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Investigation of Pre-service Elementary Mathematics Teachers' Beliefs about Mathematics Teaching Self-Efficacy and the Nature of Mathematics, Teaching and Learning *

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Abstract: The present study aims to find out pre-service elementary mathematics teachers' beliefs about mathematics teaching self-efficacy and mathematics, teaching and learning and to investigate their beliefs in terms of gender and years of study. The study was carried out based on quantitative research methods. In this regard, relational survey model was employed in the study. The study group consists of 198 pre-service mathematics teachers studying at 2nd, 3rd and 4th grades of Primary Mathematics Teacher Education Program at a public university in the 2017-2018 academic year as well as the pre-service teachers graduated in the previous year from the same program. For data collection, "The Mathematics Teaching Self-Efficacy Scale (MTSES)" developed by Enochs, Smith and Huinker (2000), adapted to Turkish by Hacıömeroğlu and Şahin-Taşkın (2010) and the "Mathematics Related Beliefs Scale (MRBS)" developed by Kayan, Haser and Işıksal-Bostan (2013) were used. As a result of the research, it was found that the teacher candidates differ in their beliefs about mathematics teaching proficiency beliefs and nature of mathematics, mathematics teaching and mathematics learning about grade level variable but not by gender variable.

Keywords: self-efficacy beliefs, mathematics-related beliefs, preservice teacher.

INTRODUCTION

Although there is not a single definition accepted by everyone, there is a consensus in the literature about the importance of beliefs (Aguirre & Speer, 2000; Handal, 2003). Some researchers believe that beliefs are what individuals regard as right about the world and define them as

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structures that affect behavior (Beswick, 2011; Philipp, 2007). Teacher's self-efficacy belief is defined as the belief in the ability of teachers to influence student performance (Dellinger, Bobett, Olivier & Ellet, 2008; Woolfolk-Hoy & Burke-Spero, 2005).

Teachers' beliefs are shaped by their previous educational experiences before they come to university and the experiences they gained during teacher education at the university (Handal, 2003; Philipp, 2007). This means that preservice teachers have beliefs about mathematics which they have learned from their previous education and are structured by the teachers they have met (Ball, 1988) before starting the teacher education program. The beliefs about mathematics can be defined as the decisions that people have about the nature, learning and teaching of mathematics and their decisions shaped by their experiences (Raymond, 1997).

Ensuring teacher candidates to develop beliefs as will help them to become competent teachers is among the most important goals of teacher education (Green, 1971). Some of the preservice teachers' beliefs about mathematics are shaped outside the classroom environment because of their lack of classroom and school experiences during their undergraduate education (Haser, 2006). Determination of the beliefs of preservice teachers is important because they will affect their future teaching in the first years of their teaching (Lester & Garofalo, 1987). In addition, determining the effects of the vocational courses of teacher education programs on their beliefs about mathematics and to determine the differences in students' beliefs about mathematics in subject processes will contribute to the professional development of the teachers (Dede & Karakuş, 2014).

Preservice elementary mathematics teachers' self-efficacy beliefs about teaching mathematics and also beliefs about the nature of, teaching and learning mathematics seem to be highly important in their professional development. When the research conducted with pre-service teachers are examined, it can be seen that the self-efficacy beliefs about mathematics teaching and student beliefs about mathematics teaching, teaching and learning are examined separately. In this study, it is considered that the study contributes to the literature in this sense since these variables are examined separately in relation to each other. In addition, this study examines and compares not only the self-efficacy beliefs of preservice teachers who are studying at university, but also the self-efficacy beliefs of preservice teachers who have just graduated. In this context, the present study aims to find out pre-service elementary mathematics teachers' beliefs about mathematics teaching self-efficacy and beliefs about mathematics, teaching and learning and to investigate their beliefs in terms of gender and grade. Within the scope of this aim, the following questions were sought:

1. What is the level of preservice elementary mathematics teachers' self-efficacy beliefs about mathematics teaching?
2. What is the level of preservice elementary mathematics teachers' self-efficacy beliefs about the nature of, teaching and learning mathematics?
3. Is there a meaningful difference between the preservice elementary mathematics teachers' self-efficacy beliefs about teaching mathematics and beliefs about the nature of, teaching and learning mathematics according to grade variable?
4. Is there a meaningful difference between preservice elementary mathematics teachers' self-efficacy beliefs about teaching mathematics and beliefs about the nature of, teaching and learning mathematics according to gender variable?
5. What is the relationship between the preservice elementary mathematics teachers' self-efficacy beliefs about mathematics teaching and self-efficacy beliefs about the nature of, teaching and learning mathematics?

METHOD

This study, which aims to examine the relationship between the preservice elementary mathematics teachers' self-efficacy beliefs about mathematics teaching and also self-efficacy beliefs about the nature of, teaching and learning mathematics, is designed in the relational survey model. The relational survey model is a research model that aims to determine the presence and/or degree of change between two and more variables. There are two types of relational survey models. These are comparative relational survey and correlative relational survey (Karasar, 2014). The comparative type of relational survey model was used to examine preservice elementary mathematics teachers' self-efficacy beliefs about mathematics teaching and also self-efficacy beliefs about the nature of, teaching and learning mathematics according to grade and gender variable. Besides, a correlational type of relational survey model was used to reveal whether there exists a relationship in beliefs about mathematics teaching and beliefs about the nature of, teaching and learning mathematics.

Study Group

The study group consists of 198 pre-service mathematics teachers studying at 2nd, 3rd and 4th grades of Primary Mathematics Teacher Education Program at a public university in the 2017-2018 academic year as well as the pre-service teachers who graduated from the same program in the previous year. The distribution of the number of preservice teachers according to grade and gender variables is given in Table 1.

Table 1: Distribution of preservice teachers according to independent variables

Independent variables		f	%
Grade	Grade 2	48	24.2
	Grade 3	60	30.3
	Grade 4	63	31.8
	Graduated	27	13.6
Gender	Female	144	72.7
	Male	54	27.3

Data Collection Tools

For data collection, "The Mathematics Teaching Self-Efficacy Scale (MTSES)" developed by Enochs, Smith and Huinker (2000) adapted to Turkish by Hacıömeroğlu and Şahin-Taşkın (2010) and the "Mathematics Related Beliefs Scale (MRBS)" developed by Kayan, Haser and Işıksal-Bostan (2013) were used. The pre-service mathematics teachers' beliefs about mathematics teaching self-efficacy were investigated under the sub-dimensions of 'Personal Self-Efficacy (PSE)', 'Efficacy Beliefs about Teacher's Role in Effective Teaching (EBaTRiET)' and 'Teaching Performance (TP)' whereas the beliefs about Mathematics Teaching and Learning were handled separately under the dimensions of 'Constructivist Beliefs (CB)' and 'Traditional Beliefs (TB)'. In these 5-point Likert-type scales, positive statements are scored as "Strongly Disagree (1 point)," "Disagree (2 points)," "Neither Agree nor Disagree (3 points)," "Agree (4 points)," and "Strongly Agree (5 points)" while the negative statements are scored reversely. In evaluating the responses given to both scales, the group interval coefficient value was calculated by dividing the difference between the largest value and the smallest value in the measurement results sequence by the group number (Kan, 2009). As a result of the implementation of the scales, the Cronbach alfa coefficient of the scales were calculated as α=.783 for MTSES and α=.800 for MRBS therefore, the scales were evaluated as reliable.

Data Analysis

Independent Samples t-test was used in order to find out how the beliefs of pre-service teachers change according to gender while one-way Anova test was used to find out how their beliefs change according to their years of study. Furthermore, the Pearson correlation coefficient was calculated in order to discover the relationship between mathematics teaching self-efficacy beliefs and the beliefs about mathematics, teaching and learning. The data were analyzed at .05 significance level.

FINDINGS

Findings Related to Mathematics Teaching Self-Efficacy

The descriptive statistics of the preservice mathematics teachers' responses about the MTSES are as follows. Table 2 presents the points scored by preservice elementary mathematics teachers from the subscales of MTSES.

Table 2: Descriptive Statistics about the MTSES

		N	$\overline{X}$	ss
MTSES	**PSE**	198	3.97	.46
	EBaTRiET		3.99	.38
	TP		4.05	.40

According to Table 2 preservice elementary mathematics teachers scores are $\overline{X}$=3.97, ss= .46 on the PSE subscale, $\overline{X}$=3.99, ss= .38 on the EBaTRiET subscale and $\overline{X}$=4.05, ss= .40 on the TP subscale and they are all in the "agree" level.

Table 3 presents the points scored by preservice elementary mathematics teachers from the subscales of MTSES according to grade.

Table 3: Statistics on the Sub-Dimensions of the MTSES

PSE	Grade	N	$\overline{X}$	ss
	2nd grade	48	3.934	.479
	3rd grade	60	3.878	.438
	4th grade	63	3.939	.426
	Graduated	27	4.345	3.974
EBaTRiET	2nd grade	48	4.023	.275
	3rd grade	60	3.995	.404
	4th grade	63	3.959	.400
	Graduated	27	4.042	.424
TP	2nd grade	48	3.963	.326
	3rd grade	60	3.950	.413
	4th grade	63	4.079	.411
	Graduated	27	4.343	.361

Table 3 shows that the highest score of all sub-dimensions of the MTSES obtained by the graduated preservice elementary teachers and these scores are at the level of "completely agree". On the other hand, other preservice teachers' scores are at the level of "agree" in three subscales of MTSES.

Table 4 compares preservice elementary mathematics teachers' self-efficacy levels according to grade variable. Accordingly, no grade-based statistically significant difference is observed between the points scored by pre-service elementary mathematics teachers on the EBaTRiET subscale ($p>.05$)

of MTSES. There are, however, a statistically significant difference in terms of the points scored on the PSE subscale and the TP subscale (p<.05) of MTSES.

Table 4: One-way ANOVA Results According to Grade

	Source of Variance	Sum of Squares	df	Average of Squares	F	p	Significant Difference
PSE	Between Groups	4.439	3	1.480	7.566	.000	2nd grade-Graduated 3rd grade-Graduated 4th grade-Graduated
	Within Groups	37.935	194	.196			
	Total	42.374	197				
EBaTRiET	Between Groups	.180	3	.060	.418	.740	
	Within Groups	27.856	194	.144			
	Total	28.039	197				
TP	Between Groups	3.324	3	1.108	7.419	.000	2nd grade-Graduated 3rd grade-Graduated 4th grade-Graduated
	Within Groups	28.970	194	.149			
	Total	32.294	197				

The results of the independent groups t-test conducted to determine whether the pre-service teachers' beliefs on mathematics teaching differ according to gender variable are given in Table 5.

Table 5: Independent Sample t-test Results of Mathematics Teaching Self-Efficacy Beliefs According to Gender Variable

	Gender	N	$\overline{X}$	ss	t	p
PSE	Female	144	3.991	.47	.849	.397
	Male	54	3.929	.44		
EBaTRiET	Female	144	4.003	.33	.356	.722
	Male	54	3.981	.49		
TP	Female	144	4.034	.39	-.752	.453
	Male	54	4.083	.43		

Table 5 shows that there is not a significant difference in pre-service mathematics teachers' beliefs on *PSE subscale (t(196)=.849, p>.05), EBaTRiET subscale* (t(196)=.356, p>.05) and *TP subscale* (t(196)=-.752, p>.05) of *the MTSES.*

Findings Related to Beliefs about the Nature of, Teaching and Learning Mathematics

Descriptive statistics of the responses regarding the items in the MRBS are given below.

Table 6: Descriptive Statistics on Beliefs about the Nature of, Teaching and Learning Mathematics

CB	Grade Level	N	$\overline{X}$	ss
	2nd grade	48	4.114	.338
	3rd grade	60	4.081	.359
	4th grade	63	4.365	.342
	Graduated	27	4.544	.287
	Total	198	4.242	.377
TB	2nd grade	48	3.184	.711
	3rd grade	60	3.283	.617
	4th grade	63	3.185	.705
	Graduated	27	3.290	.561
	Total	198	3.229	.659

When Table 6 is examined, it is understood that pre-service teachers' CB and TB correspond to the “strongly agree” ($\overline{X}$= 4.242, ss=.287); and “neither agree nor disagree” ($\overline{X}$=3.229, ss=.659) ranges respectively.

The results of the one-way analysis to determine whether there is a meaningful difference between the pre-service teachers’ beliefs about the nature of, teaching and learning Mathematics according to the grade level is given below.

Table 7: One-way ANOVA Results on Beliefs about Nature of, Teaching and Learning Mathematics According to Grade Level

	Source of Variance	Sum of Squares	df	Mean Square	F	p	Significant Difference
CB	Between Groups	5.746	3	1.915	16.587	.000	2^{nd} grade-4^{th} grade ; 2^{nd} grade - Graduated 3^{rd} grade -4^{th} grade ; 3^{rd} grade - Graduated $4t^{h}$ grade - Graduated
	Between Groups	22.399	194	.115			
	Total	28.145	197				
TB	Between Groups	.496	3	.165	.376	.770	
	Within Groups	85.291	194	.440			
	Total	85.787	197				

When Table 7 is examined, it can be said that pre-service teachers’ CB differ in terms of grade (F(3-197) =16.587; p< .05) and there is significant differences between the 2^{nd}, 3^{rd}, 4^{th} grades and graduated pre-service teachers’ average scores related to *CB* and there is not a significant difference between the pre-service teachers’ average scores related to the *TB.*

The results of the independent sample t-test to determine whether pre-service teachers’ mathematics teaching self-efficacy beliefs differ according to the gender variable are given in the following table.

Table 8: Independent Sample t-Test Results on Beliefs about Preservice Mathematics Teachers’ Beliefs about the Nature of, Teaching and Learning Mathematics According to Gender Variable

Gender	N	$\overline{X}$	ss	t	p
Female	144	4.263	.337	1.234	.219
Male	54	4.188	.468		
Female	144	3.235	.660	.208	.835
Male	54	3.213	.665		

It is understood from Table 8 that pre-service teachers’ scores related to both constructivist (t(196)=1.234, p>.05) and traditional (t(196)=.208, p>.835) learning-teachings do not differ significantly according to the gender variable.

Table 9: The Relationship between Pre-Service Teachers' Mathematics Teaching Self-Efficacy Beliefs and Beliefs about Nature of, Teaching and Learning Mathematics

		CB	TB
PSE	Pearson Correlation	0.48	0.58
	Sig. (2-tailed)	4.98	.420
EBaTRiET	Pearson Correlation	-.143*	.009
	Sig. (2-tailed)	0.48	.900
TP	Pearson Correlation	.22	.034
	Sig. (2-tailed)	.757	.636

As can be seen in Table 9, the Pearson's product-moment correlation coefficient analysis was carried out to examine the relationship between the sub-factor of EBaTRiET from the "MTBESS" and the subfactor of CB from the "MRBS" produced the value of ($r= -.143$; $p<.01$). It shows that a very weak negative significant relationship was found between the efficacy beliefs about teacher's role in effective teaching and constructivist beliefs. It means that efficacy beliefs about teacher's role in effective teaching decrease as the constructivist beliefs increase. Considering the determination coefficient ($r^2=.02$), %2 of the total variation of the efficacy beliefs about teacher's role in effective teaching can be interpreted to be related to the constructivist beliefs.

DISCUSSION AND CONCLUSION

When the answers of the mathematics teacher candidates' sub-factors of Mathematics Teaching Proficiency Beliefs Scale were examined, it was determined that the answers in all sub-dimensions are in "agree" level. This suggests that teacher candidates' beliefs about mathematics teaching are positive and high. On the other hand, preservice mathematics teachers' mathematics teaching proficiency beliefs were found to be meaningful when they were examined in terms of grade variable. It is thought that this difference in the dimensions of 'Personal Competence' and 'Teaching Performance' for graduate students may be due to the experiences they have in real classrooms. The results show that the experience gained in the real classroom environment has a positive impact on the beliefs about the level of personal competence and thus the applicants have the opportunity to find out the theoretical knowledge they have acquired during their training. For this reason, it is proposed to make arrangements to ensure that prospective teachers remain active for longer in the course of teacher application. On the other hand, it has been determined that prospective teachers do not differ according to their genders for mathematics teaching proficiency beliefs. This finding overlaps with the findings of Hacıömeroğlu and Şahin-Taşkın (2010).

It is known that the lesson experience in teacher training programs partially alters the beliefs of prospective teachers (Ambrose, 2004; Gill, Ashton & Algina, 2004; Joram & Gabriele, 1998). Eryılmaz Çevirgen (2016) stated that there are no significant differences in the constructivist beliefs of the mathematics teacher candidates in different grades and there are significant differences in the traditional beliefs. In this study, it was determined that there is a significant difference in the constructivist beliefs of mathematics teacher candidates in favor of graduates between graduates and all other grades, in favor of final grades between intermediate classes and final grades. When it's considered that beliefs are motivated by experience (Raymond, 1997), it is understood that teaching practice courses in the fourth grade of teacher training programs and teaching experiences in real classes give the students the opportunity to gain experience in their beliefs they are beginning to develop and significantly affect constructivist beliefs about mathematics. It is recommended that

arrangements should be made to increase the time of the teaching practice courses and also to provide more opportunities for teacher candidates to teach in real classroom settings. In terms of gender, there is no significant difference between the average scores of the 3rd, 4th grades and graduated teacher candidates on the constructivist and traditional beliefs factors. This finding is consistent with the findings of Ayvaz and Dündar (2014) that used the same scale. On the other hand, Kayan, Haser and Işıksal-Bostan (2013) stated that there is a meaningful difference in beliefs of elementary mathematics teacher candidates about their mathematics in favor of female teachers according to gender variables, but this difference is not practically meaningful. It can be said that the results obtained from these studies stress to similar points with this study because of no difference in terms of gender.

In this study, a very weak negative significant relationship was found between the efficacy beliefs about teacher's role in effective teaching and constructivist beliefs. However, a significant relationship could not be found between the sub-factors of Mathematics Teaching Efficacy Beliefs scale and the traditional belief factor of the Beliefs about Mathematics, Teaching and Learning Scale. As there could not be encountered any study regarding the relationship between beliefs about Mathematics Teaching Self-Efficacy and Mathematics, Teaching and Learning, these results were expected to contribute the mathematics education literature.

This study was conducted with a limited number of preservice mathematics teachers studying at a state university. It is possible to reach more general information about this subject through the larger study groups from different universities. Also in this study, preservice mathematics teachers' beliefs about mathematics teaching and beliefs about the nature of, teaching and learning mathematics were analyzed quantitatively. Future studies using both quantitative and qualitative methods will contribute to literature to understand preservice elementary mathematics teachers' beliefs.

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