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The Relationship between Mathematics Teaching Anxiety and Mathematics Anxiety

Abstract

The aim of this study is to examine the relationship between pre-service teachers' anxiety levels in relation to teaching of mathematics and their mathematics anxiety levels, as well as to determine gender differences in these two anxieties. A total of 316 pre-service teachers were involved in this study. Of the total, 100 were pre-service primary school teachers, 115 were pre-service elementary mathematics teachers, and 101 were pre-service secondary mathematics teachers. A 23-item Mathematics Teaching Anxiety Scale and a 45-item Mathematics Anxiety Scale were used in data collection. Data analysis involved Pearson Product Moments Correlation Coefficient analysis in order to investigate the relationship between mathematics teaching anxiety and mathematics anxiety and an independent samples t-test in order to examine gender differences in mathematics teaching anxiety and mathematics anxiety. The results indicated a positive, moderate relationship between pre-service teachers' mathematics teaching anxiety and mathematics anxiety. No significant gender differences were found in pre-service teachers' mathematics teaching anxiety and mathematics anxiety.

Key words: *mathematics anxiety, teaching anxiety, pre-service teacher.*

Introduction

Mathematics is a lesson which is not favoured by many, which provokes negative attitudes and causes an experience of failure. There are many affective factors in failing. One of these affective factors is anxiety. There are various definitions

of anxiety in the literature. For example, Spielberg, Gorsuch and Lushene (1970) defined anxiety as a state of arousal experienced through physical, emotional and cognitive changes caused by a non-objective danger. Anxiety types, such as examination anxiety, test anxiety, teaching anxiety and mathematics anxiety, are among the types specified in educational studies. Mathematics anxiety is generally defined as a feeling of tension, apprehension or fear that impedes success in mathematics (Ashcraft, 2002). Similarly, Richardson and Suinn (1972) defined mathematics anxiety as feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations. Research indicated that one of the major problems in mathematics education is learners' mathematics anxiety (Baloğlu, 1999). During the last 50 years, various studies have dealt with the issue (Richardson & Suinn, 1972; Hembree, 1990; Ashcraft, 2002).

The reasons for mathematics anxiety can be classified in three categories. These are environmental factors, such as negative experiences in the classroom, parental pressure, insensitive teachers, traditional mathematics education delivered with strict rules; mental factors, such as teaching methods which are incompatible with learning styles, learners' lack of determination, lack of self-confidence in mathematical skills and lack of belief in the usefulness of mathematics; and personal factors, such as unwillingness to ask questions due to shyness, and low self-respect (Trujillo & Hadfield, 1999).

The results of a study by Uusimaki and Nason (2004) indicated that pre-service teachers' mathematics anxiety and negative beliefs about mathematics were related to their experiences at primary school. Recent research reveals that pre-service primary school teachers have a high level of mathematics anxiety (Austin, Wadlington, & Bitner, 1992). Therefore, teacher education institutions play crucial roles in diminishing mathematics beliefs and anxieties of the pre-service primary school teachers who will be influential in effective mathematics teaching in the future. One of these roles should be to decrease mathematics anxiety in pre-service teachers. Otherwise, it is highly likely that teachers with mathematics anxiety would negatively influence their students. In fact, according to Johnson (1981), evidence suggested that primary school teachers who had high levels of mathematics anxiety negatively influenced their students (cited in Austin et al., 1992).

In addition to mathematics anxiety, pre-service teachers also suffer from mathematics teaching anxiety (Levine, 1993; Peker, 2006). Various studies in the literature investigated pre – and in-service teachers' mathematics anxiety (Austin et al., 1992; Tooke & Lindstrom, 1998; Brown, McNamara, Hanley & Jones, 1999; Vinson, 2001;

Uusimaki & Nason, 2004; Brady & Bowd, 2005; Gresham, 2007). Especially in recent years studies have begun to emerge on pre-service teachers' anxiety levels in teaching mathematics (Levine, 1993/1996; Peker, 2006/2009a/2009b; Peker & Halat, 2008). Teaching anxiety is defined as the anxiety experienced about the teaching process which involves preparation for and application of classroom activities (Gardner and Leak, 1994). Mathematics teaching anxiety, more specifically, can be defined as a feeling of tension and anxiety teachers experience when teaching mathematical concepts, theories, formulas or problem solving (Peker, 2006). Mathematics teaching anxiety is accepted as a widely experienced fear among pre-service teachers (Levine, 1993). Levine (1996) stated that pre-service teachers' high levels of mathematics teaching anxiety is related to their insufficient content knowledge and previous unpleasant mathematics learning experiences. In a related study, Levine (1996) observed that while some pre-service teachers' high levels of mathematics teaching anxiety decreased when they had access to concrete materials, their mathematics teaching anxiety levels increased in abstract discussions. Levine concluded that pre-service teachers who suffer from mathematics teaching anxiety are insufficient in learning how to teach mathematics and creating materials. These findings suggest that some elements that arouse mathematics anxiety might also stimulate mathematics teaching anxiety and that the two concepts might be related. Due to a lack of studies on the issue and the suggested relationship, the current study aims to;

- (1) *Specify any gender differences in pre-service teachers' mathematics anxiety,*
- (2) *Specify any gender differences in pre-service teachers' anxieties in teaching mathematics,*
- (3) *Investigate the relationship between pre-service teachers' mathematics anxiety and their mathematics teaching anxiety.*

Method

This study belongs to a quantitative paradigm in terms of the data. It has a survey research design. Survey designs are research methods that aim to describe a past or present situation as it was/is. In survey research the object of study is described in its own context, as it is, and the investigation could be conducted on the whole population or on a group, an example, or a sample taken from the population. For the current study, convenience sampling was the chosen sampling method (McMillan & Schumacher, 2001).

Participants

This study involved 316 pre-service teachers. There was a total of 31.65% pre-service primary school teachers, 36.39% pre-service primary mathematics teachers, and 31.96 pre-service secondary mathematics teachers enrolled on a teacher education program at a university in the centre of Turkey. 62.66% of the participants were female, 37.34% were male. The participants had completed mathematics teaching I-II or teaching methods I-II courses, but had not yet started their teaching practice course.

Data Collection Tools

Data collection took place in the spring semester of the 2008–2009 academic year during a lesson using the 23-item Mathematics Teaching Anxiety Scale (MATAS) developed by Peker (2006) and the Mathematics Anxiety Scale (MAS) developed by Erkin, Dönmez and Özel (2006). The data consisted of pre-service teachers' responses to MATAS and MAS.

Mathematics Teaching Anxiety Scale is a five-point Likert scale which consists of 23 items. Item responses in the scale are: completely agree, agree, undecided, disagree and completely disagree. The negative statements were weighted from 5 to 1, and positive statements were reversed. Therefore, the aggregate score constituted a pre-service teacher's mathematics teaching anxiety score.

Mathematics Teaching Anxiety Scale developed by Peker (2006) has four factors. These are: anxiety caused by content knowledge, which consists of 10 items with factor loadings between 0.53 and 0.86; anxiety caused by self-confidence, which consists of 6 items with factor loadings between 0.57 and 0.76; anxiety caused by attitude towards teaching mathematics, which consists of 4 items with factor loadings between 0.61 and 0.70; and anxiety caused by methodological knowledge, which consists of 3 items with factor loadings between 0.68 and 0.78. The reliability coefficient of the scale is 0.91 and the reliability coefficients for each factor of the scale are as follows: anxiety caused by content knowledge: 0.90; anxiety caused by self-confidence: 0.83; anxiety caused by attitude towards teaching mathematics: 0.71; and anxiety caused by methodological (teaching) knowledge: 0.61.

Mathematics Anxiety Scale developed by Erkin et al. (2006) has four factors. These are: mathematics test and evaluation anxiety which consists of 17 items with factor loadings between 0.37 and 0.73; anxiety towards the mathematics lesson, which consists of 17 items with factor loadings between 0.25 and 0.70; mathematics

anxiety in daily life, which consists of 7 items with factor loadings between 0.40 and 0.62; and self-confidence in mathematics, which consists of 4 items with factor loadings between 0.36 and 0.68. The Cronbach's alpha coefficient calculated to determine the internal consistency of the whole scale was 0.92. The Cronbach's alpha coefficient for the mathematics text and evaluation dimension was 0.90; for anxiety towards the mathematics lesson it was 0.82; for mathematics anxiety in daily life it was 0.68; and for self-confidence in mathematics it was 0.61. Cronbach's alpha coefficient for all the items of the scale was 0.91.

Data Analysis

Following the reverse coding of the positive items in the scales, scores in each scale were aggregated to obtain the mathematics teaching anxiety and mathematics anxiety scores of each pre-service teacher. Data was then analysed using independent-samples t-test and Pearson Product Moments Correlation Coefficient.

Results

Table 1 presents the results of the independent-samples t-test conducted to determine gender differences in pre-service teachers' mathematics anxiety scores. The total mathematics anxiety scores of the pre-service teachers showed that the female pre-service teachers' mathematics anxiety mean score was 86.60 and the male pre-service teachers' mathematics anxiety mean score was 88.06. t-value between the scores of the two groups was -0.592 ($p > 0.05$) and indicated that the pre-service teachers' mathematics anxiety did not significantly differ according to gender. Subsequently, the dimensions of the mathematics anxiety scale were also investigated for gender differences.

For the dimension "mathematics test and evaluation anxiety," the female pre-service teachers' mathematics anxiety mean score was 32.73, the male pre-service teachers' mathematics anxiety mean score was 31.50. t-value between the scores of the two groups was 1.121 ($p > 0.05$). This result indicated that the pre-service teachers' mathematics anxiety for the dimension "mathematics test and evaluation anxiety" did not differ according to gender. Similarly, there were no gender differences in mathematics anxiety for the dimensions "Mathematics anxiety in daily life" and "Self-confidence in mathematics". The female pre-service teachers' mathematics anxiety mean score for the dimension "mathematics anxiety in

daily life” was 12.07, whereas the male pre-service teachers’ mathematics anxiety mean score for the same dimension was 12.32 and the t-value between the scores of the two groups was -0.480 ($p > 0.05$). For the dimension “Self-confidence in mathematics,” the female pre-service teachers’ mathematics anxiety mean score was 7.74, while the male pre-service teachers’ mathematics anxiety mean score for the same dimension was 8.22, and the t-value between the scores of the two groups was -1.669 ($p > 0.05$). However, a significant gender difference was observed in the pre-service teachers’ mathematics anxiety for the dimension “Anxiety towards the mathematics lesson”. While the female pre-service teachers’ mathematics anxiety mean score for the dimension “Anxiety towards the mathematics lesson” was 34.11, the male pre-service teachers’ mathematics anxiety mean score for the same dimension was 36.02. The t-value between the scores of the two groups was -2.222 ($p < 0.05$), which indicated a significant difference between the female and the male pre-service teachers’ anxiety scores in favour of the males. In other words, the male pre-service teachers’ anxiety scores were significantly higher than that of the females.

Table 1. Gender differences in pre-service teachers’ mathematics anxiety scores

Factors	Gender	N	\bar{x}	sd	df	t	p
Mathematics test and evaluation anxiety	Female	197	32.7259	9.4489	313	1.121	0.263
	Male	118	31.5000	9.3083			
Anxiety towards the mathematics lesson	Female	198	34.1061	7.5672	314	-2.222	0.027
	Male	118	36.0169	7.0904			
Mathematics anxiety in daily life	Female	198	12.0657	4.6807	314	-0.480	0.631
	Male	118	12.3220	4.4335			
Self-confidence in mathematics	Female	198	7.7424	2.5429	314	-1.669	0.096
	Male	118	8.2203	2.3210			
MAS TOTAL	Female	198	86.5960	21.5748	314	-0.592	0.554
	Male	118	88.0593	20.7031			

The independent samples t-test results calculated in order to determine gender differences in the pre-service teachers’ mathematics teaching anxiety scores are presented in Table 2. In terms of the pre-service teachers’ total mathematics teaching anxiety scores, the female pre-service teachers’ teaching anxiety mean score was 50.75, while the male pre-service teachers’ teaching anxiety mean score was 53.70. The t-value between the scores of the two groups was ($p > 0.05$) and indicated that

the pre-service teachers' mathematics teaching anxiety did not significantly differ by gender. Subsequently, the dimensions of mathematics teaching anxiety scale were investigated for gender differences.

The independent samples t-test results conducted for the factors "Anxiety caused by content knowledge", "Anxiety caused by self-confidence", "Anxiety caused by attitude towards teaching mathematics", and "Anxiety caused by methodological knowledge" indicated that there were not any significant gender differences. For the factor "Anxiety caused by content knowledge," the female pre-service teachers' teaching anxiety mean score was 20.92, whereas the male pre-service teachers' teaching anxiety mean score for the same factor was 21.98 and the t-value between the scores of the two groups was -1.140 ($p > 0.05$). For the factor "Anxiety caused by self-confidence," the female pre-service teachers' teaching anxiety mean score was 14.75, while the male pre-service teachers' teaching anxiety score for the same factor was 15.20 and the t-value between the scores of the two groups was -0.776 ($p > 0.05$). For the factor "Anxiety caused by attitude towards teaching mathematics," the female pre-service teachers' teaching anxiety mean score was 8.53, while the male pre-service teachers' teaching anxiety score for the same factor was 9.35 and the t-value between the scores of the two groups was -1.775 ($p > 0.05$). For the factor "Anxiety caused by methodological knowledge," the female pre-service teachers' teaching anxiety mean score was 6.56, while the male pre-service teachers' teaching anxiety score for the same factor was 7.17 and the t-value between the scores of the two groups was -1.602 ($p > 0.05$).

Table 2. Gender differences in pre-service teachers' mathematics teaching anxiety scores

Factors	Gender	N	\bar{x}	sd	df	t	p
Anxiety caused by content knowledge	Female	198	20.9192	7.8050	314	-1.140	0.255
	Male	118	21.9831	8.3829			
Anxiety caused by self-confidence	Female	198	14.7475	5.0356	314	-0.776	0.438
	Male	118	15.1949	4.8203			
Anxiety caused by attitude towards teaching mathematics	Female	198	8.5253	3.8785	314	-1.775	0.077
	Male	118	9.3475	4.1518			
Anxiety caused by methodological knowledge	Female	198	6.5606	2.8434	314	-1.892	0.059
	Male	118	7.1695	2.6322			
MATAS TOTAL	Female	198	50.7525	15.5153	314	-1.602	0.110
	Male	118	53.6949	16.2515			

In order to investigate the relationship between the pre-service teachers' mathematics teaching anxiety scores and mathematics anxiety scores Pearson Product Moments Correlation Coefficient was calculated. The analysis results are presented in Table 3. Pearson Product Moments Correlation Coefficient value calculated in order to determine the relationship between the pre-service teachers' Mathematics Teaching Anxiety Scale total teaching anxiety scores and Mathematics Anxiety Scale total anxiety scores was $r = 0.460$, $p < 0.001$. In other words, a moderate, positive and significant relationship was observed between the pre-service teachers' mathematics teaching anxiety and their mathematics anxiety. Therefore, the pre-service teachers' mathematics teaching anxiety was found to increase when their mathematics anxiety increased. Regarding the determination coefficient ($r^2 = 0.21$), 21% of the total variance in teaching anxiety was caused by mathematics anxiety.

Pearson Product Moments Correlation Coefficients calculated in order to investigate the relationship between the factors of Mathematics Teaching Anxiety Scale and Mathematics Anxiety Scale are presented in Table 3. The highest relationship between these factors was observed between the "anxiety caused by self-confidence" factor of Mathematics Teaching Anxiety Scale and the "anxiety towards the mathematics lesson" of Mathematics Anxiety Scale ($r = 0.396$, $p < 0.001$). According to Table 3, each factor of Mathematics Teaching Anxiety Scale is related to each factor of Mathematics Anxiety Scale. When the total score of Mathematics Teaching Anxiety Scale and total scores of the factors of Mathematics Anxiety Scale were compared, the highest relationship was found between the factor "anxiety towards the mathematics lesson" and total teaching anxiety ($r = 0.456$, $p < 0.001$). A moderate, positive relationship was also observed between teaching anxiety and the rest of the factors of mathematics anxiety. When the total score of Mathematics Anxiety Scale and the total scores of the factors of Mathematics Teaching Anxiety Scale were compared, the highest relationship was found between the factor "anxiety caused by content knowledge" and total mathematics anxiety ($r = 0.401$, $p < 0.001$). Here, again, a moderate, positive relationship was observed between total mathematics anxiety and "Anxiety caused by content knowledge", "Anxiety caused by self-confidence", and "Anxiety caused by attitude towards teaching mathematics" factors of teaching anxiety. A low, positive relationship was also observed between "Anxiety caused by methodological knowledge" factor of teaching anxiety and total mathematics anxiety.

Table 3. The relationship between mathematics teaching anxiety and mathematics anxiety

		Mathematics anxiety				
		Mathematics test and evaluation anxiety	Anxiety towards the mathematics lesson	Mathematics anxiety in daily life	Self-confidence in mathematics	MAS TOTAL
Mathematics teaching anxiety	Anxiety caused by content knowledge	r = 0.358** p = 0.001 N = 315	r = 0.374** p = 0.001 N = 316	r = 0.353** p = 0.001 N = 316	r = 0.303** p = 0.001 N = 316	r = 0.401** p = 0.001 N = 316
	Anxiety caused by self-confidence	r = 0.335** p = 0.001 N = 315	r = 0.396** p = 0.001 N = 316	r = 0.315** p = 0.001 N = 316	r = 0.264** p = 0.001 N = 316	r = 0.385** p = 0.001 N = 316
	Anxiety caused by attitude towards teaching mathematics	r = 0.298** p = 0.001 N = 315	r = 0.373** p = 0.001 N = 316	r = 0.312** p = 0.001 N = 316	r = 0.266** p = 0.001 N = 316	r = 0.361** p = 0.001 N = 316
	Anxiety caused by methodological knowledge	r = 0.203** p = 0.001 N = 315	r = 0.278** p = 0.001 N = 316	r = 0.216** p = 0.001 N = 316	r = 0.177** p = 0.001 N = 316	r = 0.255** p = 0.001 N = 316
	MATAS TOTAL	r = 0.397** p = 0.001 N = 315	r = 0.456** p = 0.001 N = 316	r = 0.394** p = 0.001 N = 316	r = 0.335** p = 0.001 N = 316	r = 0.460** p = 0.001 N = 316

** p<0.01

Discussion and Conclusion

The current study aimed at investigating gender differences that could exist in pre-service teachers' mathematics anxiety and their mathematics teaching anxiety, and also at identifying the relationship between mathematics anxiety and mathematics teaching anxiety.

Many studies have investigated gender differences in mathematics anxiety (Bowd & Brady 2003; Baloğlu, 2004; Haynes, Mullins, & Stein, 2004; Dane, 2005; Malinsky et al., 2006; Aydın, Delice, Dilmaç, & Ertekin, 2009). Some of them observed significant gender differences (Bowd & Brady 2003; Baloğlu, 2004; Malinsky et al., 2006). For example, Malinsky et al. (2006), and Bowd and Brady (2003) reported a significantly higher mathematics anxiety level of female pre-service teachers than that of male pre-service teachers. Moreover, there are also studies which examined gender differences in teaching anxiety (Marso & Pigge, 1998; Fish &

Fraser, 2001; Ameen, Guffey, & Jackson, 2002; Peker & Halat, 2008). For example, Fish and Fraser (2001) pointed to a gender difference among university professors in terms of teaching anxiety and stated that female professors were more anxious than male ones. However, other studies reported no significant gender differences in mathematics anxiety (Haynes, Mullins, & Stein, 2004; Dane, 2005; Aydın et al., 2009). Likewise, in teaching anxiety (Marso & Pigge, 1998; Fish & Fraser, 2001; Ameen, Guffey, & Jackson, 2002), particularly in mathematics teaching anxiety (Peker & Halat, 2008), some studies reported no significant gender differences.

The findings of the presented study were parallel to the findings of some of the studies mentioned above. While the findings did not suggest gender differences in terms of total mathematics anxiety scores, only in the dimension of anxiety towards the mathematics lesson the male pre-service teachers were significantly more anxious than the female pre-service teachers. Hence, the male pre-service teachers could be more anxious in the mathematics lesson. These findings contradict the results of Malinsky et al. (2006), and Bowd and Brady (2003). Both of these studies reported higher anxiety levels in female pre-service teachers than male ones. Moreover, the findings of the current study did not indicate any differences in the female and male pre-service teachers' mathematics teaching anxiety levels, neither in total scores nor in sub-dimensions of the mathematics teaching anxiety scale. These results were parallel to the findings of other relevant studies (Peker & Halat, 2008). Therefore, gender is not considered to be a variable that affects mathematics teaching anxiety.

Although, to the knowledge of the authors, there were not any studies on the relationship between mathematics anxiety and mathematics teaching anxiety, the similarities between the causes of mathematics anxiety and that of mathematics teaching anxiety suggested a possible relationship between the two. Hence, the results of the current study indicated significant positive relationships in terms of both the total scores and the dimensions of the two anxiety types. Accordingly, the pre-service teachers' mathematics teaching anxiety was found to increase as did their mathematics anxiety. On the other hand, among the dimensions of the mathematics anxiety scale, the highest relationship was observed between 'anxiety towards the mathematics lesson' dimension and mathematics teaching anxiety. This could be explained by the pre-service teachers' previous negative experiences, or even current negative experiences at university, in their mathematics lessons which could also be a relevant factor in mathematics teaching anxiety. Although all the dimensions of both anxiety scales were positively correlated, the pre-service teachers' anxieties towards the mathematics lesson played a significant role in their teaching anxiety as suggested by the highest relationship found between the total

scores of mathematics teaching anxiety and anxiety towards the mathematics lesson. The literature suggests various factors which are related to pre-service teachers' mathematics teaching anxiety and their mathematics anxiety. For instance, Levine (1996) and Peker (2009a / 2009b) reported links between pre-service teachers' mathematics teaching anxiety and the teaching they received. Levine (1993) suggested that mathematics teaching anxiety could be a reflection of previous mathematics anxiety. Tooke and Lindstrom (1998) and Vinson (2001) indicated that mathematics anxiety is related to teaching methods. Furthermore, one of the reasons for mathematics anxiety, i.e. the effects of the classroom environment where traditional teaching methods are foregrounded, seemed best to explain the relationship observed in the current study between mathematics teaching anxiety and anxiety towards the mathematics lesson.

The literature suggests that the reasons for mathematics anxiety include previous failure in mathematics and negative experiences (Uusimaki & Nason, 2004). The pre-service teachers who participated in this study were still continuing their university education which would enhance their mathematics content knowledge. However, traditional teaching methods still dominate teaching practice at the university level. Thus, the high relationship observed in the current study between mathematics anxiety and teaching anxiety caused by content knowledge indicated that mathematics content knowledge is an important component that could explain teaching anxiety. Moreover, anxiety caused by the methodological knowledge dimension of teaching anxiety had the lowest relationship with mathematics anxiety. This suggested that content knowledge was a more significant factor in explaining mathematics teaching anxiety than methodological knowledge.

This study recommends that teacher educators should recognize their students' mathematics anxiety and teaching anxiety. If teacher educators recognize their students' mathematics anxiety level they may help them to increase their confidence in mathematics teaching, they may create an environment that encourages pre-service teachers to teach mathematics. According to Peker (2009b), if teacher educators create an environment that encourages pre-service teachers to teach mathematics, pre-service teachers may develop their confidence in mathematics teaching.

The findings of this study encourage teacher educators and researchers to evaluate the relationship between mathematics anxiety and mathematics teaching anxiety.

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