A Research on the Mathematical Problem Solving Beliefs of Mathematics, Science and Elementary Pre-Service Teachers in Turkey in terms of Different Variables

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Abstract

In this study, we aimed to report the results of the statistical analysis that was performed to determine the beliefs about mathematical problem solving of the mathematics, science and elementary school pre-service teachers and the results of whether gender and the teaching field they studied have any effect on problem solving beliefs. A total of 567 mathematics, science and elementary school pre-service teachers participated in the research. Mathematical Problem Solving Beliefs Instrument applied to these pre-service teachers. In conclusion, there could not be found any significant differences between the beliefs of pre-service teachers and their genders or their education field in which they were studying. It has been understood that the beliefs about mathematical problem solving of pre-service teachers need to develop.

Keywords: Problem solving, beliefs, problem solving beliefs, pre-service teachers.

Introduction

Enabling individuals to gain the skill of problem solving and to train the individuals, who could overcome the problems encountered during their real lives, are amongst the priority objectives and principal purposes of the education currently. This is because, it has become a requirement in our present day world that the employees should be open for new ideas, should adapt easily for changes, should overcome difficulties, should perceive patterns and should be able to solve problems, which are not traditional (Cai, 2003a and 2003b; Meier, Hovde & Meier, 1996). Individuals learn to create new strategies and to solve new types of problems by regulating the old strategies by working during problem situations (Olkun & Toluk, 2003: 44). At the same time, since the problem solving is a scientific method, it requires the use of critical thinking, the creative and reflecting thinking, the skills of analysis and synthesis (Soylu & Soylu, 2006). Individuals learn to put forward their thoughts, which develop when they are solving problems, in a systematic way through solving problems and find new ways of thinking. Hence, they gain self confidence when they are faced with events that they are not accustomed to (National Council of Teachers of Mathematics-NCTM, 2000). Logical thinking of individuals and their reasoning can be reached properly by investigating the solution strategies they use, depiction of the mathematic knowledge, representation of the solution processes, assertion of the mathematical reasoning and the processes of setting up of new problems, which rely on a problem situation. These cognitive aspects, on the other hand, are defined in general within the cognitive psychology and in detail within the mathematical problem solving (Cai, 2003a and 2003b).

Because of that, it could be said that these cognitive aspects are related with individual's problem solving and solving capabilities indirectly. Problem solving, which is one of the important elements of school mathematics, can be defined as the process of finding the best way to clear the hurdle that is faced, which requires series of attempts with regards to eliminating difficulties that are faced in order to achieve a certain objective (Bingham, 1998; Cited in Şirin & Güzel, 2006). It can be thought as steering the cognitive operations towards a target respectively (Anderson, 1980). Problem solving is eliminating the uncertainties at the same time. It is the process of finding the solution of a problem when the method is not known by the problem solver (Yong & Kiong, 2005).

Education of individuals, who could solve problems, share his/her solutions and thoughts, who can perform group activities, feel confident and develop positive attitude, is intended in the Primary School Mathematics Education Program that has been prepared by the Ministry of Education (Milli Eğitim Bakanlığı, 2005). Problem solving has also been itemised by NCTM (1989) in *Curriculum and Evaluation Standards for School Mathematics* and it has been defined in these standards as "a process that provides the conditions, where it covers the whole of the program and where the skills are learned and which does not contain a certain topic". Problem solving has also been defined in the third section that is included under the title of *Standards* within the *Principles and Standards for School Mathematics* by NCTM (2000) as "being busy with a situation, where the key to the solution is not known". It can be seen as a general plan for problem solving behaviors that are put forward during the problem solving process. The problem solving behavior includes the activities, which are performed by the student during problem solving and every activity is formed by a strategy or by application of a strategy. Each of the strategies contains a behavior or series of behaviors and they are interpreted through behavior (Dhillon, 1998). The problem solving techniques can be defined as the method, which is used to go over the hurdles in cases, where a solution and a method for solution are not obvious at the first instance (Reys, Suydam, Lindquist & Smith, 1998).

Problem solving skills do not develop within few weeks or months and it is also not a topic that is thought in special class level. Development for the problem solving skill is slow and progressive. Problem solving should be expressed every day, in every lesson and should continue from the start of the preschool until high school, because learning of mathematics and problem solving are related to each other as such. In addition to this, it is a requisite to be informed about what a good problem solving skill covers while involving students with problem solving activities (Van de Walle, 1994). According to Fitzpatrick (1994), there are four important sub-dimensions, which have effect on mathematical problem solving behavior, and these sub-dimensions can be thought as meta-cognitive knowledge, meta-cognitive regulation, beliefs and mathematical knowledge.

The notion of *belief*, which is one of these sub-dimensions and which is personal value judgment that are formed by the past experiences of the individual, is a notion that had gained importance in mathematics education lately and it has been beneficial for the students to be able to develop positive attitude against mathematics. Beliefs with regards to mathematics have a rather important place within the learning process (Raymond, 1997; Thompson, 1992). Importance of the positive beliefs towards mathematics, rather than the problem solving skills and the applicability of these for real life situations, has also been emphasised in standards, which had been approved by the Flemish Parliament of the Flemish section of Belgium for primary school education (De Corte, 2003). The proposal of NCTM (1989) with regards to consideration of the beliefs of teachers and students for matters related to their motivations, performances and successes is another indicator about the importance of beliefs. Sub-dimensions like, the teaching ways of the teacher, evaluation of the teacher for the topic that he/she lectures, the beliefs, which teacher believes that should really be reached, the role that teacher has casted for himself/herself for the education and the decisions of the teacher about the issue be acceptable, also constitute the beliefs for the issue of the mathematics education (Thompson, 1984). Very serious part of the beliefs that are related to mathematics is formed during the school life and the mathematical beliefs of individuals determine the point of view of them towards the mathematical world (Frank, 1988; Schoenfeld, 1992).

The mathematical belief, which is important for explaining the meaning of what had been learned, has direct or indirect effect on the success of students (Cobb, 1986; Kloosterman, 1991; Kloosterman & Cougan, 1992 and 1994; Thompson, 1984). It has also been determined in many researches that had been performed (Aksu, Demir & Sümer, 1998; Carter & Norwood, 1997; Hart, 2002 and 2004; Swars, Hart, Smith, Smith & Tolar, 2010; Thompson, 1984) that beliefs about the nature and education of mathematics have relationship with the mathematics education provided for the students.

Findings, which have been obtained from some of the researches that studied beliefs with regards to mathematics, manifest as; that the difficulty of a mathematics problem is related to the magnitude and amount of the numbers (Garofalo, 1989), that problems have one correct solution and it is believed that this solution could be found within few minutes (Lampert, 1990; Silver, 1985), that there is no need to read the whole of the text of the problem and only the key words contained in the last sentence or the parts in the question that give an idea about which operations should be performed (Garofalo, 1989), that the rules provided by the teacher is followed for performing the mathematics and it is thought that mathematics mean to apply the rules directly and to remember the rules (Lampert, 1990), that ordinary students would not understand mathematics but would remember what they had learned and would apply these (Schoenfeld, 1992). In situation shows in that the beliefs of individuals about the mathematics have an effect on learning and on problem solving (Kloosterman & Stage, 1992). As a conclusion, beliefs could impede the success for the mathematics and could create an unsurpassable obstacle for effective learning of the mathematics since beliefs have effect on how the mathematics is learned and on how it is used (Collison, 1992; Pehkonen & Törner, 1999; Cited in Kayaaslan, 2006). Unsuccessful students might not be aware of the negative beliefs they have about the mathematics. These beliefs could also have a negative influence on their learning and on their successes (Mason, 2003). Therefore, development of mathematical beliefs of students is important.

Beliefs can be examined in three different groups in order to analyse and to define the beliefs of students in the field of mathematics as the beliefs about learning of the mathematics and about problem solving, as the beliefs of the individual about mathematics and as the beliefs of the social environment lived in about learning of the mathematics (De Corte, Op't Eynde & Verschaffel, 2002). Personal beliefs of students about the mathematics and about learning of the mathematics and their skills for solving of the mathematical problems can be understood through their beliefs about problem solving (Kloosterman & Stage, 1992; Mason, 2003).

The Aim and the Importance of the Research

International literature is convincing about the issue, where many students do not possess efficient knowledge and skills that are based on learning, thinking and problem solving abilities, in schools of today (De Corte, 2003). Students see the mathematics as a field, where certain rules are applied, which is direct and independent of other fields, where problems have one correct solution whose correctness can be proven easily and where the mathematical understanding requires a special ability (Lampert, 1990; Schoenfeld, 1992). This situation, which is still valid in schools, frightens the students and makes them weak-spirited (Boaler, 1997; Burton, 1999). Negative attitudes and thoughts as to; students can not solve problems on their own, every problem has one correct answer only, every problem has one correct way of solution and there are serious differences between the mathematics used in the real life and the one used in the school also have effect on the students (Verschaffel, De Corte, Lasure, Van Vaerenbergh, Bogaerts & Ratinckx, 1999). Students have negative thoughts about the necessity of learning of the mathematics since they believe that the mathematics is a process of remembering the directives of the teacher and due to the negative belief they have against mathematics (Clewell, Anderson & Thorpe, 1992). Above mentioned insufficiencies are also observed clearly in Turkey for the development of the problem solving skills that are tried to be provided in mathematics lessons in schools. Nevertheless, it is thought that efforts with regards to problem solving as being related to the real life would increase the belief points of students about problem solving and also that the individuals, who have high points related to beliefs would be more successful about the problem solving (Blumenfeld, Soloway & Marx, 1991; Pajares & Miller, 1997).

This situation shows that teachers could be effective for development of beliefs of students with regards to the mathematics and mathematical problem solving as well as problem solving skills of students. It has also been disclosed in some of the researches that had been performed (Kayan & Çakıroğlu, 2008; Lloyd & Wilson, 1998) that the beliefs of pre-service teachers with regards to solving of mathematical problem is an effective sub-dimension for the success of the learning environment and for the success of the student, where they would create in the future as teachers. Therefore, it is seen that the beliefs of pre-service teachers with regards to solving of mathematical problems are important but there could not found many studies that examine the mathematical problem solving beliefs of pre-service teachers (Kayan ve Çakıroğlu, 2008; Yılmaz & Delice, 2007). Hence, the beliefs of pre-service teachers with regards to solving of mathematical problems have been tried to be determined in this research and the differences between beliefs of pre-service teachers with regards to solving of problems according to different variables have been studied. For this purpose, answers for the below stated research problems have been sought:

1. What are the beliefs about mathematical problem solving of pre-service teachers?
2. What are the average points of pre-service teachers related to the sub-dimensions (Mathematical skill, place of the mathematics, understanding of the problem, importance of the mathematics and problem solving skill) of the Beliefs about Mathematical Problem Solving Instrument?
3. Do the beliefs about mathematical problem solving of pre-service teachers vary according to gender or education fields significantly?
4. Are there significant differences between the average points of pre-service teachers related to the sub-dimensions and the gender or education fields they are studied in?

Methodology

This research have been implemented by using the general screening model, which aims to depict a situation that was in the past or that is still available in the form that it exists and which is a quantitative research model (Karasar, 2005: 77-78). Beliefs of pre-service teachers about mathematical problem solving have been studied in this study.

Participants

The sample of the research constitutes a total of 567 mathematics, science and elementary pre-service teachers, who were studying as freshmen, sophomores, juniors and seniors in the Education Faculty of Abant İzzet Baysal University located in the Black Sea Region in Turkey during the fall semester of the 2011. In this research, participants involved 422 female pre-service teachers and 145 male pre-service teachers.

Table 1. Distribution of pre-service teachers according to their education fields and to gender

	Education Fields							
	Mathematics		Science		Elementary		Total	
Gender	f	%	f	%	f	%	f	%
Female	146	25.7	148	26.1	128	22.6	422	74.4
Male	49	8.6	39	6.9	57	10.1	145	25.6
Total	195	34.3	187	33.0	185	32.7	567	100.0

Data Collection Instrument

The data were collected by using two instruments, the *Beliefs about Mathematical Problem Solving Instrument*, which had been developed by Kloosterman and Stage (1992) and which had been adapted into Turkish by Hacıömeroğlu (2011a).

The Turkish form of this scale, which contains five point likert scale type rating, constitutes 24 items under 5 sub-dimensions. These sub-dimensions with regards to the scale are in the form of *mathematical skills, place of mathematics, understanding of the problem, importance of mathematics* and *problem solving skills*. These factors include Mathematical Skill, Place of Mathematics, Understanding of the Problem, Importance of Mathematics, and Problem-solving Skill. The scale contained 7 negative and 17 positive items, permitting a score of 120 at the highest and 24 at the lowest. We drew our conclusions by dividing the total points by number of items. Higher point totals indicate that the problem-solving beliefs of pre-service teachers are high. The factor loads of 24 items included in the scale vary between 0.39 and 0.86. Cronbach Alpha reliability coefficients are 0.73 for the whole of the scale, calculated as 0.77, 0.67, 0.76, 0.54 and as 0.84 respectively for the factors that constitute the scale. The item total test correlation values with regards to the items included within the scale vary between 0.21 and 0.51. Cronbach Alpha internal reliability coefficients related to each of the factors have been calculated as 0.877, 0.775, 0.704, 0.500 and as 0.802 respectively, and the internal reliability coefficient related to the whole of the scale is 0.768. The test-retest reliability coefficient is 0.704 (p=0.001) (Hacıömeroğlu, 2011a).

Data Collection and Analysis

The completion of the *Beliefs about Mathematical Problem Solving Instrument* surveys took a total of 20 minutes for volunteer mathematics, science and elementary prospective teachers. The data were analysed using the SPSS 14.0 program.

The group interval coefficient value has been calculated by dividing the difference between the greatest value and the smallest value of the progression of the measurement results by the determined number of groups in the study (Kan, 2009: 407). Therefore, the average arithmetical reference interval, which has been calculated as being related to the responses provided by prospective teachers, has been calculated as to be (5-1)/5=0.80 in the study. As a result, the scale intervals were taken as follows: 4.21 and above average points indicates *I definitely agree* choice, the average points between 3.41 and 4.20 indicates *I agree* choice, the average points between 2.61 and 3.40 indicates *I do not idea* choice, the average points between 1.81 and 2.60 indicates *I do not agree* choice, 1.80 and below average points indicates *I do not definitely agree* choice.

Descriptive statistics methods were used to determine the beliefs about mathematical problem solving of the pre-service teachers. Independent two sample t-test was applied for the analysis of data related to the second research question; One-way ANOVA was used for analysis of data related to the third research question. For all of the statistical decoding, .05 significance level was taken as the base.

Findings

In this section, we report the results of the statistical analysis that was performed to determine the beliefs about mathematical problem solving of the mathematics, science and elementary pre-service teachers. In additionally, we report the results of whether gender and the teaching field they are studied in have any effect on problem solving beliefs.

Descriptive statistical results related to the average points, where the pre-service teachers have been given for the items that were included on the *Beliefs about Mathematical Problem Solving Instrument*, have been included in Table 2. The statistics results have shown that the significant part of the pre-service teachers (27.5%) have average points as above 3.41 point, which correspond to *I agree* and *I definitely agree* choices, from the instrument. The percentage value of pre-service teachers, whose beliefs about mathematical problem solving average points are 4.21 and above (0.3%) being rather low, is also striking. Besides, almost none of the pre-service teachers have negative beliefs. In additionally, most of the pre-service teachers' average points were between 2.61 and 3.40 points, which correspond to *I do not idea* choice and this situation indicates that the beliefs of pre-service teachers about mathematical problem solving need to develop.

Table 2. Average points of the beliefs about problem solving of pre-service teachers

Average Points									
Between 4.21-5.00 points		Between 3.41-4.20 points		Between 2.61-3.40 points		Between 1.81-2.60 points		Between 1.00-1.80 points	
f	%	f	%	f	%	f	%	f	%
1	0.2	155	27.3	407	71.8	4	0.7	0	0.0

It is aimed to exert which sub-dimensions efficient on the deficiency of the beliefs about mathematical problem solving of mathematics, science and elementary school pre-service teachers in this study. Average points related to the sub-dimensions of the beliefs about mathematical problem solving instrument, have been examined with this aim and the descriptive analysis results have been included below.

Table 3. Distribution of the average points related to the sub-dimensions

Sub-Dimensions	**Average Points**									
	Between 4.21-5.00 points		Between 3.41-4.20 points		Between 2.61-3.40 points		Between 1.81-2.60 points		Between 1.00-1.80 points	
	f	%	f	%	f	%	f	%	f	%
Mathematical Skills	0	0.0	23	4.1	519	91.5	25	4.4	0	0.0
Place of Mathematics	1	0.2	34	6.0	331	58.4	192	33.9	9	1.5
Understanding of Problem	134	23.6	279	49.2	117	20.6	30	5.3	7	1.3
Importance of Mathematics	196	34.6	198	34.9	135	23.8	28	4.9	10	1.8
Problem Solving Beliefs	18	3.2	181	31.8	260	45.9	99	17.5	9	1.6

As a result of the descriptive statistics, it has been understood that majority of pre-service teachers have gained average points of 3.41 and above (72.8% and 69.5% respectively), where these correspond to *I agree* and *I definitely agree* choices of the U*nderstanding of the Problem* and *Importance of the Mathematics* sub-dimensions. Nevertheless, it is also striking that few of the students have gained average points of 2.60 and lower (6.6% and 6.7% respectively), where these correspond to *I do not idea, I do not definitely agree* and *I do not agree* choices of these sub-dimensions. It has been understood that significant part of pre-service teachers (80.9%) have had average points of 2.61 and above for the *Problem Solving Skill* sub-dimension of the instrument, but it has also been seen that few of the pre-service teachers (35%) have had average points of 3.41 and above, where this correspond to *I agree* and *I definitely agree* choices of this sub-dimension of the instrument. It is also striking that majority of pre-service teachers (95.9 % and 93.8% respectively) have had average points of 3.41 and lower, where these correspond to *I do not have idea, I do not agree* and *I definitely do not agree* choices of the sub-dimensions of the *mathematical skill* and *place of mathematics* of the instrument. This situation indicates that *mathematical skill, place of the mathematics* and *problem solving skill* sub-dimensions of pre-service teachers are not enough and these sub-dimensions have effect on the beliefs about mathematical problem solving of pre-service teachers.

Average points, where the pre-service teachers have given for the items that were included on the beliefs about mathematical problem solving instrument have been examined in terms of the gender while searching for answers and results for third research problem obtained have been given below.

Table 4. Average points of beliefs about problem solving according to gender

	Average Points									
Gender	Between 4.21-5.00 points		Between 3.41-4.20 points		Between 2.61-3.40 points		Between 1.81-2.60 points		Total	
	f	%	f	%	f	%	f	%	f	%
Female	1	0.2	114	27.0	303	71.8	4	1.0	422	100
Male	0	0.0	41	28.3	104	71.7	0	0.0	145	100

When the average points of pre-service teachers for their beliefs about mathematical problem solving have been examined in terms of the gender, it could be understood that the percentage values of female and male pre-service teachers, who have gained points within the same point interval, are rather close to each other. This situation makes one to think that there is not any significant difference between average points of female and male pre-service teachers in relation to their beliefs about problem solving. Independent two sample t-test has been applied for these independent groups with this aim and the result for this test has been included in Table 5.

Table 5. *Results of the t-test in relation to differentiation of beliefs according to gender*

Gender	N	$\bar{x}$	S	sd	t	p
Female	422	3.23	0.24	565	0.604	.546
Male	145	3.25	0.26			

It was determined that there is not a significant difference between the average points about mathematical problem solving beliefs of female and male pre-service teachers who participated in this research ($t_{(565)}$=0.604; p>.05). The average points about beliefs of the male pre-service teachers ($\bar{x}$ =3.23) and the average points about beliefs of the female pre-service teachers ($\bar{x}$ =3.25) are at a similar level. Pre-service teachers in both of the groups show homogeneous distribution with regard to standard deviation values. Average points, where the pre-service teachers have given for the sub-dimensions (*mathematical skills, place of mathematics, understanding of problem, importance of mathematics* and *problem solving beliefs*) related with the beliefs about problem solving instrument have been examined in terms of the gender while searching for answers and results for fourth research problem obtained have been given below.

Table 6. *The variation of the average points in relation to sub-dimensions of the pre-service teachers according to gender*

Sub-Dimensions	Gender	Average Points: Between 4.21-5.00 points f	%	Between 3.41-4.20 points f	%	Between 2.61-3.40 points f	%	Between 1.81-2.60 points f	%	Between 1.00-1.80 points f	%
Mathematical Skills	Female	0	0.0	14	3.3	390	92.4	18	4.3	0	0.0
	Male	0	0.0	9	6.2	129	89.0	7	4.8	0	0.0
Place of Mathematics	Female	0	0.0	24	5.7	250	59.2	141	33.4	7	1.7
	Male	1	0.7	10	6.9	81	55.9	51	35.2	2	1.4
Understanding of Problem	Female	91	21.6	220	52.1	83	19.7	23	5.5	5	1.2
	Male	43	29.7	59	40.7	34	23.4	7	4.8	2	1.4
Importance of Mathematics	Female	141	33.4	153	36.3	100	23.7	18	4.3	10	2.4
	Male	55	37.9	45	31.0	35	24.1	10	6.9	0	0.0
Problem Solving Beliefs	Female	13	3.1	140	33.2	192	45.5	71	16.8	6	1.4
	Male	5	3.4	41	28.3	68	46.9	28	19.3	3	2.1

When the average points of pre-service teachers about the sub-dimensions included within the beliefs instrument are examined in terms of their gender, it can be seen that the percentages of female and male pre-service teachers, who have gained points within the same point range are closed to each other in majority of cases. However, it has also been understood that percentages of female and male pre-service teachers have shown differences for some of the sub-dimensions, even though this was small. The most significant change has occurred for the distribution of the average points of female pre-service teachers about the understanding of the problem sub-dimension and the distribution of the average points of male pre-service teachers about this sub-dimension, in other words, it has occurred between the percentages that are related to these points. It has been realized from this consideration that research especially with respect to finding out whether there would be a meaningful difference between the average points of female and male pre-service teachers about the understanding of the problem sub-dimension or not, could be appropriate.

Independent two sample t-test has been applied for these independent groups with the aim of showing that there was not any difference between points in relation to sub-dimensions of beliefs instrument of pre-service teachers in terms of gender and the result for this test has been included in Table 7.

Table 7. *Results of the t-test in relation to differentiation of sub-dimensions according to gender*

Sub-Dimensions	Gender	N	$\bar{x}$	S	sd	t	p
Mathematical Skills	Female	422	3.002	0.221	565	0.204	.839
	Male	145	3.007	0.258			
Place of Mathematics	Female	422	2.727	0.433	565	1.118	.264
	Male	145	2.775	0.481			
Understanding of Problem	Female	422	3.829	0.688	565	0.325	.745
	Male	145	3.851	0.761			
Importance of Mathematics	Female	422	3.807	0.805	565	0.590	.555
	Male	145	3.853	0.797			
Problem Solving Skills	Female	422	3.168	0.587	565	0.944	.345
	Male	145	3.114	0.607			

It was determined that there is not significant differences between the average points about sub-dimensions (*mathematical skills, place of mathematics, understanding of problem, importance of mathematics* and *problem solving beliefs*) related to beliefs of female and male pre-service teachers who participated in this research ($t_{(MB-565)}$=0.204, $t_{(MY-565)}$=1.118, $t_{(PA-565)}$=0.325, $t_{(MÖ-565)}$=0.590; $t_{(PÇ-565)}$=0.944; p>.05).

The average points about beliefs of the male and female pre-service teachers have shown that pre-service teachers in both of the groups show homogeneous distribution with regard to standard deviation values.

Percentage and frequency values have been figured out especially for each of the education fields while searching for the answers for the fifth research problem. After that, One-way ANOVA test was used to test whether there is a significant difference between beliefs about mathematical problem solving of pre-service teachers and education fields of pre-service teachers (Table 8 and 9).

Table 8. *Distribution of average points about beliefs according to education fields*

	Average Points									
	Between 4.21-5.00 points		Between 3.41-4.20 points		Between 2.61-3.40 points		Between 1.81-2.60 points		Total	
Education Fields	f	%	f	%	f	%	f	%	f	%
Mathematics	0	0.0	61	31.3	133	68.2	1	0.5	195	100
Science	0	0.0	47	25.1	140	74.9	0	0.0	187	100
Elementary	1	0.5	47	25.1	134	72.4	3	1.6	185	100

When the average points of pre-service teachers, which were calculated out of 5, have been examined in terms of their education fields, it had been seen that the average points of the pre-service teachers, whose average points for mathematical problem solving beliefs were 2.61 and above, which correspond to the *I do not idea, I agree* and *I definitely agree* choices, amongst the participating pre-service teachers that are educated in different education fields and their percentage values were very high and close to each other (respectively 95.5%-100%-98.4% for mathematics-science-elementary school pre-service teachers). In additionally, the average points of the pre-service teachers, whose average points for mathematical problem solving beliefs were 3.21 and above, amongst the participating pre-service teachers that are educated in different education fields and their percentage values were rather low (respectively 31.3%-25.1%-25.6%), is also striking. Besides, the fact, where the percentage value (31.3%) of mathematics pre-service teachers, who have obtained 3.41 points and above from the instrument applied, is higher than that of science and elementary school pre-service teachers (25.1% for science and 25.6% for elementary school pre-service teachers) makes one to think that the beliefs of mathematics pre-service teachers about mathematical problem solving are better than the beliefs of science and elementary school pre-service teachers, even though this is small in comparison.

One-way ANOVA test was used to test whether there is a significant difference between beliefs about mathematical problem solving of the pre-service teachers with respect to education fields.

Table 9. *Results of One-way ANOVA test in relation to variation of average points of the beliefs according to education fields*

	Sum of Squares	sd	Average of Squares	F	p	Significant Difference
Inter-Groups	0.355	2	0.177	2.887	.075	-
Within Groups	34.647	564	0.061			
Total	35.002	566				

The results of the analysis indicate a significant difference was not found between the education fields of the pre-service teachers and their mathematical problem solving beliefs ($F_{(2,564)}=2.887$, $p>.05$). In other words, the beliefs about mathematical problem solving of pre-service teachers do not change significantly according to education fields they are studied in.

Average points, where the pre-service teachers have given for the sub-dimensions (*mathematical skills, place of mathematics, understanding of problem, importance of mathematics* and *problem solving beliefs*) related with the beliefs about mathematical problem solving instrument have been examined in terms of the gender while searching for answers and results for sixth research problem obtained have been given in Table 10.

Independent two sample t-test has been applied for these independent groups with the aim of showing that there was not any difference between average points in relation to beliefs sub-dimensions of pre-service teachers in terms of gender and the result for this test has been included in Table 11.

Table 10. *Variation of the points of pre-service teachers about sub-dimensions included within the instrument with respect to teaching field*

		Average Points									
		Between 4.21-5.00 points		Between 3.41-4.20 points		Between 2.61-3.40 points		Between 1.81-2.60 points		Between 1.00-1.80 points	
Sub-Dimensions	**Education Field**	f	%	f	%	f	%	f	%	f	%
Mathematical Skills	Mathematics	0	0.0	7	3.6	179	91.8	9	4.6	0	0.0
	Science	0	0.0	5	2.7	176	94.1	6	3.2	0	0.0
	Elementary	0	0.0	11	5.9	164	88.6	10	5.5	0	0.0
Place of Mathematics	Mathematics	0	0.0	6	3.1	108	55.4	81	41.5	0	0.0
	Science	0	0.0	13	7.0	116	62.0	54	28.9	4	2.1
	Elementary	1	0.5	15	8.1	107	57.8	57	30.8	5	2.7
Understanding of Problem	Mathematics	50	25.6	104	53.3	30	15.4	8	4.1	3	1.6
	Science	44	23.5	95	50.8	38	20.3	8	4.3	2	1.1
	Elementary	40	21.6	80	43.2	49	26.5	14	7.6	2	1.1
Importance of Mathematics	Mathematics	88	45.1	64	32.8	37	19.0	5	2.6	1	0.5
	Science	54	28.9	65	34.8	55	29.4	11	5.8	2	1.1
	Elementary	54	29.2	69	37.3	43	23.2	12	6.5	7	3.8
Problem Solving Skills	Mathematics	8	4.1	65	33.3	91	46.7	28	14.4	3	1.5
	Science	4	2.1	49	26.2	93	49.7	38	20.4	3	1.6
	Elementary	6	3.2	67	36.2	76	41.2	33	17.8	3	1.6

When the average points of pre-service teachers for the sub-dimensions included within the Mathematical Problem Solving Beliefs are examined in terms of the teaching field they are educated in, it can be seen that the percentages of pre-service teachers, who have obtained points within the same range and who are from different teaching fields, are close to each other in majority of cases. Nevertheless, it has been understood that especially the points of mathematics pre-service teachers about the sub-dimensions of *understanding of the problem* and *importance of the mathematics* and the points of mathematics and elementary school pre-service teachers about *problem solving skills* were higher when compared with those of science pre-service teachers, even though this was in small amount. One-way ANOVA test was used to test whether there is a significant difference between the average points in relation to sub-dimensions of beliefs instrument of the pre-service teachers and education fields and the results are given in Table 11.

Meaningful differences have been found between the points of pre-service teachers about *place of mathematics, understanding of the problem, importance of mathematics* and *problem solving skills* of the instrument applied with respect to the teaching field they are educated with respect to the results of analysis with regards to examination of average points of pre-service teachers for the sub-dimensions included within the instrument applied in terms of the teaching field they are educated in ($F_{MY(2,564)}$= 3.4, $F_{PA(2,564)}$= 3.52, $F_{MÖ(2,564)}$= 10.01, $F_{PÇ(2,564)}$= 3.36, $p<.05$).

Table 11. *Results of One-way ANOVA test in relation to variation of average points in relation to sub-dimensions according to education fields*

Sub-Dimensions		Sum of Squares	sd	Average of Squares	F	p	Significant Difference
Mathematical Skills	Inter-Groups	0.047	2	0.023	0.44	.645	-
	Within Groups	30.113	564	0.053			
	Total	30.160	566				
Place of Mathematics	Inter-Groups	1.342	2	0.671	3.40	.034	-
	Within Groups	111.304	564	0.197			
	Total	112.646	566				
Understanding of Problem	Inter-Groups	3.489	2	1.745	3.52	.030	Mathematics -Elementary
	Within Groups	279.353	564	0.495			
	Total	282.842	566				
Importance of Mathematics	Inter-Groups	12.497	2	6.248	10.01	.000	Mathematics -Science Mathematics -Elementary
	Within Groups	352.025	564	0.624			
	Total	364.521	566				
Problem Solving Skill	Inter-Groups	2.342	2	1.171	3.36	.035	Mathematics -Science
	Within Groups	196.295	564	0.348			
	Total	198.636	566				

According to the Tukey test, which has been performed in order to find out from which of the teaching fields these differences had taken place, it has been understood that the points of mathematics pre-service teachers about the *understanding of the problem* sub-dimension and the points of elementary school pre-service teachers about this sub-dimension and the points of mathematics pre-service teachers about the *problem solving skills* sub-dimension and the points of science pre-service teachers about this sub-dimension and the points of mathematics pre-service teachers about the *importance of the mathematics* sub-dimension and the points of elementary school and science pre-service teachers about this sub-dimension had varied, in other words their points had differed. However, any meaningful difference had not been found between the teaching fields the pre-service teachers are educated in and their points about the *mathematical skill* sub-dimension of the instrument applied ($F_{(2,564)}$= 2.887, p>.05). In other words, it can be said that the points of pre-service teachers about the *mathematical skill* sub-dimension of the instrument do not change with respect to the teaching field they are educated in. Independent two sample t-test has been applied separately for each of the teaching fields as the *priority* in order to search for the variation of beliefs of pre-service teachers about mathematical problem solving with respect to the teaching field they are educated in and to the gender while the responses for the seventh research problem was sought and the results that obtained has been included below.

Table 12. *Results of the t-test in relation to differentiation of average points of mathematics, science and elementary school pre-service teachers according to gender*

Field	**Gender**	N	$\bar{x}$	S	sd	t	p
Mathematics	Female	146	3.28	0.229	193	1.102	.272
	Male	49	3.24	0.228			
Science	Female	148	3.22	0.244	185	0.664	.507
	Male	39	3.25	0.256			
Elementary	Female	128	3.19	0.254	183	1.409	.160
	Male	57	3.25	0.296			

It has been understood from the studies performed that the averages of the male pre-service teachers for the belief points, who are educated in different teaching fields, were almost the same with each other ($\bar{x}_{EM}$ =3.24, $\bar{x}_{EF}$ =3.25, $\bar{x}_{ES}$ =3.25). It has also been understood that the averages of the female pre-service teachers for the belief points, who are educated in mathematics, science and elementary school teaching fields, were rather close to each other ($\bar{x}_{KM}$ =3.28, $\bar{x}_{KF}$ =3.22, $\bar{x}_{KS}$ =3.19).

In addition, it has also been seen that the averages of the male pre-service teachers for the belief points about mathematical problem solving, who are educated in different teaching fields and the averages of the female pre-service teachers for the belief points were at rather close to each other. It was determined that there are not significant differences between the average points about mathematical problem solving beliefs of female and male mathematics, science and elementary school pre-service teachers who participated in this research ($t_{(193)}$ =1.102, $t_{(185)}$ =0.664, $t_{(183)}$ =1.409; p>.05).

Two-way ANOVA test has been applied for independent samples in order to search whether the beliefs of pre-service teachers about mathematical problem solving had differed or not as being related to the common effect of the teaching field they are educated and the gender (the seventh research problem) and the results obtained have been included in the table below (Table 13). Hence, a general evaluation of the findings, which had been obtained through t-test and/or variation analysis with single factor that were applied for the third and fifth research problem, have been performed together with this analysis at the same time.

Table 13. *Results of Two-way ANOVA test in relation to variation of average points in relation to problem solving beliefs according to education fields and gender*

Source of Variance	Sum of Squares	sd	Average of Squares	F	p
Education Field	0.106	2	0.053	0.864	.422
Gender	0.027	1	0.027	0.440	.508
ExG	0.204	2	0.102	1.659	.191
Error	34.415	561	0.061		
Total	35.002	566			

The results of the analysis indicate a significant difference was not found between gender of the pre-service teachers and their mathematical problem solving beliefs ($F_{(1,561)}$=0.440; p>.05). Similarly, the results of the analysis indicate a significant difference was not found between education fields of the pre-service teachers and their mathematical problem solving beliefs ($F_{(2,561)}$=0.864; p>.05). These results are inline with the results of the t-test that had been applied separately for each of the teaching fields. There could not been found any significant differences between the average points of pre-service teachers with regards to their beliefs about problem solving and their genders or education field in which they are studying, as the result of the analysis had been performed for seventh research problem ($F_{(2,561)}$=1.659; p>.05).

Conclusion and Suggestions

In this study, we tried to determine the beliefs about mathematical problem solving of the mathematics, science and elementary school pre-service teachers and put forward whether gender and the teaching field have any effect on the problem solving beliefs. The Beliefs about Mathematical Problem Solving Instrument was applied to 567 pre-service teachers with this aim.

It has been understood that majority of the pre-service teachers do not have enough beliefs about mathematical problem solving especially about *mathematical skills, place of mathematics* and *problem solving beliefs* sub-dimensions, although pre-service teachers do not have negative beliefs about mathematical problem solving as it had been found out from the studies that had been performed regarding their beliefs about mathematical problem solving. This situation, in turn, makes one to think that development of the beliefs of pre-service teachers about problem solving is a requirement.

It is thought that participation of pre-service teachers at problem solving activities during the mathematics classes and even provision of lectures with regards to mathematical problem solving could be effective for development of their beliefs about problem solving. It has been understood as the results of the studies, which had been performed with respect to the sub-dimensions of the instrument, that it is also important for the pre-service teachers to develop their beliefs about *mathematical skill, place mathematics* and *problem solving skills* sub-dimensions in order that they would develop their beliefs about mathematical problem solving. Besides, differentiation at significant level had not been found in the studies that had been performed between beliefs of pre-service teachers about problem solving and the teaching field or the gender.

As the conclusion, mathematics, science and elementary school pre-service teachers, who have participated at this research, are the pre-service teachers, who have generally received good level of mathematics education prior to their university education and it is thought that the teaching field they are educated in and their gender do not have different effect on the beliefs of pre-service teachers about problem solving. It can also be said according to the result obtained when the average points of pre-service teachers for the sub-dimensions included within the instrument are examined in terms of the teaching field they are educated in that their points for the *understanding of the problem, problem solving skills* and the *importance of the mathematics* sub-dimensions of the instrument do change and their points for the mathematical skill sub-dimensions of the instrument do not change. Teaching field and gender do not also have common effect on the beliefs of pre-service teachers about mathematical problem solving, who have participated with the research. Similar results were found by Aksan and Sözer (2007) and Hacıömeroğlu (2011b).

Researches, which would aim to understand beliefs of pre-service teachers about mathematical problem solving and which would especially aim how the beliefs with regards to understanding of mathematical problems, problem solving skills and importance of the mathematics within this context and which would manifest detailed suggestions for solutions with respect to this, can be performed for future works. It would be appropriate to determine the beliefs about mathematical problem solving of pre-service teachers, who have had social sciences based education before their university education and to compare the beliefs about mathematical problem solving of pre-service teachers, who have had science and social sciences based education before their university education, in the researches to be performed. The issue of how the beliefs about mathematical problem solving of pre-service teachers could be developed can be researched and suggestions for solutions with regards to this matter can be put forward in detail.

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