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Examining pre-service elementary teachers' changing beliefs within the context of a mathematics education course

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Abstract

This study was done to determine the changes in belief of pre-service elementary teachers in a mathematics education course towards mathematics, and to address the effect of gender and academic success variables on this change. The study was designed according to the panel study model of longitudinal research method. 92 pre-service teachers who are being educated in the primary school teaching department of a state university in the 2013-2014 academic years formed the research sample. A data collection tool "Mathematics Belief Scale" developed by Steiner (2007) and whose reliability, validity and language equivalency in the Turkish form that was examined by Masal and Takunyacı (2012), was used. In analyzing the data, a paired samples t-test and, for repeated measures, a two-way ANOVA technique were used. At the end of research, positive change was observed in terms of the beliefs of the pre-service teachers towards mathematics as a result of the mathematics education course; it was also found that the gender and academic success variables have no effect on the beliefs of pre-service teachers with regard to mathematics.

Keywords: belief, mathematics education, pre-service elementary teachers

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1. Introduction

According to many mathematics educators, addressing the beliefs and belief systems of students is very important in terms of teacher training (Hart, 2002; Thompson, 1992; Wilkins & Brand, 2004). Within this context, researchers emphasize that the beliefs of pre-service teachers towards mathematics will also play a key role in their own classroom activities in the future (Adnan, & Zakari, 2010; Foss & Kleinsasser, 1996; Gates, 2006; Mischo & Maaß, 2013; Stipek, Givvin, Salmon & MacGyvers, 2001; Wilkins, 2008). In other words, belief can be defined as mostly non-developmental mental structures that individuals form on the basis of their past life experiences (Phillip, 2007; Thompson, 1992). When it is considered from this point of view, mathematical belief was defined by Ernest (1989) as "concepts, ideologies, values of individuals and philosophies about life and mathematics". Again Raymond (1997) states that beliefs with regard to mathematical training are shaped by past experiences. In the literature, most of the studies that address the beliefs of pre-service teachers with regard to mathematics training, point out that the education provided causes changes in the beliefs of pre-service teachers (Evans, , Leonard, Krier & Ryan, 2013; Gill, Ashton & Algina, 2004; Harding DeKam, 2005; Hart, 2002; Scharton, 2007; Swars, Smith, Smith & Hart, 2002; Tam, 2015; Tillema & Knol, 1997; Vacc & Bright, 1999; Wilkins & Brand, 2004; Yesil-Dagli, Lake & Jones, 2010). In this context, Hart (2002) addresses the change in the mathematical beliefs of pre-service teachers found that the actual teacher training programme affects the beliefs of pre-service teachers positively. On the other hand, in their experimental study, Gill et al. (2004) found that there is an increase in the mathematical beliefs of the experimental group that was trained in a way that developed the beliefs of pre-service teachers compared to the control group that was trained according to the actual programme. Again, Harding DeKam (2005) examined the changes in the beliefs and behaviours of pre-service teachers at the beginning and at the end of a mathematics education course. At the end of study, he reached a conclusion that the beliefs of pre-service teachers towards mathematics education had changed substantially. Similarly, Evans et al. (2013) examined the change in the beliefs of pre-service elementary teachers towards mathematics education, and at the end of the study he reported that an innovative education programme given to pre-service teachers causes positive changes in their beliefs in terms of mathematics education and training. Again Scharton (2007), in his longitudinal study in which he examined the effect of a teacher training programme on the beliefs, knowledge and applications of pre-service teachers, reached the conclusion that pedagogic training increases the beliefs of pre-service teachers in a positive way.

As can be seen from the studies referred to above, addressing the beliefs of students is very important in terms of teacher training. Also, it is thought that the results obtained from this study will contribute to the literature since it is the first longitudinal study in our country. Based on this fact, the aim of this study is to examine the beliefs of pre-service elementary teachers within the context of a mathematics education course offered in our country, as well as to consider the effect of gender and academic success variables on this change. In order to achieve this general aim, the answers for these sub-problems were sought:

1) Do the beliefs of pre-service teachers with regard to mathematics show a significant change from the beginning of the course to the end?
2) Do the beliefs that pre-service teachers exhibit at the beginning and at the end of the mathematics education course show a significant difference in terms of gender?
3) Do the beliefs that pre-service teachers exhibit at the beginning and at the end of the mathematics education course show a significant difference in terms of academic success?

2. Method

This study is based on a longitudinal panel research model involving developmental descriptive research. In the panel research model the researcher makes measurements of the same people at different times (Fraenkel & Wallen, 2009). Also in this study, we examined if there was any change in the beliefs of pre-service teachers who were engaged in a mathematics education course.

2.1. Population and Sample

Since pre-service teachers educated in a state university in the 2013-2014 academic year formed the population involved in the research, 92 pre-service teachers who took part in a 3rd grade mathematics education course formed the sample. The demographic properties of the participants are given in Table 1.

Table 1. Frequency and percentage distribution regarding the demographic properties of the sample of pre-service teachers

Variables		f	%
Gender	Female	59	66.4
	Male	33	33.6
Type of High School Graduate	General	52	56.5
	Anatolian	27	29.3
	Others	13	14.2
Mathematics Achievement	2.00-2.49 (Low)	26	28.3
	2.50-2.99 Medium)	42	45.7
	3.00-4.00 (High)	24	26.0

When Table 1 is examined it can be seen that 66.4% of the sample are female and 33.6% are male. In addition, 56.5% were graduates of a general high school, 29.3% were from Anatolian high schools, and 14.2% were from other types of high school. The mathematics achievement grade point averages of 28.3% of the sample were between 2 and 2.49 (low), 45.7% were between 2.5 and 2.9 (medium) and 26% were between 3.0 and 4.00 (high).

2.1. Data Collection Tools

In the study the data collection tool "Mathematics Belief Scale" developed by Steiner (2007) and whose reliability, validity and language equivalency in Turkish form was examined by Masal and Takunyacı (2012), was used. Both Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were used to provide structural validity in the period of adaptability of the Mathematics Belief Scale. The scale is made up of 34 items related to the Turkish culture In measurements of the reliability of the scale, the internal consistency coefficient of the scale (Cronbach Alpha) was found to be .87; using the split-half method it was found to be .92, and in test-retest method it was found to be .83 (Masal & Takunyacı, 2012). The data obtained regarding scale dimensions in the sample used in the research are given in Table 2.

Table 2. Sub factors, item numbers and Cronbach Alpha values of the Mathematics Belief Scale

	Factors	Item Numbers	Item Total Point Correlations	Cronbach Alpha
Mathematics Beliefs	Time	6	.36-.56	.92
	Steps	6	.23-.61	.66
	Understanding	6	.29-.65	.71
	Usefulness	6	.52-.81	.75
	Self-Concept	10	.39-.74	.75
	Total	34	.21-.74	.82

When Table 2 is examined, it can be seen that the Mathematics Belief Scale consists of five factors - time, steps, understanding, usefulness and self-concept. These factors also consist of 6-10 items each. The material point correlation values of scale in terms of total point, ranges between .21 and .81. The Cronbach Alpha coefficient of consistence of this scale ranges between .66 and .92.

2.2. Analysis of data

Since the pre-test and post-test scores in terms of mathematical belief form the dependent variable of the study, gender and academic success variables form independent variables. Based on this, in the first sub-aim of the study was assessed in terms of the t-test, whereas with regard to the other sub-aims, the two-way ANOVA techniques were used for repeated measures. Before the analysis stage precondition assumptions were tested and were found to be suitable.

3. Findings

The data obtained in order to identify the beliefs of the pre-service teachers towards mathematics who were enrolled in the mathematics education course were analyzed using the paired samples t-test. The results of the analysis are presented in Table 3.

Table 3. Results of paired samples t-test regarding pre-test and post-test scores in terms of mathematics beliefs

Factors		N	X	S	sd	t	p
Time	Pre-test	92	3.38	.52	91	6.072	.00**
	Post-test	92	2.89	.56			
Steps	Pre-test	92	3.06	.49	91	2.420	.018*
	Post-test	92	2.89	.56			
Understanding	Pre-test	92	3.48	.63	91	-3.842	.00**
	Post-test	92	3.82	.63			
Usefulness	Pre-test	92	3.64	.73	91	-5.424	.00**
	Post-test	92	4.21	.68			
Self-Concept	Pre-test	92	3.65	.78	91	-5.095	.00**
	Post-test	92	4.21	.70			
Total	Pre-test	92	3.44	.40	91	-5.091	.00**
	Post-test	92	3.73	.39			

When Table 3 is examined, the paired samples t-test was used to identify if there is a significant difference between the scores in terms of the Mathematics Belief Scale at the beginning and at the end of the mathematics education course. According to this, significant difference was found in terms of all factors. Again, according to the results of the t-test, the pre-test scores are higher in the time ($t_{(91)}$ = 6.072, p<.01) and steps ($t_{(91)}$ = 2.420, p<.05) factors. In other dimensions and in the total points of the scale, we observed a significant difference in favour of post-test scores [Understanding ($t_{(91)}$ = -3.842, p<.01); Usefulness ($t_{(91)}$ = -5.424, p<.01); Self Concept ($t_{(91)}$ = -5.095, p<.01); Total ($t_{(91)}$ = -5.091, p<.01)].

The two-way ANOVA test was used in order to determine if there is a significant difference between the scores that are taken from Mathematics Belief Scale at the beginning and at the end of mathematics education course according to gender. The results are presented in Table 4.

Table 4. Two way ANOVA results regarding Mathematics Belief Scale pre-test and post-test points of pre-service teachers according to gender for repeated measures

Mathematics Belief Scale Sub Factors	Gender	N	Pre-test		Post-test		Group X Factor	
			X	S	X	S	F	p
Time	Female	59	3.39	.46	3.46	.53	1.801	.183
	Male	33	3.37	.60	3.62	.52		
Steps	Female	59	3.08	.44	2.81	.58	4.04	.047
	Male	33	3.01	.59	3.03	.49		
Understanding	Female	59	3.40	.62	3.87	.63	3.627	.060
	Male	33	3.61	.64	3.73	.64		
Usefulness	Female	59	3.60	4.3	4.25	.70	1.497	.224
	Male	33	3.72	.72	4.12	.69		
Self-Concept	Female	59	3.66	.77	4.21	.74	.008	.927
	Male	33	3.60	.82	4.20	.63		
Total	Female	59	3.42	.42	3.72	.39	.045	.832
	Male	33	3.48	.36	3.74	.39		

When Table 4 is examined, the steps factor pre-test average for female pre-service teachers is 3.08, while for male pre-service teachers it is 3.01; the post-test averages for female pre-service teachers it is 2.81, while for male pre-service teachers it is 3.03. At the end of the two factor variance analysis for repeated measures, it was observed that the interaction of the pre-test and post-test scores in terms of the gender and mathematics beliefs scale indicates a significant difference in terms of the steps factor ($F_{(1-90)}$ = 4.04, p<.05). However, it was clear that there is no significant difference regarding the other factors [Time ($F_{(1-90)}$ = 1.801, p>.05); Understanding ($F_{(1-90)}$ = .060, p>.05); Usefulness ($F_{(1-90)}$ = .224, p>.05); Self Concept ($F_{(1-90)}$ = = .008, p>.05); Total ($F_{(1-90)}$ = .045, p>.05)].

The results of the two-way ANOVA test regarding the Mathematics Belief Scale pre-test and post-test scores of the pre-service teachers in terms of academic success, and if the changes between these scores show a significant difference according to gender, are presented in Table 5.

Table 5. Two way ANOVA results regarding Mathematics Belief Scale pre-test and post-test scores of pre-service teachers in terms of academic success for repeated measures

Mathematics Belief Scale Sub Factors	Achievement Level		Pre-Test		Post-Test		Group X Factor	
		N	X	S	X	S	F	p
	Low	26	3.56	.45	3.58	.49	.911	.060
Time	Medium	42	3.28	.52	3.57	.50		
	High	24	3.36	.53	3.31	.57		
	Low	26	3.16	.55	2.80	.45	1.696	.189
Steps	Medium	42	3.03	.40	2.93	.60		
	High	24	2.99	.56	2.91	.56		
Understanding	Low	26	3.31	.49	3.74	.64	.376	.688
	Medium	42	3.48	.63	3.81	.68		
	High	24	3.67	.72	3.90	.52		
	Low	26	3.36	.58	3.99	.77	.124	.883
Usefulness	Medium	42	3.71	.83	4.26	.70		
	High	24	3.85	.62	4.34	.44		
	Low	26	3.43	.77	4.17	.69	1.475	.234
Self-Concept	Medium	42	3.72	.78	4.33	.64		
	High	24	3.79	.79	4.03	.77		
	Low	26	3.36	.33	3.65	.42	.817	.445
Total	Medium	42	3.44	.45	3.78	.40		
	High	24	3.53	.38	3.70	.30		

When Table 5 is examined, it can be observed that all factors of the Mathematics Belief Scale on the part of the pre-service teachers having low, medium and high success levels, are very close to each other. According to this analysis, it was observed that the interaction of pre-test and post-test scores with regard to academic success levels and mathematics beliefs do not demonstrate a significant difference [Time ($F_{(2-\ 89)}$ = .911, p>.05); Steps $F_{(2-\ 89)}$ = 1.696, p<.05); Understanding ($F_{(2-\ 89)}$ = .376, p>.05); Usefulness ($F_{(2-\ 89)}$ = .124, p>.05); Self-Concept ($F_{(2-\ 89)}$ = = 1.475, p>.05); Total $F_{(2-\ 89)}$ = .817, p>.05)].

4. Discussion and Results

This study was done to determine whether or not there were any changes in the beliefs of pre-service elementary teachers with regard to mathematics as a result of a mathematics education course, and to address the effect of gender and academic success variables on this change. In the study, it was found that there were some changes in the mathematics beliefs of pre-service teachers who attended a mathematics education course. This result shows similarity with those of other studies in the literature (Evans et al, 2013; Gill et al., 2004; Harding DeKam, 2005; Hart, 2002; Scharton, 2007; Swars et al., 2002; Tam, 2015; Tillema & Knol, 1997; Vacc & Bright, 1999; Wilkins & Brand, 2004; Yesil-Dagli et al., 2010). However, a limited number of research studies that contradict the findings of this study should also be noted (Schuck, 1996; Tillema, 1998; Wilkins, 2008).

In the study, as a secondary sub-aim, the belief scores of the pre-service teachers that were taken at the beginning and at the end of mathematics education course were addressed in terms of gender. The analysis shows that there is a significant difference between the belief scores and gender within the context of the steps factor. However, in terms of other factors, there is no significant difference.

However in the literature it is possible to find some limited research support for the view that gender has an effect on beliefs (Ayvaz, & Dündar, 2014; Kayan, Haser & Işıksal Bostan, 2013; Pişkin-Tunç ve Haser, 2012).

Lastly, the third sub-aim addressed the possibility that the belief scores of pre-service teachers at the beginning and at the end of the mathematics education course, show a significant difference in terms of their academic success. However, no significant difference were noted between belief scores and academic success. The result obtained from the study shows a degree of similarity with the results of similar studies (Perry, Way, Southwell, White, & Pattison, 2005; White, Perry, Way & Southwell, 2005). However, there are also studies (Emenaker, 1996; Schommer-Aikins, Duell, Hutter, 2005; Suthar & Tarmizi, 2010)) that disagree with this finding. In this context, Suthar and Tarmizi (2010) at the end of their study, suggested that there is a significant relationship between the beliefs of university students towards mathematics and their success in mathematics.

The results of this study were obtained with the support of pre-service teachers training in the primary school teaching department of a state university. However, in order to identify the beliefs of pre-service teachers in other branches of teacher education and to examine the subject extensively, additional research needs to be undertaken. Also, the study was done using quantitative data collection tools. Qualitative and combined methods could be used in similar studies in the future. 7

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