Elementary Pre-Service Teachers' Mathematics Anxiety and Mathematics Teaching Anxiety

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Abstract

The present study examined the structure of elementary pre-service teachers' mathematics anxiety and mathematics teaching anxiety by asking whether the two systems of anxiety are related. The Turkish Mathematics Anxiety Rating Scale Short Version and the Mathematics Teaching Anxiety Scale were administered to 260 elementary pre-service teachers. Results of the study revealed that overall pre-service teachers' had a low-level of mathematics anxiety and mathematics teaching anxiety. Mathematics anxiety had a statistically significant effect on mathematics teaching anxiety. Thus, the significant relationship between mathematics anxiety and mathematics teaching anxiety should be acknowledged by mathematics teacher educators.

Key words: Elementary pre-service teacher, mathematics anxiety, mathematics teaching anxiety

Introduction

Mathematics is a gatekeeper for successful college completion and employment. Therefore, students' achievement in mathematics could be considered one of the vital factors in their career development. Nevertheless, many of the students from elementary through college level have experienced learning difficulties and illustrated poor mathematical performances due to different variables such as mathematics anxiety, mathematics teaching anxiety and the relationship between these two concepts (e.g., Bates, Latham & Kim, 2013; Peker & Ertekin, 2011;Sherman & Wither, 2003). These variables, mathematics anxiety and mathematics teaching anxiety have a great influence on pre-service teachers' potential effectiveness in teaching of mathematics to students (Brown, Wetenskow & Moyer-Packenham, 2012; Bursal & Paznokas, 2006; Peker & Ertekin, 2011). However, there is a limited research investigating the relationship between mathematics anxiety and mathematics teaching anxiety and how this affects pre-service teachers' instruction (Brown, et al., 2012; Peker & Ertekin, 2011). Therefore, this present study will take a closer look at mathematics anxiety and mathematics teaching anxiety of elementary pre-service teachers at a public university in Turkey.

Mathematics Anxiety

Over the last three decades, mathematics anxiety has been an important and common problem in learning and teaching from elementary through university levels (Uusimaki & Nason, 2004; Vinson, 2001). Mathematics anxiety is defined 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" (Richardson & Suinn, 1972, p.551). It might be a greater block to learning since it influences effectiveness of one's understanding of mathematical concepts (Gresham, 2009; Hembree, 1990; Vinson, 2001). Researchers (Sloan, 2010; Vinson, 2001) indicated that teachers who have higher levels of anxiety might unintentionally transfer their negative feelings, avoidance and fear of mathematics to students since mathematics anxiety is related to how one teaches mathematics. Correspondingly,

research studies (Swetman, Munday & Windham, 1993; Vinson, 2001) indicated that elementary teachers with higher levels of mathematics anxiety might promote early development of mathematics anxiety for their students. Mathematics anxiety of teachers might lead to development of negative attitudes toward mathematics and poor mathematical performances for their future students (Battista, 1990; Gresham, 2009). Similarly, results of the studies revealed that elementary pre-service teachers had the highest mathematics anxiety level (Hembree, 1990; Kelly & Tomhave, 1985; Vinson, 2001). This leads to some concern about pre-service teachers' potential effectiveness in teaching mathematics to their students (Burns, 1998).

Mathematics Teaching Anxiety

Mathematics teaching anxiety is defined as one's feelings of tension and fear that takes place during the teaching of mathematical concepts (Levine, 1993; Peker, 2006). Mathematics teaching anxiety has a major role in how one would teach or introduce abstract concepts in a way more concrete or understandable for students. Often pre-service teachers feel extremely nervous and unable to concentrate on their teaching due to their high level of mathematics teaching anxiety (Levine, 1993, 1996; Peker, 2006). They could easily get upset by noises in class and have difficulty of understanding students (Peker, 2009). In the same way, researchers (Malinsky, Ross, Pannells & McJunkin, 2006; Uusimaki & Nason, 2004) suggested that negative school experiences as a student, lack of family support and effect of their previous mathematics teachers could be the reasons for the sources of pre-service teachers' mathematics anxiety. Uusimaki and Nason (2004) claimed, "situations which caused most anxiety for the participants included communicating one's mathematical knowledge, whether in a test situation or in the teaching of mathematics such as that required on practicum" (p. 374).

Several research studies focused on mathematics anxiety of the pre-service teachers as a result of participating in mathematics and mathematics teaching methods courses (Bursal & Paznokas, 2006; Gresham, 2007; Peker, 2009; Uusimaki & Nason, 2004). Research studies (Malinsky, Ross, Pannells & McJunkin, 2006; Vinson, 2001; Wilson, 2013) revealed that a variety of factors (e.g., past negative experiences, inappropriate teaching practices, engagement with future teaching of mathematics) contribute to pre-service teachers mathematics anxiety. However, little is known about pre-service teachers' mathematics teaching anxiety as well as the relationship between mathematics anxiety and mathematics teaching anxiety. Research studies examined mathematics anxiety and mathematics teaching anxiety of pre-service teachers individually (Bursal & Paznokas, 2006; Gresham, 2009; Harper & Daane, 1998; Levine, 1996; Peker, 2009). Results of these studies suggested that pre-service teachers with high level of mathematics anxiety and mathematics teaching anxiety are unable to learn mathematical concepts or how to teach mathematics effectively. As it was indicated by the study of Bates, Latham and Kim (2013) pre-service teachers demonstrated lack of confidence in their teaching ability. They often mentioned their limited content knowledge for teaching mathematics. However, Brown, Wetenskow and Moyer-Packenham (2011) found that one-third of the pre-service teachers had high level of mathematics anxiety but did not have mathematics teaching anxiety. Brown et. al (2011) suggested that the link between mathematics anxiety and mathematics teaching anxiety did not always exist. Brown et. al (2012) examined the teaching anxieties of the pre-service teachers in classroom settings. Results of this study revealed that pre-service teachers' mathematics teaching anxiety did not always align with their mathematical skills or backgrounds. Nevertheless, the study of Peker and Ertekin (2011) demonstrated that mathematics anxiety and mathematics teaching anxiety were related. Results of their study revealed that there was a significant positive relationship between pre-service teachers' mathematics anxiety and mathematics teaching anxiety with a

medium effect size. Considering the numbers of studies conducted with pre-service teachers to examine their mathematics anxiety and mathematics teaching anxiety individually, further research is needed to examine the link between these two variables. Therefore, the present study investigated the structure of elementary pre-service teachers' mathematics anxiety and mathematics teaching anxiety. Furthermore, the study tested the hypothesis that pre-service teachers' mathematics anxiety was linked to their mathematics teaching anxiety.

The present study aims to answer the following research questions:
1. What is level of elementary pre-service teachers' mathematics anxiety and mathematics teaching anxiety?
2. Is there a significant difference in mathematics anxiety and mathematics teaching anxiety scores of elementary pre-service teachers regarding number of years spent in teacher education program?
3. Is there a significant difference in mathematics anxiety and mathematics teaching anxiety scores of elementary pre-service teachers regarding gender?
4. What is the relationship between elementary pre-service mathematics anxiety and mathematics teaching anxiety?

Method

Participants

In this study, data were collected from 260 pre-service teachers enrolled in elementary teacher education program at a public university located in northwest part of Turkey. At the time of the study, a total number of 260 pre-service teachers involving 129 seniors and 131 juniors agreed to participate in this study. There were 165 females and 95 males.

Elementary Teacher Education Program

In Turkey, elementary teacher education programs at four-year universities have used a standardized curriculum prepared by Higher Education Council (Higher Education Council, 2007). These programs consist of three domains: content courses (e.g., mathematics, mathematics education, science, and technology education), general education courses (e.g., computer literacy, foreign language, and Turkish history and language), and pedagogy courses (e.g., educational psychology, classroom management, and counseling). General education courses are designed to provide backgrounds to pre-service teachers in social, cultural and historical topics. Content courses focus on development of pre-service teachers' content and pedagogical content knowledge in areas such as mathematics, science, and social studies. In addition, pedagogy courses are designed to guide pre-service teachers for the development of their pedagogical knowledge. In this program, pre-service teachers are prepared to teach subjects such as mathematics, social studies, and science and technology courses when they become an elementary school teacher. In summary, pre-service teachers are required to enroll in a number of courses (e.g., practicum, mathematics teaching methods courses and classroom management) related to teaching profession during the 4-year coursework. Currently, pre-service teachers are certified to teach 1st through 4th grade level in elementary education program (Higher Education Council, 2007).

Instruments

The Turkish Mathematics Anxiety Rating Scale-Short Version (T-MARS-SV)

The Mathematics Anxiety Rating Scale-Short Version ([MARS-SV], Suinn & Winston, 2003) was designed to measure participants' mathematics anxiety. In this present study, the Turkish adaptation of the MARS-SV instrument ([T-MARS-SV], Baloglu, 2010) was used to measure elementary pre-service teachers' mathematics anxiety. In this study, pre-service teachers were

asked to indicate the extent to which they felt anxiety on a five point Likert scale anchored at points with the statements: not at all, very little, somewhat, and very much. The scale includes 30 items on a four-point Likert scale (See Appendix A). Higher scores reflect lower level of mathematics anxiety. The reliability coefficient of the five subscales, test anxiety, course anxiety, application anxiety, computation anxiety and social anxiety were 0.86, 0.85, 0.92, 0.92 and 0.88 respectively. The internal reliability of the T-MARS-SV was 0.93.

The Mathematics Teaching Anxiety Scale (MATAS)

The Mathematics Teaching Anxiety Scale (MATAS) was developed by Peker (2006) to measure pre-service teachers' mathematics teaching anxiety level. In this present study, the MATAS was used to measure teaching anxiety toward mathematics in particular. Pre-service teachers were asked to indicate the extent to which they felt teaching anxiety on a five point Likert scale anchored at points with the statements: strongly disagree, disagree, undecided, agree, and strongly agree. Higher scores indicate lower level of mathematics teaching anxiety. The MATAS consists of 23 items in a five-point Likert-type of scale (See Appendix B). The reliability coefficient of the four subscales, content knowledge, self-confidence, attitude towards mathematics teaching, and teaching knowledge were 0.90, 0.83, 0.71 and 0.61 respectively. The internal reliability of the overall instrument was calculated as 0.91.

Procedure

In this study, data were collected with two instruments. The T-MARS-SV and the MATAS were administered to elementary pre-service teachers. Pre-service teachers who agreed to be part of this study were given these instruments to complete during their regular class hours. It took approximately 20-25 minutes for pre-service teachers to complete the instruments.

Data analysis

Elementary pre-service teachers' scores on the T-MARS-SV and the MATAS were analyzed by using descriptive and inferential statistics. A two-way between-groups multivariate analysis of variance was performed to investigate gender and year spent in the program differences in both mathematics anxiety and mathematics teaching anxiety scores of the pre-service teachers. In addition, Pearson correlations were calculated to explore the bivariate relations between pre-service teachers' mathematics anxiety and mathematics teaching anxiety. Then, standard multiple regression analysis was conducted to determine whether pre-service teachers' mathematics anxiety was a predictor of their anxiety about mathematics teaching. Subscales of T-MARS-SV and MATAS were competed for entry. Only variables that were significant at the 0.05 levels were allowed to enter the equation.

Findings

Elementary pre-service teachers' scores on the T-MARS-SV and MATAS were analyzed to examine their mathematics anxiety and mathematics teaching anxiety level as well as the link between these two systems of anxiety. Results of the study revealed that pre-service teachers generally had a low level of mathematics anxiety and mathematics teaching anxiety. The participants' responses to T-MARS-SV demonstrated low scores on test (M=3.51; SD=0.89), course (M=3.95; SD=0.77), application (M=4.24; SD=0.67), computation (M=4.77; SD=0.50) and social anxiety (M=4.52; SD=0.68). In the same way, pre-service teachers had a low level of mathematics teaching anxiety in general. Their responses to the MATAS revealed generally high scores on self-confidence (M=3.4; SD=0.82), attitude towards mathematics teaching (M=3.87; SD=0.77), and teaching knowledge (M=3.88; SD=0.73). These findings showed that pre-service teachers held a low level of mathematics teaching anxiety regarding self-confidence, attitude towards mathematics teaching, and teaching knowledge. However, it was found that they had a low score on the content knowledge subscale (M=2.19; SD=0.78).

This finding showed that pre-service teachers had a high-level of mathematics teaching anxiety regarding content knowledge.

A two-way multivariate analysis of variance was performed to compare the mean scores of the dependent variables (i.e., mathematics anxiety and mathematics teaching anxiety) and two independent variables (i.e., gender and year spent in the program). Nine dependent variables were used: Test anxiety, course anxiety, application anxiety, computation anxiety and social anxiety, content knowledge, self-confidence, attitude towards mathematics teaching, and teaching knowledge. The independent variables were gender and year spent in the program. Results of the analysis revealed that there was a statistically significant difference between males and females on the combined dependent variables, $F(9, 248) = 3.278$, $p = 0.001$; Wilks' Lambda = 0.894; partial eta squared = 0.106. When the results were considered separately, the only difference to reach statistical significance, using a Bonferroni adjusted alpha level of 0.005 was computational anxiety, $F(1, 256) = 5.504$, $p = 0.020$, partial eta squared = 0.021. An inspection of the mean scores indicated that females reported lower levels of computation anxiety (M = 4.82, SD = 0.37) than males (M = 4.68, SD = 0.65). However, there was no significant difference between third year and fourth year pre-service teachers on the combined dependent variables, $F (9, 248) = 1.214$, $p = 0.057$; Wilks' Lambda = 0.936, partial eta squared = 0.064.

In making comparisons between the measures of pre-service teachers' mathematics anxiety and mathematics teaching anxiety score correlations were calculated for the subscales of each instrument (See Table 1). The set of potential antecedents of mathematics anxiety for mathematics teaching anxiety were entered in multiple regression analysis. The variables that were significant at the 0.05 levels were allowed to enter the equation.

Table 1.
Correlations between mathematics anxiety and mathematics teaching anxiety

Subscales	MATAScontent knowledge	MATASself -confidence	MATASattitude	MATASteaching knowledge
T-MARStest	-0.52(*)	0.38(*)	0.33(*)	0.21(*)
T-MARScourse	-0.56(*)	0.33(*)	0.38(*)	0.24(*)
T-MARSapplication	-0.36(*)	0.22(*)	0.25(*)	0.19(*)
T-MARScomputation	-0.35(*)		0.24(*)	0.19(*)
T-MARSsocial	-0.38(*)	.10(**)	0.19(*)	.11(**)

N=260; *p<0.05 **p<0.01

Predicting pre-service teachers' content knowledge anxiety from their test, course, application, computation and social anxiety

Results revealed that the relationships between social and content knowledge and application and content knowledge were found to be non-significant at $F (5, 254) = 29.29$, $p>0.05$, respectively. Although bivariate correlations between application and content knowledge and social and content knowledge were significant at $r(260)=-0.36$, $p<0.05$ (two-tailed) and $r(260)=-0.38$, $p<0.05$ (two-tailed), respectively, these variables did not predict content knowledge individually. These findings demonstrated that application and social anxiety were unrelated to content knowledge. In addition, neither social nor application anxiety individually predicted content knowledge anxiety regarding mathematics teaching. Therefore, these variables were excluded from regression analysis. Next, test, course and computation variables were entered in regression. Results of the standard multiple regression analysis was demonstrated that overall there was a significant relationship between predictors (i.e., test, course, and computation) and content knowledge anxiety related to mathematics teaching at

F(3, 256) =48.41, p<0.05 R^2 =0.35 respectively. This criterion meets for a large effect size (Cohen, 1988). Thus a large proportion (35%) of the variability in pre-service teachers' content knowledge anxiety related to mathematics teaching was predicted by their test, course and computation anxiety. Individually, these variables, test (β=-0.24, p < 0.05), course (β =-0.29, p < 0.05) and computation (β =-0.17, p < .05) significantly predicted their content knowledge anxiety in a negative direction.

Predicting pre-service teachers' self-confidence anxiety from their test, course, application and social anxiety

It was found that computation was unrelated to pre-service teachers' self-confidence (See Table 1). Therefore, it was excluded from the analysis. Next, test, course, application and social variables were entered for the regression. Results of the analysis revealed that the relationships between course and self-confidence and between application and self-confidence were non-significant. Similarly, the relationship between social and self-confidence was found to be non-significant at F(3, 256) =15.48, p>0.05, R^2 =0.15 respectively. Thus, these variables were excluded from the analysis. Next, the test variable was entered for the regression. Findings of the analyses showed that only pre-service teachers' test anxiety predicted their self-confidence regarding mathematics teaching anxiety. The relationship between test anxiety and self-confidence related to mathematics teaching anxiety were significant at F(1, 258) =44.17, p<0.05, R^2 =0.14 respectively. Thus, a medium proportion (14%) of the variability in pre-service teachers' self-confidence related to mathematics teaching anxiety was predicted by test anxiety. Individually, test (β =0.38, p<0.05) predicted pre-service teachers' self-confidence in a positive direction.

Predicting pre-service teachers' attitude towards mathematics teaching anxiety from their test, course, application, computation and social

The predicted variables (i.e., test, computation and social) were entered for the regression analysis for the pre-service teachers' attitude towards mathematics teaching. Results of the analysis revealed that the relationship between predictors and attitude towards mathematics teaching were found to be non-significant F(5, 254) =10.59, p>0.05, R^2 =0.15. In addition, test (β=0.06, p >0.05), computation (β =0.14, p > 0.05) and social anxiety (β =-0.16, p >0.05) did not predict attitude towards mathematics teaching. Therefore, test, computation and social were excluded from regression analysis. Next, the predicted variables (i.e., course and application) were entered for the regression analysis. Findings of the analysis revealed that the relationships between attitude and course and between application and attitude were found to be significant at F(2, 257) = 24.15, p<0.05, R^2 =0.15 respectively. Consequently, a medium proportion (15%) of the variability in pre-service teachers' attitude towards mathematics teaching was predicted by course and application anxiety. Individually, application (β=0.12, p<0.05) and course anxiety (β=0.33, p <0.05) predicted pre-service teachers' attitude towards mathematics teaching in a positive direction.

Predicting pre-service teachers' teaching knowledge anxiety from their test, course, application, computation and social anxiety

The set of potential antecedents of mathematics anxiety for teaching knowledge were entered in multiple regression analysis. Results of the analyses revealed that the relationships between test and teaching knowledge were found to be non-significant at F(4, 255) =5.42, p>0.05, respectively. Although bivariate correlations between test and teaching knowledge were significant at r(260)=0.21, p<0.05 (two-tailed), respectively, this variable did not predict teaching knowledge individually. Similarly, there was no relationship between teaching knowledge and social and between computation and teaching knowledge. These findings showed that test anxiety was unrelated to teaching knowledge. As a result, this variable was

excluded from analysis. Next, the predicted variables (i.e., course and application) were entered for the regression analysis. Results of the analyses demonstrated that the relationships between course and teaching knowledge were found to be non-significant at $F(2, 257) = 10.29$, $p > 0.05$ respectively. As a result, the variable, course was excluded from the analysis. Only predicted variable, application entered for the regression. Results showed that there was a significant relationship between application and teaching knowledge at $F(1, 258) = 10.44$, $p < 0.05$, $R^2 = 0.03$ respectively. Therefore, 3% of a small variability in pre-service teachers' teaching knowledge was explained by application anxiety. Individually, application ($\beta = 0.19$, $p < 0.05$) significantly predicted pre-service teachers' teaching knowledge in a positive direction.

Conclusion

This present study revealed that elementary pre-service teachers held a low-level of mathematics anxiety. This finding was inconsistent with many of the research studies conducted with pre-service teachers. Results of these studies posited that pre-service teachers held a high-level of mathematics anxiety (Bursal & Paznokas, 2006; Gresham, 2009; Levine, 1996). Thus, this present study suggests that the reason for the pre-service teachers' low level of mathematics anxiety could be related to their mathematical backgrounds. In Turkey, high school graduates have to take the Transition to Higher Education Exam (THEE) to enroll in programs at the university level. THEE is designed to measure students' skills on different subjects such as mathematics, social and natural sciences. Students' enrolments into teacher education programs at universities are based on the scores they received from this exam. In order to enter the elementary teacher education programs, high school graduates have to do well on mathematics part of the THEE since enrollment into these programs requires students to receive high mathematics scores. As a result, this study suggests that the reason for the pre-service teachers' low level of mathematics anxiety could be reflection of their mathematical backgrounds.

The study also showed that pre-service teachers had a low-level of mathematics teaching anxiety in general. The study of Peker (2008) revealed that pre-service teachers' mathematics teaching anxiety increases as their need for finding concrete examples escalates. On the contrary, this study demonstrated that the pre-service teachers held a low-level of mathematics teaching anxiety. A possible reason for their low levels of teaching anxiety could be related to the participation required by the mathematics teaching methods courses and practicum in elementary teacher education program. These courses are both intended to give real-life experiences to pre-service teachers in teaching of mathematics. Their positive experiences in these courses might be the reason for their low level of mathematics teaching anxiety. However, the pre-service teachers had a high level of content knowledge anxiety in this study. Correspondingly, Peker and Ertekin (2011) found that pre-service teachers held a high level of content knowledge anxiety regarding mathematics teaching. Along with the study of Bates, Latham and Kim (2013), the results showed that pre-service teachers had a lack of confidence in their teaching ability. Although elementary teacher education programs emphasize reform oriented classroom teaching (Higher Education Council, 2007), Peker and Ertekin (2011) emphasized that pre-service teachers enrolled in these programs have experienced traditional teaching methods for a long period as a student. Having been exposed to this type of experiences for a long period might be the reason for their high level of content knowledge anxiety.

Research studies examined gender differences in mathematics anxiety (Bowd & Brady, 2003; Malinsky et al., 2006). Results of these studies reported that there was a significant difference between female and male pre-service teachers' mathematics anxiety scores. In the same way,

the present study demonstrated that there was a significant difference between female and male pre-service teachers' computation anxiety scores regarding gender. The female pre-service teachers seemed to have lower computation anxiety in comparison to male pre-service teachers. This could be explained by the female pre-service teachers' previous or current positive experiences related to mathematics.

Brown et. al (2011) suggested that the link between mathematics anxiety and mathematics teaching anxiety did not always exist. Nevertheless, the study of Peker and Ertekin (2011) demonstrated that mathematics anxiety and mathematics teaching anxiety were related. In the same way, results of the present study revealed that there was a significant relationship between pre-service teachers' mathematics anxiety and mathematics teaching anxiety. Results showed that test, course, and computation anxiety predicted pre-service teachers' content knowledge anxiety related mathematics teaching in a negative direction. Pre-service teachers who had a lower level of test, course and computation anxiety reported a higher level of content knowledge anxiety related to mathematics teaching. As a result, pre-service teachers' content knowledge anxiety was mediated by the relationships between test and content knowledge and between course and content knowledge as well as content knowledge and computation anxiety. In addition, test anxiety predicted pre-service teachers' self-confidence in a positive direction. As a result, pre-service teachers with low levels of test anxiety held more self-confidence related to mathematics teaching. Moreover, pre-service teachers' attitude towards mathematics teaching was predicted by course and application in a positive direction. Thus, the pre-service teachers with low levels of course and application anxiety held more positive attitude towards mathematics teaching. However, a small variability in their attitude towards mathematics teaching was predicted by application anxiety in a positive direction. Correspondingly, the pre-service teachers with low levels of application had low level of teaching knowledge anxiety.

In conclusion, the present study suggests that teacher educators should recognize elementary pre-service teachers' mathematics teaching anxiety. Brady and Bowd (2005) emphasized that changes are needed in the approach to mathematics instruction. As teacher educators, we should understand underlying factors and reasons for pre-service teachers' mathematics teaching anxiety when planning courses and instructional methods. Therefore, mathematics teaching methods courses should focus on learning how to teach mathematics effectively as well as how to introduce mathematical concepts to elementary school students. Therefore, the present study suggests that these courses should create opportunities for pre-service teachers to work with elementary students individually. In this environment, pre-service teachers should be encouraged to use approaches that are appropriate for students to introduce mathematical concepts. Working with students would help pre-service teachers to decrease their anxieties related to mathematics teaching. Understanding pre-service teachers anxieties related to mathematics teaching could also guide teacher educators to better prepare them for positive and successful mathematics teaching experiences as elementary teachers.

References

Baloglu, M. (2010). An investigation of the validity and reliability of the adapted mathematics anxiety rating scale-short version (MARS-SV) among Turkish students. *European Journal of Psychological Education*, *25*, 507-518.

Battista, M. (1990). The relationship of mathematics anxiety and mathematical knowledge to the learning of mathematical pedagogy by pre-service elementary teachers. *School Science and Mathematics, 86*, 10-19.

Bates, A.B., Latham, N.I., & Kim, J. (2013). Do I have to teach math? Early childhood pre-service teachers' fears or teaching mathematics. *Issues in Undergraduate Mathematics*

Preparation of School Teachers: The Journal, Vol 5 (Teacher Attributes), August 2013. [www.k-12prep.math.ttu.edu]

Bowd, A. D., & Brady, P. H. (2003). Gender differences in mathematics anxiety among preservice teachers and perceptions of their elementary and secondary school experience with mathematics. *Alberta Journal of Educational Research, 49*(1), 24-36.

Brady, P. & Bowd, A. (2005). Mathematics anxiety, prior experience and confidence to teach mathematics among pre-service education students. *Teachers and Teaching: Theory and Practice, 11*(1), 37-46.

Brown, A.B., Westenskow, A., & Moyer-Pakenham, P.S. (2011). Elementary pre-service teachers: Can they experience mathematics teaching anxiety without having mathematics anxiety? *Issues in the Undergraduate Mathematics Preparation of School Teachers: The Journal, Vol 5 (Teacher Attributes), August 2011.* [www.k-12prep.math.ttu.edu]

Brown, A., Westenskow, A., & Moyer-Pakenham, P.S. (2012). Teaching anxieties revealed: Pre-service elementary teachers' reflections on their mathematics teaching experiences. *Teaching Education, 23*(4), 365-385.

Burns, M. (1998). *Math: Facing an American phobia*. Sausalito, CA: Math Solutions Publications.

Bursal M., & Paznokas, L. (2006). Mathematics anxiety and pre-service elementary teachers' confidence to teach mathematics and science. *School Science and Mathematics, 106*(4) 173-179.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences.* (2nd ed.) Mahwah, NJ: Lawrence Erlbaum Associates.

Gresham, G. (2007). A study of mathematics anxiety in pre-service teachers. *Early Childhood Education Journal, 35*(2), 181-188.

Gresham, G. (2009). Examining the relationship between pre-service elementary teachers' experience of mathematics anxiety and their efficacy for teaching mathematics. *Journal of Classroom Interaction, 44*(2), 22-38.

Harper, N., & Daane, C. (1998). Causes and reductions of math anxiety in pre-service elementary teachers. *Action in Teacher Education, 19*(4), 29-38.

Hembree, R. (1990). The nature, effect, and relief of mathematics anxiety. *Journal for Research in Mathematics Education, 21*(1), 33-46.

Higher Education Council. (2007). Teacher preparation and faculty of education [Ögretmen yetistirme ve egitim fakülteleri] (1998-2007). Ankara, Turkey: YOK.

Kelly W., & Tomhave, W. (1985). A study of math anxiety and math avoidance in pre-service elementary teachers. *Arithmetic Teacher, 32*, 51-53.

Levine, G. (1993). Prior mathematics history, anticipated mathematics teaching style, and anxiety for teaching mathematics among pre-service elementary school teachers. *Proceedings of the 17th Conference of the International Group for the Psychology of Mathematics Education* Annual Meeting of the International Group for Psychology of Mathematics Education, North American Chapter. (ERIC Document Reproduction Service No. ED373972).

Levine, G. (1996). *Variability in anxiety for teaching mathematics among pre-service elementary school teachers enrolled in a mathematics course*. Paper presented at the Annual Meeting of the American Educational Research Association, April 12, 1996, New York, NY. (ERIC Document Reproduction Service No. ED 398 067).

Malinsky, M., Ross, A., Pannells, T., & McJunkin, M. (2006). Math anxiety in pre-service elementary school teachers. *Education, 127*(2), 274-279.

Peker, M. (2006). Matematik ogretmeye yonelik kaygi olceginin gelistirilmesi. *Egitim Bilimleri ve Uygulama, 9*, 73-92.

Peker, M. (2008). Pre-service teachers' teaching anxiety about mathematics and their learning styles. *Eurasia Journal of Mathematics, Science & Technology Education*, *5*(4), 335-345.

Peker, M. (2009). The effects of an instruction using problem solving strategies in Mathematics on the teaching anxiety level of the pre-service primary school teachers. *The New Educational Review*, *19*(3-4), 95-114.

Peker, M., & Ertekin, E. (2011). The relationship between mathematics teaching anxiety and mathematics anxiety. *The New Educational Review*, *23*(1), 213-226.

Richardson, F., & Suinn, R.M. (1972). The mathematics anxiety rating scale: Psychometric data. *Journal of Counseling Psychology, 19*, 551-554.

Sherman, B.F., & Wither, D.P. (2003). Mathematics anxiety and mathematics achievement. *Mathematics Education Research Journal*, *15*(2), 138-150.

Sloan, T. R. (2010). A quantitative and qualitative study of math anxiety among pre-service teachers. *The Educational Forum*, *74*(3), 242-256.

Suinn, R. M., & Winston, E. H. (2003). The mathematics anxiety rating scales, a brief version: Psychometric data. *Psychological Reports, 92*, 167-173.

Swetman, B., Munday, R., & Windham, R. (1993). Math anxious teachers: breaking the cycle, *College Student Journal*, *22*(4), 421-427.

Uusimaki, L., & Nason, R. (2004). Causes underlying pre-service teachers' negative beliefs and anxieties about mathematics. In M. Hoines & A. Fuglestad (Eds), *Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education, 4*, (pp. 369-376). Bergen, Norway.

Vinson, B. M. (2001). A comparison of pre-service teachers' mathematics anxiety before and after a methods class emphasizing manipulatives. *Early Childhood Education Journal*, *29*(2), 89-94.

Wilson, S. (2013). Mature age pre-service teachers' mathematics anxiety and factors impacting on university retention. In V. Steinle, L. Ball & C. Bardini (Eds.), Mathematics education: Yesterday, today and tomorrow. *Proceedings of the 36th annual conference of the Mathematics Education Research Group of Australasia,* (pp.666-673). Melbourne, VIC: MERGA.

Appendix A

Sample items from the Turkish Mathematics Anxiety Rating Scale-Short Version

- Taking an examination (final) in a math course.
- Thinking about an upcoming math test one week before.
- Thinking about an upcoming math test one day before.

Appendix B

Sample items from the Mathematics Teaching Anxiety Scale

- I got anxious when it comes to the point of teaching some mathematical topics.
- It is very easy for me to teach mathematics.
- I like answering questions about the topic I am teaching.