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Preservice Early Childhood Education Teachers' Mathematics Teaching Efficacy Beliefs and Mathematics Anxieties

Okul Öncesi Öğretmen Adaylarının Matematik Öğretimine Yönelik Öz-Yeterlik Algıları ve Matematik Kaygıları

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Abstract
This study investigated mathematics teaching efficacy beliefs and mathematics anxieties of preservice Early Childhood Education (ECE) teachers. Furthermore, the difference between preservice ECE teachers' mathematics teaching efficacy beliefs and mathematics anxieties across the grade levels, and the relationship between these two variables were investigated. The data sources were Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) and Mathematics Anxiety Scale-Revised (MAS-R). Findings revealed that preservice ECE teachers have relatively high levels of mathematics teaching efficacy and low levels of mathematics anxiety. Furthermore, 3rd and 4th grade preservice ECE teachers had significantly higher mathematics teaching efficacy beliefs than 1st grade preservice ECE teachers, and 3rd grade preservice ECE teachers had significantly higher levels of mathematics anxiety than 2nd and 4th grade preservice ECE teachers. There was a moderate negative relationship between mathematics teaching efficacy beliefs and mathematics anxiety. All these findings were presented and discussed in detail in the current study.

Keywords: Early childhood education, preservice teachers, mathematics teaching efficacy, mathematics anxiety

Öz
Bu çalışmada okulöncesi öğretmen adaylarının matematik öğretimine yönelik öz-yeterlik algıları ve matematik kaygıları araştırılmıştır. Ayrıca, öğretmen adaylarının matematik öğretimine yönelik öz-yeterlik algılarının ve matematik kaygılarının öğretmen eğitim programındaki yıllara göre farklılık gösterip göstermediği ve matematik öğretimine yönelik öz-yeterlik algıları ile matematik kaygılarının ilişkili olup olmadığı da araştırılmıştır. Veri toplama aracı olarak Matematik Öğretimine Yönelik Öz Yeterlik Algısı Ölçeği ve Düzenlenmiş Matematik Kaygı Ölçeği kullanılmıştır. Çalışma bulguları, çalışmaya katılan öğretmen adaylarının görece yüksek öz-yeterlik algılarına ve düşük matematik kaygısına sahip olduğunu göstermiştir. Ayrıca, 3. ve 4. sınıf öğretmen adaylarının 1. sınıf öğretmen adaylarından anlamlı olarak daha yüksek öz-yeterlik algılarına sahip oldukları ve 3. Sınıf öğretmen adaylarının 2. ve 4. sınıf öğretmen adaylarından anlamlı olarak daha yüksek matematik kaygısına sahip oldukları sonucuna ulaşılmıştır. Öğretmen adaylarının matematik öğretimine yönelik öz-yeterlik algıları ile matematik kaygıları arasında da negatif yönlü orta dereceli bir ilişki bulunmuştur. Tüm bu bulgular çalışma içerisinde detaylı bir şekilde açıklanmış ve tartışılmıştır.

Anahtar Kelimeler: Okul öncesi eğitimi, öğretmen adayları, matematik öğretimi öz-yeterlik algıları, matematik kaygısı

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1. Introduction

It is widely acknowledged that early years are highly crucial for young children in developing a robust mathematical understanding, thus mathematics education became an integral part of early childhood education and there has been increasing interest in research (Cohrssen & Tayler, 2016; Hachey, 2013; Linder & Simpson, 2017; Stipek, 2013). In line with the reform efforts that started in 2006 in Turkey, mathematics education gained increased attention in the education of young children and Early Childhood Education (ECE) teachers (Haktanır, 2008; Sancar-Tokmak, 2015). In the national context, ECE teachers are expected to create learner-centered mathematical learning environments for young children in order to support their mathematical understanding and developing positive attitudes towards mathematics (MONE, 2013). In achieving these aims, in addition to the cognitive development of teachers, affective development of teachers—developing positive beliefs and attitudes towards mathematics and its teaching, feeling competent in mathematics and its teaching, having low levels of mathematics anxiety, experiencing positive emotions in dealing with mathematics and its teaching—is also crucial. Although there are many studies related to these affective factors for elementary, middle and high school level teachers and teacher candidates in the literature, there is very limited study in the early childhood level. Therefore, the current study aimed to contributed to existing limited literature via focusing on preservice ECE teachers' mathematics teaching efficacy beliefs and mathematics anxieties.

In the literature, teaching efficacy was defined as *"A teacher's judgement of his or her capabilities to bring about desired outcomes of student engagement and learning, even among those students who may be difficult or unmotivated"* (Tschannen-Moran & Hoy, 2001, p. 783). It comprised of two dimensions: Personal teaching efficacy and teaching outcome expectancy (Enochs, Smith, & Huinker, 2000). While personal teaching efficacy was related to teachers' own beliefs on making an effective teaching, teaching outcome expectancy was interested in the teachers' beliefs that effective teaching of mathematics can lead to student learning without external factors. According to Woolfolk and Hoy (1990), teaching efficacy is an important factor in determining mathematics teaching strategy. It was stated that teachers who had high teacher efficacy showed more effective mathematics teaching compared to teachers with low teacher efficacy. Furthermore, earlier studies indicated that teachers who have high level of teaching efficacy beliefs are more likely to apply learner-centered and innovative teaching methods rather than traditional teacher-centered approaches (Czerniak, 1990). When the studies related to mathematics teaching efficacy beliefs of teachers and/or teacher candidates are investigated, it was seen that there are very limited studies in early childhood level. In one of the studies, Kim and Connelly (2019) found the high levels of mathematics teaching efficacy of preservice ECE teachers. Furthermore, it was revealed that harmonious passion was the most significant predictor of participants' mathematics teaching efficacy beliefs. In another study, Sancar-Tokmak (2015) investigated how ECE teachers' mathematics teaching efficacy beliefs were changed after the course related to curriculum-generated play instruction. Results revealed that preservice teachers had higher levels of mathematics teaching efficacy beliefs after the course. Similarly, Cohrssen and Tayler (2016) found that play-based course in mathematics teaching improved participant preservice ECE teachers' content knowledge and efficacy in mathematics teaching. In another study, Jett (2018) found that the use of children literature in mathematics education course in the teacher education program, positively contributed to preservice ECE teachers' efficacy in mathematics and its teaching. Bandura (1997) claimed that efficacy might show resistance to change. However, the findings revealed in the above-mentioned studies illustrated that teaching efficacy beliefs might be improved during the teacher education programs. Therefore, giving importance to preservice teachers' teaching efficacy beliefs and making research about it is considered as valuable (Swars, Daane, & Giesen, 2010; Woolfolk & Hoy, 1990).

Mathematics anxiety was defined as *"feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of ordinary life and academic situations"* (Richardson & Suinn, 1972, p. 551). Mathematics anxiety is crucial in terms of student learning and effectiveness of teacher while teaching (Hembree, 1990). In the literature, it was mentioned that teachers who have high levels of mathematics anxiety avoid teaching mathematics, spend less time on mathematics activities, and prefer lecturing rather than learner centered methods (Gresham, 2018; Hollingsworth & Knight-McKenna, 2018). Moreover, it was found that teachers who have mathematics anxiety may make their students have early anxiety and these teachers' mathematics anxiety adversely influence their students' success in mathematics (Martinez, 1987). In the accessible literature, it was seen that many researchers focused on the mathematics anxieties of preservice elementary teachers (e.g., Brown, Westenskow & Moyer-Packenham, 2011; Hacıömeroğlu, 2013; Işıksal, 2010; Swars, Daane, & Gresen, 2010), there is not much study investigating preservice ECE teachers' mathematics anxiety. In these limited studies, it was stressed that preservice ECE teachers have some serious fears related to mathematics and its teaching (see Bates, Latham, & Kim, 2013; Ginsburg, Lee, & Boyd, 2008; Hachey, 2009) which might be developed because of different factors such as poor mathematics experiences in schools, societal and parental beliefs, and expectations related to

mathematics (Ramirez, Shaw, & Maloney, 2018). Preservice teachers who experience mathematics anxiety are likely to experience anxiety in their in-service years (Gresham, 2018), and thus determining preservice teachers' mathematics anxiety during the teacher education programs are necessary to help them overcome their anxieties (Harper & Daane, 1998). Therefore, mathematics anxiety topic is worth of investigation for preservice ECE teachers.

There might be a relationship between mathematics teaching efficacy beliefs and mathematics anxiety (Wenta, 2000). This potential relationship is investigated predominantly with elementary preservice teachers and moderate negative relationship was found between mathematics teaching efficacy and mathematics anxiety (e.g., Gresham, 2008; 2009; Swars, Daane, & Gresen, 2010). Furthermore, in a recent study conducted by Heffernan and Newton (2019), it was revealed that mathematics education course helped preservice ECE teachers to replace mathematics anxiety with self-efficacy for teaching mathematics which might also be interpreted as an indication of negative relationship. However, Lee (2009) investigated students' mathematics self-efficacy, mathematics anxiety and mathematics performance based on the data obtained from PISA 2003. Results displayed that it is difficult to explain a relationship consistent across all countries and cultural factors play an important role in explaining the differences on the relationships among these variables. In order to extend the knowledge in the literature, it was decided to investigate this potential relationship for preservice ECE teachers in the current study.

As explained detailed above, the current study mainly aimed to investigate mathematics teaching efficacy beliefs and mathematics anxieties of preservice ECE teachers in one of Turkish universities. Specifically, the following research questions were investigated:

1- What are the mathematics teaching efficacy beliefs and mathematics anxieties of preservice ECE teachers?

2- Is there any significant change in preservice ECE teachers' mathematics teaching efficacy beliefs and mathematics anxieties across the grade levels in the teacher education program?

3- Is there any significant relationship between preservice ECE teachers' mathematics teaching efficacy beliefs and their mathematics anxiety?

2. Method

2.1. Research Design

In this quantitative research study, it is aimed to explore mathematics teaching efficacy beliefs and mathematics anxieties of preservice ECE teachers, the relationship between these two constructs, and how these beliefs and anxieties change across the grade levels in the teacher education program. In line with these purposes, it is benefitted from more than one quantitative research design. Survey research design principles were applied for the first research question, and associational research (casual-comparative and correlational research) design principles were followed for the second and third research questions of the study. Therefore, research design of the study could be described as survey research combined with associational research. Combining survey and associational research design is described as a commonly used research design in the literature (Fraenkel & Wallen, 2006), moreover some researchers consider associational research as a subset of survey research (Sönmez & Alacapınar, 2017).

2.2. Participants and Context

The sample of this study consists of preservice teachers who were studying in ECE program in one of the universities in Ankara/Turkey. In total, 146 voluntary preservice ECE teachers participated in this study. Among the participants, 33 of them were 1st graders, 25 of them were 2nd graders, 40 of them were 3rd graders, and 48 of them were 4th graders. In line with the general profile of ECE programs in Turkey, most of the preservice teachers were female, there were only few male participants in each grade level. No information regarding gender was asked in the questionnaire since it was thought that it might affect the confidentiality of the participants.

In Turkish context, preservice ECE teachers need to fulfill 240 ECTS course in three domains namely: Educational Knowledge (e.g., Introduction to Education, Teaching Philosophy), General Culture Knowledge (e.g., History, Community Service), and Content Knowledge (e.g., Music Education in Early Childhood, Science Education in Early Childhood). Mathematics Teaching in Early Childhood was the only course related to mathematics education during the 4 years long teacher education program. This course was offered to the participants in 3rd grade in the teacher education program in order to enhance their knowledge on the effective ways of teaching mathematics to early childhood students. However, it should be mentioned that there were no available data informing participants' prior experiences related to mathematics before entering the teacher education program which could be regarded as one of the limitations of the study.

2.3. Data Collection Tools and Analysis

The data for this study was collected at the end of the 2015-2016 academic year via two Likert type scales: Mathematics Teaching Efficacy Belief Instrument (MTEBI) and Mathematics Anxiety Scale-Revised (MAS-R). MTEBI was developed by Enochs, Smith, and Huinker (2000) and adapted to Turkish by Çakıroğlu (2000). This scale consists of two dimensions namely Personal Mathematics Teaching Efficacy (PMTE) with 13 items and Mathematics Teaching Outcome Expectancy (MTOE) with 8 items. There are five response categories of the scale ranging from strongly disagree (1) to strongly agree (5). Before conducting the analyses, required recoding was completed for the reverse items. Therefore, scoring high on MTEBI was associated with having higher levels of mathematics teaching efficacy—higher levels of personal mathematics teaching efficacy and mathematics teaching outcome expectancy as well. The maximum score could be obtained from MTEBI was 105 (highest level of mathematics teaching efficacy) whereas the minimum score was 21 (lowest level of mathematics teaching efficacy). Sample items of MTEBI scale is given in Table 1.

Table 1
Sample Items of MTEBI

Dimension	English Version
Personal Mathematics Teaching Efficacy	I will continually find better ways to teach mathematics effectively
	I know how to teach mathematics concepts effectively
Mathematics Teaching Outcome Expectancy	The inadequacy of a student's mathematics background can be overcome by good teaching
	When a low achieving child progresses in mathematics, it is usually due to extra attention given by the teacher

In order to ensure the validity of the scale for the data collected in this study, confirmatory factor analysis was applied via LISREL. The calculated fit indices were as follows: The Root Mean Square Error of Approximation (RMSEA) = 0.071, The Goodness of Fit Index (GFI) = 0.82, and The Comparative Fit Index (CFI) = 0.94. These calculated RMSEA, CFI and GFI indexes were interpreted as evidence of good fit (Kelloway, 1998; Kliene, 2005; Hu & Bentler, 1999), thus ensures the validity of the scale for the sample in this study. Reliability of the data obtained through MTEBI was investigated via calculating Cronbach alpha value. Cronbach alpha value was calculated as 0.81 for MTEBI, specifically 0.76 for PMTE dimension and 0.85 for MTOE dimension. All these calculated Cronbach alpha values were higher than the required 0.70 value, thus could be interpreted as satisfactory for the internal consistency of the data (Pallant, 2007).

The second scale used in this study was MAS-R which was developed by Bai (2011) and adapted into Turkish by Aslan (2013). MAS-R consists of two dimensions called Positive Affect (6 items) and Negative Affect (8 items). MAS-R is 5-point Likert scale in which options range from strongly disagree (1) to strongly agree (5). Before the analyses, recoding was carried out for the items in Positive Affect dimension. Therefore, high scores obtained from MAS-R were associated with high levels of mathematics anxiety. The maximum score could be obtained from MAS-R was 70 (highest level of mathematics anxiety) whereas the minimum score was 14 (lowest level of mathematics anxiety). Sample items of MAS-R can be seen in Table 2.

Table 2
Sample Items of MAS-R

Dimension	Item
Positive Affect	I find mathematics interesting
	Math relates to my life
Negative Affect	I get uptight during math tests
	I find mathematics challenging

Similar procedure with MTEBI was applied for MAS-R in order to ensure validity and reliability of the obtained data. In confirmatory factor analysis, RMSEA was calculated as 0.075 which indicates a good fit (Kelloway, 1998). The other calculated fit indices (GFI=0.88, CFI=0.98) also indicated hypothesized factor structure fits the data obtained in the current study well (Hu & Bentler, 1999). Furthermore, calculated Cronbach alpha values (Total

MAS-R = 0.86, Positive Affect = 0.91, Negative Affect = 0.87) indicated the high internal consistency of the data (Pallant, 2007).

In analyzing the data, firstly required recoding was carried for both of the scales, and total scores were calculated for each participant in both of the scales. Then, descriptive statistics were calculated to establish preservice ECE teachers' mathematics teaching efficacy beliefs and mathematics anxieties. After the calculation of descriptive statistics, normality of the obtained scores from both of the scales was checked. In total and each grade level, skewness and kurtosis values for the obtained scores from both of the scales were found in between the desired range of -2 and 2, thus interpreted that there is no violation of normality assumption of parametric tests (Pallant, 2007). Therefore, in order to investigate whether there is a significant change in preservice ECE teachers' mathematics teaching efficacy beliefs and mathematics anxieties across the grade levels in the teacher education program, one-way between-groups ANOVA with post-hoc tests was applied. As the final step, correlation analysis was applied in order to establish the relationship between preservice ECE teachers' mathematics teaching efficacy beliefs and their mathematics anxiety. In the inferential analyses, signification level was determined as .05.

3. Findings

In this part of the study, findings were given respectively below for each research question of the study.

3.1. Mathematics Teaching Efficacy Beliefs of Preservice ECE Teachers

Descriptive analysis results (see Table 3) indicated that preservice teachers had higher scores than the average level in MTEBI (Average Score = 63), PMTE (Average Score = 39), and MTOE (Average Score = 24) in all grade levels. Therefore, it is possible to claim that preservice teachers had relatively high levels of mathematics teaching efficacy. Furthermore, there was an increase on preservice ECE teachers' total mean scores on MTEBI scale and its two dimensions (PMTE and MTOE) across the grade levels in the teacher education program.

Table 3
Descriptive Statistics for MTEBI and Its Dimensions

Scale	Grade	Mean	Std. Deviation
MTEBI	1	77,00	10,44
	2	80,65	10,20
	3	83,80	10,17
	4	85,00	11,09
	Total	82,11	10,91
PMTE	1	49,22	9,53
	2	51,12	6,40
	3	53,13	6,98
	4	54,73	9,00
	Total	52,44	8,41
MTOE	1	27,81	4,93
	2	29,12	5,13
	3	31,27	4,57
	4	30,26	4,09
	Total	29,74	4,73

In order to explore whether preservice teachers' mathematics teaching efficacy beliefs differ based on grade level, one-way between groups ANOVA was conducted for the data obtained from MTEBI and then for the dimensions of MTEBI, called PMTE and MTOE. Before conducting ANOVA, assumptions of the analysis were checked and it was seen that there was no violation of assumptions. According to one-way between groups ANOVA, there was a statistically significant difference at the $p < .05$ level in MTEBI scores for the four grade levels [$F (3, 131) = 4.011$, $p = .01$]; in PMTE scores [$F (3, 134) = 3.064$, $p = .03$]; and in MTOE scores [$F (3, 135) = 3.582$, $p = .02$]. Details of the analysis can be seen in Table 4 below.

Table 4
ANOVA results for the data obtained through MTEBI

		Sum of Squares	df	Mean Square	F	Sig.
PMTE	Between Groups	622,798	3	207,599	3,064	,030
	Within Groups	9079,238	134	67,756		
	Total	9702,036	137			
MTOE	Between Groups	228,561	3	76,187	3,582	,016
	Within Groups	2871,626	135	21,271		
	Total	3100,187	138			
MTEBI	Between Groups	1342,516	3	447,505	4,011	,009
	Within Groups	14616,817	131	111,579		
	Total	15959,333	134			

Since there was a significant difference in ANOVA for MTEBI and its two dimensions, effect size was calculated via using following formula: Eta squared = Sum of Squares between groups / Total sum of squares (Pallant, 2007). Eta squared was calculated as .06 for PMTE, .07 for MTOE, and .08 for MTEBI. All these calculated eta square values could be interpreted as medium effect in Cohen's (1988) classification.

In order to explore where the significant differences among the pairs specifically lie, post-hoc comparisons using Tukey HSD were applied. For MTEBI scores, it was seen that Grade 1 (M = 77.00, SD = 10.44) was significantly different from Grade 3 (M = 83.80, SD = 10.17) and Grade 4 (M = 85.00, SD = 11.09). In other words, 3rd and 4th grade preservice ECE teachers had significantly higher mathematics teaching efficacy beliefs than 1st grade preservice ECE teachers. There was no significant difference among the other pairs.

For PMTE scores, post-hoc comparisons indicated that Grade 1 (M = 49.23, SD = 9.53) was significantly lower than Grade 4 (M = 54.73, SD = 9.00). For MTOE scores, it was seen that Grade 1 (M = 27.82, SD = 4.93) was significantly lower than Grade 3 (M = 30.26, SD = 4.09). For both PMTE and MTOE scores, there was no significant difference among the all other pairs. Details of post-hoc comparison results can be seen in Table 5 below.

Table 5
Post-hoc comparisons for the data obtained through MTEBI

Dependent Variable	Grade	Grade	Mean Difference	Std. Error	Sig.
PMTE	1	2	-1,89919	2,23804	,831
		3	-3,90933	2,00422	,212
		4	**-5,51332***	1,91275	**,024**
	2	3	-2,01014	2,15740	,788
		4	-3,61413	2,07270	,305
	3	4	-1,60400	1,81774	,814
MTOE	1	2	-1,30682	1,23729	,717
		3	**-3,45960***	1,11151	**,012**
		4	-2,44269	1,05214	,098
	2	3	-2,15278	1,21539	,292
		4	-1,13587	1,16135	,762
	3	4	1,01691	1,02630	,755
MTEBI	1	2	-3,65217	2,90699	,592
		3	**-6,80000***	2,60524	**,049**
		4	**-8,00000***	2,45458	**,008**
	2	3	-3,14783	2,83535	,684
		4	-4,34783	2,69757	,376
	3	4	-1,20000	2,36930	,957

Note. Significant differences among pairs were highlighted with bold.

3.2. Mathematics Anxieties of Preservice ECE Teachers

Firstly, descriptive statistics were calculated for the data obtained through MAS-R (see Table 6). Descriptive statistics indicated that anxiety levels of preservice teachers are lower than the average score that could be obtained from MAS-R (Average Score = 42) in all grade levels. Therefore, it was interpreted that preservice ECE teachers had relatively low levels of mathematics anxiety. When the mean differences across grade levels were taken into

consideration, it was seen that 3rd grade preservice ECE teachers had the highest mathematics anxiety scores whereas 2nd graders had the lowest scores.

Table 6
Descriptive Statistics for MAS-R

Scale	Grade	Mean	Std. Deviation
MAS-R	1	34,66	15,00
	2	29,00	9,01
	3	39,91	6,58
	4	30,87	11,91
	Total	33,78	11,80

Then, one-way between groups ANOVA was performed in order to explore whether there was a significant difference on preservice ECE teachers' mathematics anxieties across grade levels in the teacher education program. Before the analysis, assumptions of the analysis were checked and ensured that there was no violation of assumptions. According to the analysis (see Table 7), there was a statistically significant difference at the $p < .05$ level in MAS-R scores for the four grade levels [$F (3, 138) = 6.368$, $p = .000$]. Eta squared was calculated as .12 which could be interpreted as a medium effect size in Cohen's (1988) categorization.

Table 7
ANOVA results for the data obtained through MAS-R

		Sum of Squares	df	Mean Square	F	Sig.
MAS-R	Between Groups	2388,908	3	796,303	6,368	,000
	Within Groups	17255,324	138	125,039		
	Total	19644,232	141			

As the final step of the analysis, post-hoc comparisons using Tukey HSD were applied. Post-hoc comparisons revealed that Grade 3 (M = 39.91, SD = 6.58) was significantly different from Grade 2 (M = 29.00, SD = 9.01) and Grade 4 (M = 30.87, SD = 11.91). In other words, 3rd grade preservice ECE teachers had significantly higher levels of mathematics anxiety than 2nd and 4th grade preservice ECE teachers. There was no significant difference among the other pairs. Details of the post-hoc comparisons are given in Table 8.

Table 8
Post-hoc comparisons for the data obtained through MAS-R

Dependent Variable	Grade	Grade	Mean Difference	Std. Error	Sig.
MAS-R Score	1	2	5,66667	2,96489	,228
		3	-5,25225	2,67740	,208
		4	3,79433	2,53958	,444
	2	3	**-10,91892***	2,89499	**,001**
		4	-1,87234	2,76802	,906
	3	4	**9,04658***	2,45760	**,002**

Note. Significant differences among pairs were highlighted with bold.

3.3. The Relationship between Mathematics Teaching Efficacy Beliefs and Mathematics Anxiety

Establishing the relationship between mathematics teaching efficacy beliefs of preservice teachers and their mathematics anxieties required to calculate Pearson product moment correlation coefficient. Before conducting the analysis, scatterplots were created to ensure that there was no violation of linearity and homoscedasticity assumptions. Scatterplots created for the relationship between MAS-R and MTEBI—and its dimensions PMTE and MTOE—showed linear lines in a cigar shape. Therefore, it was decided that the data did not violate the assumptions of correlation analysis (Pallant, 2007).

In calculating Pearson product moment correlation coefficient, both MTEBI scores and dimensions of MTEBI (PMTE and MTOE scores) were taken into consideration. Calculated correlation coefficients can be seen in Table 9. In interpreting how strong the relationship is, Cohen's (1988) guide was used.

Table 9
Pearson product-moment correlation coefficients

		MTEBI	PMTE	MTOE
MAS-R	Pearson correlation	-,444	-,507	-,078
	Sig. (2 tailed)	,000	,000	,360
	N	134	137	138

According to the analysis given above, there was a medium negative correlation between MTEBI scores and MAS-R scores [r = -.44, n = 134, p < .05]. That means, high level of mathematics teaching efficacy beliefs of preservice ECE teachers was associated with low level of mathematics anxiety. When the dimensions of MTEBI were taken into consideration, it was seen that there was a strong negative correlation between PMTE and MAS-R scores [r = -.51, n = 137, p < .05]. In other words, preservice ECE teachers who had high level of personal mathematics teaching efficacy beliefs were more likely to have lower level of mathematics anxiety. On the other hand, there was a very small negative correlation—which was not significant—between MTOE and MAS-R scores [r = -.08, n = 138, p > .05]. It was interpreted as there was a very week association between mathematics teaching outcome efficacy beliefs and math anxiety of preservice ECE teachers.

4. Conclusion and Discussion

The findings indicated that preservice ECE teachers in the current study had higher than average scores in mathematics teaching efficacy, thus it was concluded that they felt themselves relatively efficacious in mathematics teaching. When the link between one's efficacy beliefs and perseverance and effectiveness in instruction is taken into consideration (see Bandura, 1997; Woolfolk & Hoy, 1990), this result could be considered as promising. It might be expected that pre-service ECE teachers would be more perseverant and effective in applying learner centered mathematics teaching methods in their future classes. In the further analysis, it was revealed that preservice ECE teachers' mathematics teaching efficacy beliefs increased among years in the university. 3rd and 4th graders had significantly higher mean scores on MTEBI than 1st graders. This result might be expected since participant preservice teachers took a course on mathematics teaching on 3rd grade. The experiences in such lessons might work as a mastery experience for them (Işıksal & Çakıroğlu, 2006) which in turn improve their mathematics teaching efficacy beliefs. Furthermore, experiences in these courses improve preservice ECE teachers' mathematical content knowledge which might lead to feel more efficacious in teaching mathematics (Hollingsworth & Knight-McKenna, 2018). Therefore, offering more mathematics and mathematics education courses in the teacher education program might be beneficial for early childhood education teachers. When their mathematics teaching efficacy beliefs were investigated in terms of the dimensions of MTEBI, it was seen that their PMTE beliefs also increased among years, and 4th graders had the highest mean scores on PMTE which was significantly different than 1st graders. In other words, participants had opportunities in the university to improve their PMTE and when they graduate, their efficacy level was at the highest level. However, when the focus is on MTOE, it was seen that 3rd graders had the highest mean score which was significantly different than 1st graders. Preservice teachers who took mathematics education course at 3rd grade might believe more on their capability to affect student' mathematics learning. However, these beliefs might not be supported with the experiences in teaching practice periods in 4th grade since there was a decrease on MTOE scores at this grade level. In this time period, they might observe the external factors which might have a role on students' mathematical learning which in turn decrease the scores in MTOE dimension. If this was the case, teacher education programs and mentor teachers in the teaching practicum should pay attention on preservice teachers' mathematics teaching outcome expectancies and should provide the necessary support for the preservice teachers.

Negative attitudes and feelings related to mathematics and its teaching are common among ECE teachers (Hachey, 2009; Hollingsworth & Knight-McKenna, 2018). However, in the current study it was revealed that participant preservice ECE teachers had relatively low levels of mathematics anxiety. This result could be considered as satisfactory for participants' future mathematics teaching practices. Nevertheless, it should be beneficial to bear in mind that there were still some preservice teachers in the sample with high levels of mathematics anxiety. Such teachers should be determined in teacher education programs and individual support should be given them during the program. Because, the study of Gresham (2018) revealed that teachers who could not overcome their mathematics anxiety in the teacher education program, continue to experience anxiety even after 5 years of teaching. In providing the necessary support, the first attempt should help preservice teachers to be aware of their own mathematics anxieties (Harper & Daane, 1998). Then, they might be supported in the teacher education

program with using different methods: Applying narrative rehabilitation and bibliotherapy (Lutovac & Kaasila, 2011), providing academic service learning (ASL) experiences in mathematics education courses (Hollingsworth & Knight-McKenna, 2018), promoting intervention tasks in mathematics education courses that trigger preservice teachers' meaningful exploration of mathematical content (Heffernan & Newton, 2019). When the difference on mathematics anxiety scores across the grade levels in the teacher education program was investigated, it was explored that 3rd grade preservice teachers had significantly higher anxiety levels than 2nd and 4th grade level preservice teachers. This result could be interpreted as unexpected since the participant teachers took a course related to mathematics teaching in 3rd grade, and they had high level of mathematics teaching efficacy scores in 3rd grade. At this point, the findings of the current study were limited since there were no data for the further investigations on the reasons of their mathematics anxiety. One possible explanation for the higher level of mathematics anxiety in 3rd grade might be that the detailed requirements and assignments in the mathematics education course might cause to increase preservice ECE teachers' mathematics anxiety level. Another explanation might be the increase in knowledge level might lead to feel more anxious in that grade level. In their study, Aydın, Delice, Dilmaç and Ertekin (2009) emphasized that the increase level of mathematical knowledge does not mean that the anxiety levels certainly fall. We strongly suggest to investigate this issue with different samples in the further studies. Exploring the mathematics anxiety differences across grade levels in the teacher education program and investigating the potential reasons of mathematics anxiety in the further studies might help to better interpret the related finding of this study.

Outcomes also revealed that there was a medium negative correlation between MTEBI scores and MAS-R scores. This finding shows parallelism with previous research studies conducted with primary school teachers (e.g. Gresham, 2008; Swars, Daane & Giesen, 2010). When the dimensions inspected separately, while there was a significant relationship between PMTE and MAS-R scores, no significant relationship was found between MTOE and MAS-R scores. The negative strong relationship between PMTE and MAS-R might be expected since teacher candidates with higher beliefs regarding own teaching skills and abilities are able to overcome their anxieties on mathematics teaching even if they have. While preservice teachers with less belief in their skills and ability regarding teaching mathematics effectively had higher levels of mathematics anxiety, others with higher beliefs in their skills and ability on teaching mathematics effectively had lower levels of mathematics anxiety. However, analysis of the relationship between MTOE and MAS-R showed no relationship. It might be related to participants' limited teaching experience which may have led to no relationship between mathematics teaching outcome expectancy and mathematics anxiety (Gresham, 2008).

In conclusion, it should be mentioned that there are some limitations of the current study such as collecting data at single time point and only from a single ECE program, which also limits the generalizability of the obtained results. However, it is believed that the findings of the current study might help to improve limited literature related to affective factors in preservice ECE teachers and teacher candidates. In line with the findings of this study, it is suggested to make further investigations on preservice ECE teachers' mathematics teaching efficacy beliefs, mathematics anxieties, and the relationship between efficacy beliefs and anxieties. In essence, it is suggested to investigate mathematics anxieties of preservice ECE teachers in different phases of teacher education and the potential reasons of mathematics anxieties in order to have a better interpretation of the related findings in the current study. Investigating how teaching practice experiences affect preservice ECE teachers' PMTE, and MTOE beliefs might also be beneficial to better interpret the decrease in their MTOE in the 4th grade. Moreover, there is a need for in depth investigations on how mathematics anxiety of preservice ECE teachers affects their MTOE beliefs to understand the relationship clearly between MTOE and mathematics anxiety.

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