex issue including the ideas that teachers' beliefs influence their practice or that teachers' practice influences their beliefs (McGalliard, 1983). Raymond (1993) suggested that teachers' mathematical beliefs are influenced by previous school experiences, teachers' current practice and teacher education courses. Teachers' mathematical beliefs affect students' learning (Kagan, 1992) and in turn students' perceptions of subjects (Carter & Norwood, 1997; cited in Yesil-Dagli, Lake & Jones, 2010). In a previous research which conducted with 21 fourth- through sixth-grade teachers, Stipek, Givvin, Salmon and MacGyvers (2001) investigated teachers' beliefs and practices related to mathematics assessed. Researchers found that teachers who have more traditional beliefs towards mathematics pay more attention to traditional practices such as performance and getting correct answers. Peterson et al. (1989) found that there was a significant positive relation among teachers' beliefs, teachers' knowledge, and students' problem-solving achievement. In line with these findings, current study conducted with the aim of investigating the effects of early childhood teachers' mathematics anxiety and beliefs on children's mathematics achievement.

II. METHOD

2.1. Sample

The sample of this study consisted of 400 six-year-old children. The children in the sample were grouped under four categories as those whose teachers, a)- had higher math anxiety (N=100), b)- had lower math anxiety (N=100), c)- had higher belief in math (N=100), and d)- had lower belief in math (N=100). All the children came from middle income families. While determining the sample, first of all, 70 of 6-year-old-children teachers were chosen randomly among those (N=156) working at public preschools in central Adana,

Turkey. The researchers applied Math Anxiety Scale Revised and Beliefs Survey to the teachers. Of the each test, teachers who received the top 5 and the last 5 scores were determined (20 teachers in total). Then, 20 children from each of those 20 teachers' classrooms were chosen through ratio random sampling method.

2.2. Data Collection Tools

As data collection tools Math Anxiety Scale-Revised (Bai, 2010), Beliefs Survey (Platas, 2008), Number and Operation Task (Aktaş Arnas, Deretarla Gül & Sığırtmaç, 2003) and Geometric Shapes Sorting Task (Aslan & Aktaş Arnas, 2007) were used. Math Anxiety Scale is a likert type assessment tool and consists of 14 items about mathematics anxiety. It includes positive and negative affect as two dimensions of math anxiety. Belifs Servey is also a likert type assessment tool and consists of 40 items about teachers' beliefs concerning teaching mathematics for young children. Items in the Beliefs Survey were grouped into four domains: Age-appropriateness of mathematical instruction in the early childhood classroom, locus of generation of mathematical knowledge, social and emotional versus mathematical development as primary goals of preschool education and teacher comfort in mathematical instruction. The Number and Operation Task includes 88 questions that test children's abilities related to numbers and operators, including counting, writing numbers, recognizing numbers, matching, conservation of number, working with ordinal numbers and subtracting. Children receive 1 point for each question they answer correctly. The maximum possible score on this test is 88. The Geometric Shapes Sorting Task consists of 4 subtasks: Triangle Sorting, Rectangle Sorting, Square Sorting and Circle Sorting. The test includes a total of 48 items. Each subtask consists of 12 items, including one typical example, non-typical examples and palpable and impalpable distracters. For instance, an equilateral triangle is a typical example on the Triangle Sorting Task. Non-typical examples are triangles that differ in size, orientation, skewness and aspect ratio. Examples of palpable distracters are squares and circles, and impalpable distracters are figures that are similar to triangles but have incompatible side and corner characteristics. Children receive 1 point for each item they sort correctly. The maximum possible score on this test is 48. KR-20 Alpha and Cronbach's Alpha values were calculated to test the reliability of the measuring tools. KR-20 Alpha value was .98 for Number and Operation Task and .94 for Geometric Shapes Sorting Task. Cronbach's Alpha value was .90 for Math Anxiety Scale and .94 for Beliefs Survey.

2.3. Data Collection

Before collecting the data, the required permissions were obtained from the administrators of the preschools in the study and from the parents of the children selected from these schools. The data were collected through interviews with the children conducted by the researchers in silent rooms in the schools. The Number and Operation Task was conducted with the children first. The next day, the Geometric Shapes Sorting Task was conducted.

2.4. Data analysis

Total scores that the teachers got from "Beliefs Survey" and "Math Anxiety Scale" were calculated. The independent sample t-test was used to analyze data which was obtained by children from Number and Operation Task and Geometric Shapes Sorting Task.

III. FINDINGS

Table 1. Children's Means Scores according to their Teachers' Mathematics Anxiety

	Groups			
Task	High Anxiety (n=200)	Low Anxiety (n=200)	t	df
Number and operation	47.46 (24.85)	45.53 (25.03)	.54	198
Geometric shapes	32.29 (6.79)	33.83 (7.11)	1.56	198

Note: * = $p < .05$, ** = $p < .001$. Standard Deviations appear in parentheses below means.

An independent-samples *t*-test was conducted to compare the scores on the Number and Operation task and Geometric Shapes Sorting Task between the children whose teachers had high math anxiety and low math anxiety. It was found that no meaningful difference existed between groups in Number and Operation task ($t(198)=.54$, $p>.05$) and Geometric Shapes Task ($t(198)=1.56$, $p>.05$).

Table 2. Children's Means Scores according to their Teachers' Beliefs about Mathematics

	Groups			
Task	High Anxiety (n=200)	Low Anxiety (n=200)	t	df
Number and operation	58.85	34.13	8.07**	198
	(22.55)	(20.69)		
Geometric shapes	38.93	30.38	10.64**	198
	(4.97)	(6.31)		

Note: * = $p < .05$, ** = $p < .001$. Standard Deviations appear in parentheses below means.

Table 2 shows the t-test results for the scores that the children obtained on the Number and Operation Task and Geometric Shapes Sorting Task according to their teachers' beliefs about preschool mathematics. There was a significant differences between children's scores in Number and Operation Task ($t(198)=8.07$, $p<.01$). The effect size for this analysis was high ($d=.24$). These results indicate that children whose teachers' had high beliefs about mathematics for young children had higher score ($M=58.85$, $SD=22.25$) than children whose teachers had low beliefs ($M=34.13$, $SD=20.69$) in Number and Operation task. There was also significant differences between children's scores in Geometric Shapes Sorting Task ($t(198)=10.64$, $p<.01$). The effect size for this analysis was very high ($d=.36$). Children whose teachers' had high beliefs got higher score ($M=38.93$, $SD=4.97$) than children whose teachers' had low beliefs ($M=30.38$, $SD=6.31$).

IV. DISCUSSION

The present study was conducted to investigate the impacts of preschool teachers' mathematics anxiety and beliefs on children's mathematics achievement. Teachers' mathematics anxiety didn't have any significant impact on children's number, operation and geometric shapes achievement. That teachers' anxiety did not have any significant difference on children's mathematics achievement may result from the characteristic of early childhood mathematics. It includes basic and simple subjects of mathematics such as numbers, basic geometric shapes, classification, one to one correspondence, ordering, comparison, measurement and operation (Aktaş Arnas, 2012). The level of teachers' mathematics anxiety may not make a difference on mathematics education to preschool children due to this characteristic of early childhood mathematics. The findings of the current study do not support the previous research (Beilock et al., 2010) which suggests that mathematics anxiety has an effect on students' mathematics achievement. As noted above, the main reason of this can be the age of the implementation group and the structure of mathematics instructed at this age group. However, teachers' beliefs about mathematics for young children had a significant effect on children's both number and operation and geometric shapes achievement. This situation demonstrates that teachers' attitudes toward mathematics education in early childhood are parallel with mathematics practice. These results are consistent with previous studies (Ashton & Webb, 1986; Peterson et al., 1989; Kaplan, 1991; Stipek et al., 2001). Peterson et al. (1989), for instance, found that there was a significant positive relation between teachers' beliefs and students' problem-solving achievement.

V. CONCLUSION

The results of this study reveal that the teachers' mathematics anxiety does not lead to any significant differences on children's mathematics achievement while their beliefs about mathematics education make a significant difference on children's mathematics achievement. Additionally, these results show that children whose teachers have high beliefs scores have better performance. It should be beneficial to improve teachers' beliefs about mathematics education in early childhood. Besides, the current research conducted with preschool children. A further study with more focus on the effects of teachers' attitudes and anxiety on older children's mathematics achievement is therefore suggested.

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