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Abstract

The purpose of the research is to investigate the relationships between self-efficacy beliefs toward mathematics, mathematics anxiety and self-efficacy beliefs toward mathematics teaching, mathematics teaching anxiety variables and testing the relationships between these variables with structural equation model. The sample of the research, which was conducted in accordance with relational survey model, consists of 380 university students, who studied at the department of Elementary Mathematics Education at two state universities. In order to collect data for the present research, "Self-efficacy Beliefs towards Mathematics Scale", "Self-efficacy Beliefs toward Mathematics Teaching Scale", "Mathematics Anxiety Scale" and "Mathematics Teaching Anxiety Scale" were utilized. Researchers developed a model in accordance with the related literature, and tested the direct and indirect relations between self-efficacy belief toward mathematics, mathematics anxiety and self-efficacy belief for mathematics teaching, mathematics teaching anxiety variables. Data were analysed with structural equation model on AMOS 19.0 program. The model shows that the most important independent variable affecting mathematics teaching anxiety is mathematics anxiety; the most important independent variable affecting self-efficacy belief toward mathematics teaching is mathematics anxiety; the most important variable affecting mathematics anxiety is self-efficacy belief toward mathematics; and the most important variable affecting mathematics teaching anxiety is self-efficacy belief toward mathematics teaching.

Introduction

Affective characteristics play an important role in mathematics education (McLeod, 1992). One of the affective characteristics; self-efficacy belief, which is also included in Bandura's Social Learning Theory, is defined as "an individual's judgement of their capacity to organize the activities required for a certain performance, and to achieve it" (Bandura, 1986, p. 391). Self-efficacy belief is individuals' beliefs in their capacity for what they can achieve and the individuals turn these into behaviours by assessing their skills and capacities (Schunk, 2009). Self-efficacy belief, which plays a very effective role in starting a behaviour and maintaining a started behaviour, is a combination of the capacity of an individual, their achievements in what they do, their motives and other elements forming the concept of self (Kuzgun, 2000). Self-efficacy belief starts developing within the family (Bandura, 1994) and individuals with high self-efficacy beliefs pay more effort when they encounter difficulties and become successful (Schunk, 2009). On the other hand, individuals with low self-efficacy belief don't make any attempts, as they believe that they will fail to obtain the desired result (Pajares, 2002).

Self-efficacy belief is fed on four main sources: direct experiences, observation (others' experiences), verbal persuasion and physical and emotional state (Schunk, 2009). The most effective of these self-efficacy sources is direct experiences. Individuals, who have successful past experiences, have a strong belief of self-efficacy, while other individuals, who experience failure before forming a strong self-efficacy belief, develop negative self-efficacy belief. Another source of self-efficacy belief is verbal persuasion. When individuals encounter persuasive encouragement or suggestions, they pay more effort to achieve the assigned task and if they achieve, this will contribute to developing their self-efficacy belief (Bandura, 1980). On the other hand, non-realistic encouragements may result in failure despite the paid efforts and the disappointment will decrease the self-efficacy belief. Indirect experiences provided by social models are also affective in forming the self-efficacy belief. The situations, in which the other similar individuals fail or achieve, affect the individuals' judgement of

their performance in a similar situation. Physical and emotional state is another source of self-efficacy belief. How well an individual feels psychologically and physically has an effect on their performing an assigned task or an expected behaviour and also their self-efficacy belief (Schunk, 2009; Hazır-Bıkmaz, 2006).

Mathematics is one of the domains, where self-efficacy belief is effective. Mathematics is an important tool used for solving problems in both science and daily life. On one hand mathematics helps us think creatively and critically, and on the other helps us understand the world (Baykul, 2009). One of the most important factors effective in mathematics teaching is mathematics self-efficacy belief, which refers to "an individual's situational or problem-based evaluation of their confidence in performing a certain mathematical task or problem successfully" (Hackett & Betz, 1989, p.262). Previous studies have reported that self-efficacy belief toward mathematic is related with students' achievements (Pajares, 1996; Pajares & Miller, 1995; Zimmerman, 2000; Zimmerman, Bandura & Martinez-Pons, 1992) and their mathematical achievements (Hackett & Betz, 1989; Pajares & Graham, 1999; Pietsch, Walker & Cahpman 2003).

Additionally, teachers also play an important role in mathematics teaching because they serve as models for their students and shape their lives (Memişoğlu, 2008). Teachers' self-efficacy beliefs effect their students' emotional, social and academic states and shape their academic tendencies. For this reason, "teachers' self-efficacy belief" should be emphasized (Akbaş & Çelikkaleli, 2006). Teacher self-efficacy belief is defined as "teachers' beliefs in their skills of affecting their students' learning positively" (Ashton, 1985); and it is very important in students' learning mathematics effectively (Dede, 2008). An incompetent teacher cannot be expected to provide their students with confidence and constitute an authority based on respect in the classroom. Accordingly, well-trained pre-service mathematics teachers are expected to have high self-efficacy beliefs toward mathematics (Umay, 2001).

In addition individuals with low self-efficacy belief toward mathematics were reported to have high mathematics anxiety (Hackett & Betz, 1989). Anxiety, as one of the affective factors, refers to stimulation resulted from physical, emotional and mental changes, that occur when individuals encounter stimulants (Aiken, 1976; Özdemir & Gür, 2011). A certain extent of anxiety increases motivation and enables learning (Binbaşıoğlu, 1995) and the sense of anxiety results from the withdrawal of support, expecting negative consequences, internal conflicts and uncertainty (Cüceloğlu, 2011). Mathematics is a domain that can raise anxiety among individuals (Özdemir & Gür, 2011).

Richardson and Suinn (1972, p. 51) defined mathematics anxiety as "the feeling of worry and tension that prevents the use of numbers in daily life and academic environments and the solution of mathematical problems". Students, who cannot understand the solution of mathematical problems, experience disappointment as a result of their failure in mathematical operations. Negative reactions forming in time result in the formation and development of mathematics anxiety (Alkan, 2011). One of the most important factors affecting the formation of mathematics anxiety is reported as the mathematics teachers' effects on their students (Alkan, 2011; Baloğlu, 2001; Hadfield & McNeil, 1994; Peker & Ertekin, 2011). The related literature reports that there is a negative correlation between mathematical achievement and mathematics anxiety (Betz 1978; Douglas, 2000; Dursun & Bindak, 2011; Ma, 1999; Meece, Wigfield & Eccles, 1990; Nazlıçiçek, 2007; Richardson & Suinn, 1972; Şentürk, 2010).

Mathematics anxiety starts in the first years of school. Besides teachers' attitudes, parents' attitudes are also an important factor on mathematics anxiety (Bindak, 2005). Accordingly, teachers' experiencing anxiety in mathematics and mathematics teaching will result in students' experiences anxiety toward mathematics. Mathematics teaching anxiety refers to "the feelings of tension and anxiety experienced by teachers when working with mathematical concepts, theorems, formulas or problems" (Peker, 2006, p. 77). It was reported that there is a correlation between mathematics anxiety and mathematics teaching anxiety (Brown, Westenskow & Moyer-Packenham, 2011; Haciömeroğlu, 2014; Peker & Ertekin, 2011). Teachers, who have high mathematics anxiety, cannot enjoy teaching mathematics and therefore cannot be successful in teaching mathematics (Brown, Westenskow & Moyer-Packenham, 2011). In this case, teachers, responsible for mathematics education in primary education, should have high self-efficacy beliefs toward mathematics teaching and should not have mathematics anxiety (Doruk & Kaplan, 2012).

Defining the factors affecting teachers' mathematics teaching is important in terms of developing the process of mathematics teaching. According to the related literature, there are correlations between self-efficacy beliefs toward mathematics and self-efficacy beliefs toward mathematics teaching (Ünlü & Ertekin, 2013); between mathematics anxiety and mathematics teaching anxiety (Hacıömeroğlu, 2014; Peker & Ertekin, 2011); between mathematics anxiety and self-efficacy beliefs toward teaching (Gresham, 2008; Swars, Daane & Giesen, 2006)

and between students' self-efficacy, self-confidence and mathematics anxiety (Alkan, 2011; Meece et al., 1990, Pajares & Kranzler, 1995; Pajares & Miller, 1995; Zimmerman & Clearly, 2006).

However, previous studies in the related literature have studied these variables separately, and tested the correlations between paired variables. The literature does not include any studies on developing a model that covers the variables of self-efficacy beliefs and anxiety toward mathematics and self-efficacy beliefs and anxiety toward mathematics teaching. The present research is important in terms of defining the relationships between the most frequently studied variables; self-efficacy beliefs toward mathematics, mathematics anxiety, self-efficacy beliefs toward mathematics teaching and mathematics teaching anxiety, and presenting the relationships between these variables with structural equation model. It is believed that the present research will fill the gap in the related literature and its findings, will shed light on teachers, mathematics educators and researchers, who will conduct researches on the field of mathematics education.

Method

Research Design

The present research, which has a quantitative research paradigm, aims to investigate the relationships between self-efficacy beliefs toward mathematics, mathematics anxiety, self-efficacy beliefs towards mathematics teaching and mathematics teaching anxiety of pre-service mathematics teachers and testing the relationships between these variables with structural equation model. For this reason, a subtype of survey model; relational survey model was preferred as the research design, in order to provide a generalization and description of the universe with the data on the aforementioned variables obtained from the pre-service teachers and to define the relationships between those variables. Survey model enables the definition of the tendencies, attitudes or opinions of a research universe through a sample, quantitatively or in numbers (Fowler, 2008). On the other hand, relational survey model aims to investigate the relationships between two or more variables and obtaining clues on cause-and-effect relationships (Büyüköztürk, Kılıç-Çakmak, Akgün, Karadeniz & Demirel, 2008).

Participants

Participants of the present research consists of 380 university students, who studied at the department of Elementary Mathematics Education at two state universities in two different cities in the spring semester of 2015-2016 academic year. Of these 380 students, 65 were 1st year, 105 were 2nd year, 110 were 3rd year and 100 were 4th year students. The sample of the research was selected through convenient sampling method. In convenient sampling method, the sample to be studied is selected among units that can be accessed and studied easily (Büyüköztürk et al., 2008). The ages of the pre-service teachers ranged between 18 and 25. Some of these pre-service teachers had taken courses on mathematics teaching, while some hadn't by the time the present research was conducted. In order to be able obtain a bigger picture of the universe, data collection tools were implemented on all students who were enrolled to the department of Mathematics Teaching.

Data Collection Tools

In order to collect data for the research, "Self-efficacy beliefs toward Mathematics Scale" developed by Umay (2001), "Self-efficacy beliefs toward Mathematics Teaching Scale" developed by Dede (2008), "Mathematics Anxiety Scale" developed by Erktin, Dönmez & Özel (2006) and "Mathematics Teaching Anxiety Scale" developed by Peker (2006) were utilized. Psychometric features of these scales are presented below under the related titles.

Self-efficacy Beliefs toward Mathematics Scale

"Self-efficacy beliefs toward Mathematics Scale" was developed by Umay (2001). The scale consists of 3 dimensions as; 5 items (items: 5, 10, 11, 12 and 13) on "mathematics self-perception", 6 items (items: 4, 5, 6, 7, 8 and 9) on "behavioural awareness on mathematic subjects", and 3 items (items: 1, 2 and 14) on "the ability to transform mathematics into life skills", with a total of 14 items. Cronbach Alpha reliability coefficient, which is an indicator of internal consistency, was calculated as .88. In this research Cronbach's alpha was found 0.89.

Self-efficacy Beliefs toward Mathematics Teaching Scale

"Self-efficacy beliefs toward Mathematics Teaching Scale" was developed by Dede (2008). The scale consists of 14 items and three dimensions as; "efficacy in teaching" (4 items), "motivating and taking responsibility" (6 items) and "effective teaching" (4 items), which can explain the 48% of the total variance. Factor loads of the items range between .44 and .78 according to the rotated components analysis. Cronbach Alpha reliability coefficient, which was calculated as .799. In this research Cronbach's alpha was found .77.

Mathematics Anxiety Scale

Mathematics Anxiety Scale is a four point Likert type scale which consists of 4 factors. Of these factors "exam and evaluation anxiety", "hesitating from mathematics", "anxiety about using mathematics in daily life" and "finding themselves efficient in mathematics" (Erktin, Dönmez & Özel, 2006). Pilot study of the Mathematics Anxiety Scale (MAS) was conducted on 145 students in first adaptation scale (Erol, 1989). The scale consists of four-choice 45 items, and the lowest score from the scale can be 45 while the highest is 180. According to the scores obtained from the scale; 45-68 points indicate low anxiety, 69-108 points indicate normal anxiety, 109-128 points indicate anxiety and 129-180 points indicate high anxiety (Erktin, Dönmez & Özel, 2006). Cronbach alpha coefficient was calculated as .91 for the first reliability test and in this research Cronbach's alpha was found .88.

Mathematics Teaching Anxiety Scale

Mathematics Teaching Anxiety Scale consists of 23 items scored on a 5-point likert type scale. It was developed by Peker (2006) consists of 4 factors. Of these factors, "anxiety resulting from content knowledge" consists of 10 items, factor loads of which range between .53 and .86; "anxiety resulting from self-confidence" consists of 6 items, factors loads of which range between .57 and .76; "anxiety resulting from the attitude towards teaching mathematics" consists of 4 items, factor loads of which range between .61 and .70, and "anxiety resulting from content education knowledge" consists of 3 items, factors loads of which range between .68 and .78. Reliability coefficient was calculates as .91 for the whole scale; .90 for anxiety resulting from content knowledge factor; .83 for anxiety resulting from self-confidence factor; .71 for anxiety resulting from attitude towards teaching mathematics factor; and .61 for anxiety resulting from content education knowledge factor. In this research Cronbach's alpha was found .87.

Data Analysis

Structural equation modelling analysis was conducted in order to define the relationships between pre-service teachers' self-efficacy beliefs toward mathematics; mathematics anxiety and self-efficacy beliefs toward mathematics teaching and mathematics teaching anxiety variables and to test the relationships between these variables. Structural equation modelling is a statistical approach that reveals the causal and reciprocal relationships between observed and latent variables in order to test a theoretic model (Shumacker & Lomax, 2004). Structural equation modelling analysis was conducted on AMOS 19.0 Program for the present research.

Findings

The obtained model (X^2 = 213.685, df = 67, $p < .001$) includes an exogenous (mathematics anxiety) and three endogenous (mathematics teaching anxiety, self-efficacy beliefs toward mathematics and self-efficacy beliefs toward mathematics teaching) data. Every path presented in the model was found statistically significant. The Bentler-Bonett normed fit index (NFI), The Tucker-Lewis coefficient fit index (TLI) and other fit indices showed that the model presents a good fit (Table 1). Every two-way correlation between endogenous data in the model is high and statistically significant. These values are also affected from the correlation values of the sub-dimensions of the scales used in the research. Some fit indices were given in Table 1.

Table 1. Statistical values related to the fitting of structural equation model

Measure	Good fit	Acceptable fit	Fit Index Values of the Model
(X^2/sd)	≤ 3	≤ 4-5	3.189
RMSEA	≤ 0.05	0.06-0.08	0.08
SRMR	≤ 0.05	0.06-0.08	0.05
NFI	≥ 0.95	0.94-0.90	0.92
CFI	≥ 0.97	≥ 0.95	0.95
GFI	≥ 0.90	0.89-0.85	0.91
AGFI	≥ 0.90	0.89-0.85	0.90
TLI	≥ 0.95	0.94-0.90	0.93

According to the fit values presented in Table 1, X^2/sd =3.189, RMSEA= 0.08, SRMR=0.050, NFI =0.92, CFI = 0.95, GFI =0.91, AGFI= 0.90 and TLI = 0.93. Generally, the model has desired fit values (Bollen, 1989; Browne & Cudeck, 1993; Byrne, 2010; Hu & Bentler, 1999; Kline, 2011; Tanaka & Huba, 1985). Tested single factor model is presented in Figure 1. All paths presented in the model are significant at .001 level.

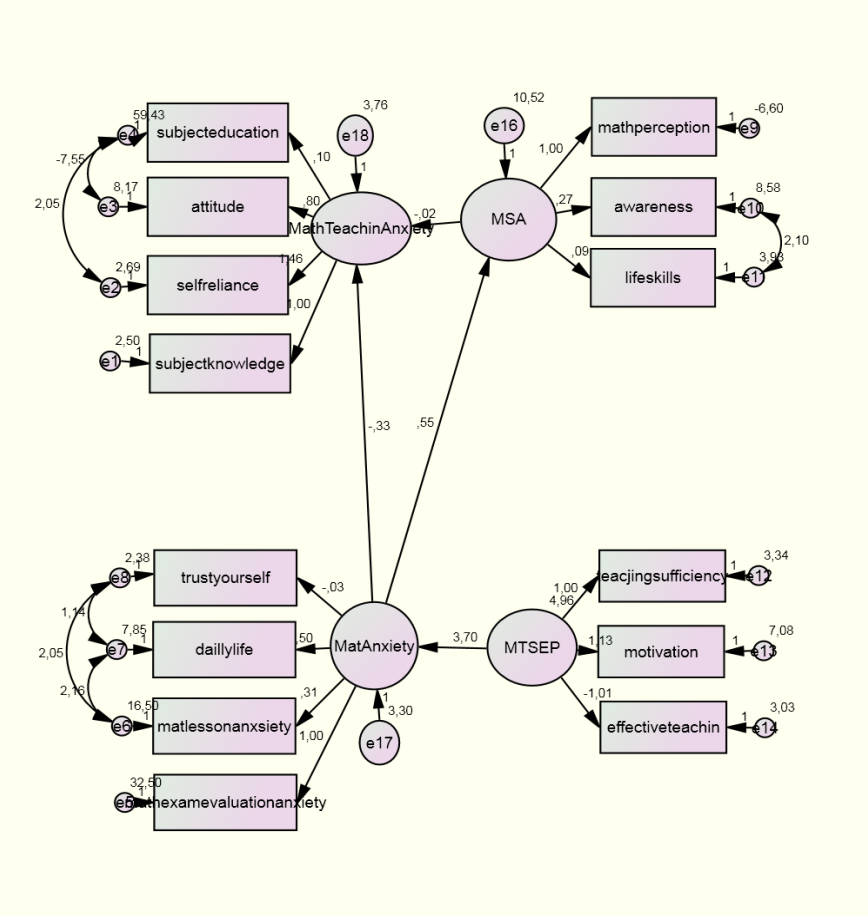

Figure 1. Path analysis for the model

Fit Indices for the predicting relationships between mathematics anxiety, mathematics teaching anxiety, self-efficacy beliefs towards mathematics and self-efficacy beliefs towards mathematics teaching of pre-service mathematics teachers were shown in Table 2.

According to the model presented in Figure 1, the most important independent variable affecting mathematics teaching anxiety is mathematics anxiety ($t = -4.28$, $p < 0.01$). Regression coefficient for this factor was calculated as $\beta = -0.82$. Predicting pre-service mathematics teachers' relationships between mathematics anxiety and mathematics teaching anxiety show that there is a positive linear correlation between these two variables. In other words, as the mathematics anxiety decreases, mathematics teaching anxiety decreases accordingly.

The model also indicated that the most important independent variable affecting self-efficacy beliefs towards mathematics teaching is mathematics anxiety ($t = -4.83$, $p < 0.01$). Regression coefficient for this factor was calculated as $\beta = -0.25$. Predicting relationships between pre-service mathematics teachers' mathematics anxiety and self-efficacy beliefs toward mathematics teaching show that there is a negative linear correlation between these two variables. According to this finding, as the mathematics anxiety decreases, self-efficacy beliefs toward mathematics teaching increases.

Table 2. Fit indices for the model

Predictor Variable	Dependent Variable	Total Effect	Direct Effect	Indirect Effect	Standard Error	Critical Value
Mathematics anxiety	Mathematics teaching anxiety	-0.82	0.82	0	0.64	-4.28*
Mathematics anxiety	Self-efficacy beliefs towards Mathematics teaching	-.025	-.025	0	0.55	-4.83*
Self-efficacy beliefs towards Mathematics	Mathematics anxiety	-0.98	-0.98	0	0.37	-7.50*
Self-efficacy beliefs towards Mathematics teaching	Mathematics teaching anxiety	-0.72	-0.72		0.44	-7.12

[a] Total effect = Direct effect + Indirect effect, $*p < 0.01$, $**p < 0.05$.

In addition the most important independent variable affecting mathematics anxiety is self-efficacy beliefs towards mathematics ($t = -7.50$, $p < 0.01$). Regression coefficient for this factor was calculated as $\beta = -0.98$. Predicting relationships between mathematics anxiety and self-efficacy beliefs toward mathematics of pre-service mathematics teachers show that there is a negative linear correlation between these two variables. In other words, as the self-efficacy beliefs toward mathematics increases, mathematics anxiety decreases.

Finally, according to the tested model, the most important independent variable affecting mathematics teaching anxiety is self-efficacy beliefs towards mathematics teaching ($t = -7.12$, $p < 0.01$). Regression coefficient for this factor was calculated as $\beta = -0.72$. Predicting relationships between mathematics teaching anxiety and self-efficacy beliefs toward mathematics teaching of pre-service mathematics teachers show that there is a negative linear correlation between these two variables. In other words, as the self-efficacy beliefs toward mathematics teaching increases, mathematics teaching anxiety decreases.

Discussion and Conclusion

The present research defined the relationships between self-efficacy beliefs towards mathematics, mathematics anxiety and self-efficacy beliefs towards mathematics teaching, mathematics teaching anxiety variables with structural equation model. In order to achieve this purpose, a structural equation model was formed in accordance with theoretical base and researches, and the model was tested. According to the findings, the model formed with the related variables has desired fit values. In addition the obtained model includes an exogenous (mathematics anxiety) and three endogenous (mathematics teaching anxiety, self-efficacy beliefs toward mathematics and self-efficacy beliefs toward mathematics teaching) data. Every path presented in the model was found statistically significant.

According to the findings obtained from the model, the most important independent variable affecting mathematics teaching anxiety is mathematics anxiety. There is a positive linear correlation between pre-service mathematics teachers' mathematics anxiety and mathematics teaching anxiety. These findings indicate that as the mathematics anxiety decreases, mathematics teaching anxiety decreases accordingly. Findings of the similar studies in the related literature are in agreement with this finding (Haciömeroğlu, 2014; Hadley & Dorward, 2011; Peker & Ertekin, 2011).

Having high mathematics anxiety will cause pre-service teachers, who are the teachers of the future, to have anxiety toward working with the mathematical concepts, theorems, formulas or problems as well. Teachers' having anxiety will cause their students to have anxiety. Additionally, Brown, Westenskow & Moyer-Packenham (2011) reported that the relationship between mathematics anxiety and mathematics teaching

anxiety was not always the same for every pre-service teacher, and like pre-service teachers with high mathematics anxiety, pre-service teachers with low mathematics anxiety may also have mathematics teaching anxiety.

According to the findings, the most important independent variable affecting self-efficacy beliefs towards mathematics teaching is mathematics anxiety. Predicting relationships between pre-service mathematics teachers' mathematics anxiety and self-efficacy beliefs toward mathematics teaching show that there is a negative linear correlation between these two variables, which indicate that, as the mathematics anxiety decreases, self-efficacy beliefs toward mathematics teaching increases. Considering that teachers' self-efficacy beliefs are very important in terms of their teaching mathematics (Dede, 2008) and it can be claimed that a pre-service teachers with high mathematics anxiety is likely to be unsuccessful in teaching mathematics.

Swars, Daane and Giesen (2006) also reported that there was a negative correlation between mathematics anxiety and efficacy towards mathematics teaching, and pre-service teachers with low mathematics anxiety had high mathematics teaching efficacy. Findings of other similar studies in the related literature are in agreement with these findings as well (Bursal & Paznokas, 2006; Gresham, 2008). On the other hand, this finding of the present research is not in agreement with the findings of the researches conducted by Doruk & Kaplan (2012) and Işıksal (2010), who reported that there wasn't a relationship between mathematics anxiety and self-efficacy beliefs towards mathematics teaching.

Another finding of this research is that the most important independent variable affecting mathematics anxiety is self-efficacy beliefs towards mathematics. Examination of the predicting relationships between pre-service mathematics teachers' mathematics anxiety and self-efficacy beliefs toward mathematics shows that there is a negative linear correlation between these two variables. This finding shows that as the self-efficacy beliefs toward mathematics increases, mathematics anxiety decreases. Hackett and Betz (1989) also reported that individuals with lower self-efficacy beliefs towards mathematics had higher levels of mathematics anxiety. The failure experienced despite the efforts made, and the related disappointment result in the decrease of self-efficacy beliefs and increase in the mathematics anxiety. This finding is also in agreement with the findings of the similar studies in the literature (Alkan, 2011; Meece et al., 1990, Pajares & Kranzler, 1995, Pajares & Miller, 1995; Zimmerman & Clearly, 2006).

Consequently, according to the findings obtained from the model, the most important independent variable affecting mathematics teaching anxiety is self-efficacy beliefs towards mathematics teaching. It was also found that there is a negative linear correlation between mathematics teaching anxiety and self-efficacy beliefs toward mathematics teaching. These findings indicate that as the self-efficacy beliefs toward mathematics teaching increases, mathematics teaching anxiety decreases. Peker (2015) also revealed that there is a significant negative relationship between pre-service primary school teachers' mathematics teaching anxiety and their self-efficacy beliefs toward mathematics teaching. This finding is also in agreement with the findings of this research. Considering the active role, the teacher play in mathematics education, teachers' beliefs in their ability to affect their students' learning mathematics, can decrease the sense of tension they experience in teaching mathematics.

Recommendations

In the light of all these findings, it can be suggested that teacher-training programs should include activities to increase pre-service teachers' self-efficacy beliefs towards mathematics teaching and decrease their mathematics teaching anxiety. These findings can be supported with qualitative studies. Finally, further studies can be conducted at different levels of education in order to define the relationships between the affective characteristics.

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