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## Examining Teacher Trainees' Belief of Mathematics and Mathematics Problem Solving

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### Abstract

**Background:** Problem solving has been considered as a student's mental development from kindergarten to high school, as a skill to be taught, and a method of teaching in mathematics education. Problem solving is emphasized as an integral part of the mathematics curriculum, and as a skill that students need to demonstrate in all subject matters. There is much concern regarding the learning of problem solving and the improvement of the current status of mathematics education at all levels of schools. Beliefs have great impact on the individual's decisions, choices and his behaviors (Pajares, 1992). Several research studies have been done on elementary students and pre-service teachers' beliefs about mathematics, as well as, problem solving. These studies found that pre-service teachers' beliefs about mathematical problem solving have an impact on their organization of the learning environment and student achievement. There is a need to examine the pre-service teachers' beliefs about general problem solving and mathematical problem solving. In the present study, we only considered some aspects of the main issues-- to find out the factors affecting mathematical problem solving beliefs.

**Aims:** To examine beliefs of pre-service class teachers and pre-service mathematics teachers' beliefs as predictors of beliefs about nature of mathematics, and mathematical problem solving. General characteristics of the problems, problem solving activity, and teaching problem solving, in particular, were examined.

**Sample:** The beliefs study about problem solving scale was conducted with pre-service elementary classroom teachers ( $N_{imo}=71$ , (imö=the number of pre-service elementary classroom teacher)) and pre-service elementary mathematics teachers ( $N_{so}=62$ , (sö=the number of pre-service mathematics teachers)) at School of Necatibey Education, Balikesir University, Turkey.

**Method:** Surveys were conducted and all written responses received from the respondents were considered. Data was collected using *The Mathematical Problem Solving Scale*. Collected data was analyzed using SPSS 11.0. In order to determine the degree of the relationship between pre-service class teachers' and pre-service mathematics teachers' mathematics beliefs and mathematical problem solving beliefs, the Pearson correlation co-efficient was used.

**Results:** The participant beliefs about teaching mathematics and problem solving reflected the characteristics of the traditional approach to mathematics teaching and the inefficiencies of that system. The results indicated that participants showed positive beliefs about mathematical problem solving.

**Conclusion:** The non-significant difference between the beliefs of pre-service elementary class teachers and pre-service elementary mathematics teachers points out the issues in mathematics teacher training, since it is expected that pre-service mathematics teachers are more familiar with mathematics and problem solving. Such finding could be due to the courses they all took pertaining to general education and mathematics education, in particular. In this study, some recommendations are given to the pre-service teachers.

**Keywords:** beliefs, mathematical problem solving beliefs, teacher education

## 查考受訓教師的數學信念和解決數學問題

Hülya Gür

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### 摘要

**背景:** 解決問題被視為學生從幼兒園到高中的心智發展、一種需要教授的技能、和數學教育的一種教學方法。數學課程強調解決問題為其中的一個組成部分，並作為一種學生在所有的科目中需要獲得的技能。在學校各級別中，學習解決問題和改善數學教育目前的境況受到很大的關注。信念對個人的決定、選擇和行為有很大的影響 (Pajares, 1992)。有多個研究小學生和初受訓教師對數學以及解決問題的基本信念，發現職前教師解決數學問題的信念影響他處理的學習環境和學生的成績，有需要研究關於職前教師解決一般問題和數學問題的信念。本研究只考慮問題的某些方面，以找出影響解決數學問題信念的因素。

**目的:** 查考職前一般教師和數學教師的信念，作為預測數學本質和數學解題信念的因素，對問題、解決問題的活動，特別是教導解決問題等一般的因素進行測試。

**樣本:** 採用解決問題量表，在土耳其巴勒克埃西爾(Balikesir)大學Necatibey教育學院，對職前一般的小學教師 ( $N_{imö} = 71$ ) 和職前小學數學教師 ( $N_{sö} = 62$ ) 進行有關信念的測試。

**方法:** 對樣本進行調查，採用[數學解題量表]收集數據，其中所有受訪者的書面答覆都在考慮之列。使用[SPSS11.0]進行分析，為了確定職前一般教師和數學教師的數學信念，和解決問題的信念之間的關係，使用Pearson相關合作係數。

**結果:** 他們教數學和解決問題的信念，反映傳統數學教學方法的特性及該系統的低效率，發現受試者解決數學問題有正面的信念。

**結論:** 原本預期職前數學教師更熟悉數學和解決問題，但研究發現職前一般小學教師和數學教師的信念沒有顯著差異，可能是由於他們都修讀了一般教育和數學教育；從而找出教師培訓中的問題，推薦了一些建議給職前教師。

**關鍵詞:** 信念、解決數學問題信念、教師培訓

## Introduction

In the 21st Century, globalization demands people all over the world to become more skilled, knowledgeable, disciplined and good at problem solving. In this aspect, teachers and “teachers-to-be” play an important role. Thus, it should be emphasized that the liability and duty of teachers to teach effectively is far greater than ever. In addition, the duty as a teacher today is far more demanding compared with teachers in the previous decade. The promotion of national, moral and cultural aspects in a nation has to be strengthened and teacher development in terms of civilization greatly depends on such an effort. As Mustafa Kemal Atatürk, the founding father of Turkey, said “The new generation will be the focus of your devotion.” Teachers also have the responsibility of instilling and explaining values. Therefore, teacher education and pre-service teachers' beliefs are very important.

Different researchers have defined ‘belief’ differently. Leder and Forgasz (2002) assert that:

In everyday language, the term of belief is often used loosely and synonymously with terms such as attitude, disposition, opinion, perception, philosophy, and value. Because these various concepts are not directly observable and have to be inferred, and because of their overlapping nature, it is not easy to produce a precise definition of beliefs (p.96).

On the other hand, some researchers stress that beliefs are related to effort (Kloosterman, 2002); conception (Thompson, 1992); feeling (Aiken, 1980); motivation, mental images, concepts and understandings (Richardson et al., 1991). Thus, one cannot say that one definition is wrong while

another is right. However, the above definitions can be considered to be more or less suitable from one individual to another, beliefs have a considerable effect on individuals' actions. In this aspect, the term, “belief”, will be defined as what one believes to be true, in spite of whether others agree or not, and regardless whether others know it to be true or not.

## Mathematics Beliefs

A new trend of research on the relationship of teachers' beliefs has been regarded as an important issue in mathematics education. Beliefs and knowledge influenced by a teacher affect trainees' practices and behavior in the classroom. Also, pre-service teachers' beliefs about mathematics teaching and pedagogical content knowledge can influence the decisions or the selection method of teaching (Pajares, 1992; Thompson, 1992). It is important to investigate the beliefs of mathematics among pre-service teachers as studies have shown that teachers' beliefs is one of the factors that guide the selection of an action in the learning process (Thompson, 1992). Thompson found that teachers' beliefs were used in determining how teachers would teach whether consciously or unconsciously. Also, understanding the beliefs of pre-service teachers is very important to policymakers for effective teacher education programs. Mathematics teachers and pre-service teachers who take mathematics education carry with them a variety of experiences based on their beliefs. Mathematical beliefs can influence the beliefs and conceptions of both teachers and pre-service teachers'. Negative beliefs also affect pre-service teachers' future. As a result, understanding the beliefs of pre-service teachers is very essential to mathematics educators so as to help them design

and implement effective teacher education programs. Hence, there is a need to assess the beliefs held by pre-service teachers of mathematics, mathematics teaching and learning.

### **Problem Solving Beliefs**

Problems create cognitive conflict by directing students to think about their present concepts about mathematics. As students are working through mathematical problems, they confirm or redefine their conceptual knowledge, relearn mathematics content and become more open to alternative ways of learning mathematics (Steele & Widman, 1997, p.190). This is because solving problems helps students see mathematics as a dynamic discipline (Conner et al., 2011). Moreover, by reflecting on their solutions, students use a variety of mathematical skills, develop a deeper insight into the structure of mathematics, and gain a disposition toward generalizing. This, in turn, helps them to acquire ways of thinking, habits of persistence and curiosity, and confidence in unfamiliar situations that serve them well outside the mathematics classroom (NCTM, 2000).

The term ‘problem solving’ has taken on different meanings at different points in education over time. At one extreme, problem solving is taken to include “situations that require little more than recall of a procedure or applications of a skill” (Grouws, 1996, p.71). Problem solving, according to the Principles and Standards for School Mathematics, published by the National Council of Teachers of Mathematics (NCTM), means “getting involved in a task for which there is no immediate answer” (2000, p.9). Problem solving has been given value as an aim for mental development, as a skill to be taught, and as a method of teaching in mathematics

education (Brown, 2003; Giganti, 2004; Jonassen, 2004; Schoenfeld, 1989). Especially in the last three decades, problem solving has been promoted to take place in mathematics classes from kindergarten to high school in many countries such as Brazil, China, Japan, Italy, Portugal, Sweden, the United Kingdom (Lester, 1994) and the United States (NCTM, 2000). Great emphasis given to problem solving instruction is due to the characteristics and necessity of problem solving not only for success in daily life, but also for the good future of societies and the improvement in the work force (Brown, 2003). That is why doing mathematics is considered by mathematicians as solving problems (Schoenfeld, 1989) and those who are able to solve problems better have been found more successful throughout history (Jonassen, 2004). When students make rote memorization, they cannot see the connections and how things fit together (Gür et al., 2001). In particular, a person’s understanding increases, as one relates a given mathematical idea to a greater variety of contexts, as one relates a given problem to a greater number of the mathematical ideas implicit in it, or as one constructs relationships among the various mathematical ideas embedded in a problem (Shroeder & Lester, 1989, p.37). In order to solve a problem, the teacher demonstrates how to solve a certain problem and directs students’ attention to salient procedures and strategies that enhance the solution of the problem (Lester, 1980, p.41). Thus, when students are taught about problem solving, they are expected to solve problems by following the same procedures step by step just as how their teacher has presented. The following definition was used in the present study. A problem is a situation where something is to be found or shown and the way to find or show it is not immediately obvious (Grouws,

1996). Problem solving is engaging in a task of which the solution method is not known in advance (NCTM, 2000). Hersh (1986) indicates that one's conception of what mathematics is affects one's conception of how it should be presented and one's manner of presenting it is an indication of what one believes to be the most essential in it (p.13). Basically, teachers have beliefs about "their profession, their students, how learning takes place, and the subject areas they teach" (Kormaz et al, 2006). Teachers' beliefs play a crucial role in changing the ways teaching takes place.

Various studies which are focused on problem solving are conducted not only in Turkey, but also in the world as a whole (e.g. Ersoy, Çömlekoğlu & Gür, 2002; Kandemir, 2006; Yıldız, 2008; Stanic & Kilpatrick, 1989; Conner et al., 2011; Charalambos et al., 2011). Thus, researchers are mostly interested in problem solving and problem solving performance in Turkey.

Literature showed that very little research was found in Turkish publications on mathematical problem solving, and teachers' beliefs about problem solving, and most of these studies were conducted in the last fifteen years. Additionally the research showed that nearly all of these studies were related to elementary students' problem-solving abilities. For instance, Soylu and Soylu (2006) conducted a study on elementary students in order to determine students' difficulties and errors in problem solving. It was found that the students did not have difficulty in answering the exercises that required procedural knowledge related to addition, subtraction, and multiplication; whereas, they had difficulties in solving problems that require conceptual and operational knowledge. Another study was conducted

by Karataş and Güven (2004) examining and discussing students' sufficiency and weakness in the problem solving process. The data showed that although students could explain problems by using variables in the representation stage, they failed in defining the problem correctly, as well as in writing an equation and reaching a correct answer. An additional study was carried out by Adıgüzel and Akpınar (2004) who studied into the effect of technology usage on elementary students' problem solving skills. The study showed that those 7th grade students' word problem-solving skills especially related to work and pool problems improved through computer-based multiple representations including graphic, symbolic, and audio representations. Additionally, Toluk and Olkun (2002) examined how the elementary school mathematics textbooks approach problem solving. The results of the study showed that elementary mathematics textbooks displayed the traditional belief of problem solving (Kayan, 2007) where mathematical concepts and skills are considered as prerequisites for problem solving. A further study was carried out by Korkmaz, Gür and Ersoy (2006) to examine what mathematics and elementary pre-service teachers do in the problem posing process, and to determine the misunderstandings that they have in this process. Findings showed that, first of all, pre-service teachers did not know the difference between the problem and the exercise. They defined problems to be the exercises solved at the end of lesson in order to practice the introduced idea. Subsequently, they thought that there is only one solution to any problem, and believed that textbooks are sufficient for developing students' problem posing abilities. Also it was found that the pre-service teachers did not realize open ended mathematics problems should be asked in

mathematics instruction. Kayan (2007) observed the kinds of beliefs pre-service elementary mathematics teachers hold about mathematical problem solving, and investigated whether, or not, gender and the university qualifications had any significant effect on their problem solving beliefs. The sample of Kayan's study consisted of 244 senior undergraduate students. In general, the pre-service elementary mathematics teachers indicated positive beliefs about mathematical problem solving. However, they still had several traditional beliefs related to the importance of computational skills in mathematics education, and the following predetermined sequence of steps taken while solving problems. Toluk, Uçar et al. (2010) identified the students' beliefs in the second grade. They found that the students were capable of fast explanation would lead to success in mathematics, to find the right answer and get high marks as stated. There are limited number of studies on problem-solving beliefs (Aksan & Sözer, 2007; Işıksal et al., 2007) and problem solving in mathematics beliefs in Turkey (Yılmaz & Delice, 2007; Yılmaz & Şahin, 2011). Problem solving has been given value from kindergarten to high school as an aim of mental development, as a skill to be taught, and as a method of teaching in mathematics education (Brown, 2003; Giganti, 2004; Jonassen, 2004; Schoenfeld, 1989) all over the world, and now in new Turkish mathematics curriculum it is emphasized as a common skill for all subject matters. As the importance given to problem solving increases, it becomes essentially important to learn more about problem solving and how to apply it in mathematics classrooms.

Particularly in Turkey, after the current innovation in the mathematics curriculum, it becomes tremendously important to understand what teachers

know and believe about these intended changes. Research reported that in Turkey very few studies have been conducted about what pre-service teachers believe about mathematical problem solving. On the other hand, it is important to study pre-service teachers' beliefs, in order to give us insight into possible changes that could be made in a pre-service education program. Moreover, learning more about pre-service teachers' beliefs will guide us "in choosing and implementing professional development programs for both pre-service and in-service teachers" (Brown, 2003, p.13). Therefore, it is vital to be aware of pre-service teachers' obstructive beliefs related to mathematical problem solving, and offer opportunities to challenge those beliefs. As a result of increased interest in problem solving, the training of both pre-service mathematics teachers and pre-service class teachers to help them become better teachers of problem solving is now a current issue for discussion, and needs detailed studies in various areas. Before designing learning environments for improving problem solving abilities, there is a need to examine the problem solving abilities and beliefs of pre-service and in-service teachers. Teachers' beliefs about mathematics, in particular problem solving, are important in determining the nature of the classroom environment which shapes the students' beliefs about the nature of mathematics and its applications (Thompson, 1992).

### **Purpose of the Study**

The objective of this study was to determine the beliefs of pre-service class teacher and pre-service elementary mathematics teachers. This study aims to answer the following questions:

1. What is the pre-service class teachers' belief

- about mathematical problem solving?
2. What are the pre-service elementary mathematics teachers' beliefs about mathematical problem solving?
  3. What are the beliefs of both the pre-service class teachers and pre-service elementary mathematics teachers about mathematical problem solving?
  4. What are the means of the group on each subscale? Is the test value the maximum score of those subscales?
  5. What are the independent t-test scores for both the pre- service class teachers and pre-service elementary mathematics teachers?

**Significance of the study.** This study provides insight into the beliefs of Turkish pre-service elementary mathematics teachers and pre-service class teachers regarding problem solving in mathematics education. Such an exploration will throw light on future developments of mathematical problem solving training in teacher education programs. Moreover, knowing more about pre-service teachers' beliefs will guide us in choosing and implementing better professional development for both pre-service and in-service teacher education in the future.

### Methodology

The main area of focus in the present study was to investigate the kinds of beliefs that pre-service elementary mathematics teachers and pre-service

elementary class teachers have towards mathematical problem solving. *It was a survey study, because a survey design mainly provides "a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population" (Creswell, 2003, p.153). It was a survey study designed to collect information from pre-service elementary mathematics teachers on their beliefs about mathematical problem solving by direct administration of a survey. First version of this scale was developed by Çömlekoğlu (2001), which was modified by the researcher (Appendix A).*

### Sample

All participants were from the School of Necatibey Education. The pre-service class teacher trainees and pre-service elementary mathematics teacher trainees had completed the educational courses such as Psychology of Education, Teaching Methods and Evaluation, School Experience I, School Experience II, Practice Teaching in Elementary Education, Methods of Mathematics Teaching as well as various mathematics courses and few science courses. The scale was applied to the sample, which was formed using the clustered sampling technique. In this study, sixty-two pre-service elementary mathematics teachers ( $N_{sö}=62$ ) and seventy-one pre-service elementary class teachers ( $N_{imö}=71$ ) participated (total sample was  $N_T=133$ ) (Table 1).

#### Composition of Sample

Category	Frequency
Pre-service elementary mathematics teachers	$N_{sö}=62$
Pre-service elementary class teachers	$N_{imö}=71$
Total	$N_T=133$

Each group might be similar to each other and these groups might represent both the school teacher trainees and mathematics teacher trainees. Direct administration of the survey was conducted to pre-service class teachers and pre-service mathematics teachers in their classroom settings within 30 minutes. The participants voluntarily participated in this study. The scales, which were anonymous and confidential, were administered to the students in groups in the classroom environment.

### **Instruments**

The instrument used was a survey study designed to collect information from pre-service teachers about mathematical problem solving, which was administrated directly and prepared by the researcher (Creswell, 2003, p.153). In this study, the questionnaire and observation (Kayan, 2007; Gravetter & Wallnau, 2003) were used as the research tools. The observation was used to clarify whether they used problem solving in mathematics teaching. The results of the factor analysis and item-total correlation indicated that the Turkish version of the scale, with all items together, consists of 6 factors and 30 items. Cronbach alpha reliability coefficient for the six factors of the questionnaire was found to range from .69 and .90 and .81 for the whole scale. The results showed that the Turkish version of the Problem Solving Belief Questionnaire were valid and reliable. Thus it can be used to reveal students' belief toward mathematics learning. It is thought that this questionnaire will be useful for mathematics educators who want to study about factors affecting students' beliefs in mathematics courses and other variables that can affect these factors.

Participants were presented with a questionnaire

having both 5 point Likert type items. The Likert type items were adopted to assess the pre-service teachers beliefs on several topics related to mathematical problem solving. Validity and reliability were considered.

In the survey, there are 30 items and one open-ended item. The scale consists of positive wording statements and negative wording statements. It is a Likert type scale which covers five categories: strongly agree, agree, uncertain, disagree, strongly disagree and scores from 5 to 1 respectively. But all negative items are scored from 1 to 5 respectively. (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree). The higher the score, the stronger beliefs pre-service elementary mathematics teachers have toward mathematical problem solving. The range for the total scale points is between 30 and 150. The reliability of the test, analyzed by Baloğlu (2005) in terms of Turkish language validity and pre-psychometric analysis, is examined by using the consistency of the items method. The internal reliability of this scale was .81.

The belief about Problem Solving Scale comprises six sub-categories.

First Sub category (S1) (5 items): What are the characteristics of mathematical problems (5 items, Attachment A- item numbers: 1, 10, 12, 13, 24);

Second sub category (S2) (5 items): The characteristics of problem solving activities (What are the characteristics of problem solving activities) (5 items) (Attachment A- item numbers: 2, 8, 9, 15, 16);

Third sub category (S3) (4 items): Constructing problems for teaching in class (How organized are mathematics problems) (4 items) (Attachment A- item numbers: 3, 4, 11, 29);

Fourth sub category (S4) (5 items): Teaching

problem solving and what is problem-solving teaching) (5 items) (Attachment A- item numbers: 21, 23, 25, 26, 27);

Fifth sub category (S5) (5 items): The reasons for solving mathematical problems in mathematics classes (Is it necessary to problem-solve in math class) (5 items) (Attachment A- item numbers: 5, 6, 7, 20, 30);

Sixth sub category (S6) (6 items): The characteristics of successful problem solvers (What are the characteristics of a successful problem solver) (6 items) (Attachment A - item numbers: 14, 17, 18, 19, 22, 28).

Examples of each category are listed (Appendix A), respectively: "There is always one correct answer for a problem", "Problem solving requires an investigative approach", "Problems should be constructed with respect to the level of concepts that are learned.", "Textbooks are adequate for teaching problem solving", "Problems should be solved at the end of the units for consolidating the concepts", "Knowledge of the mathematical content of the problem is adequate for being a better problem solver".

The open-ended item of the questionnaire is about whether the courses offered by the education faculty were sufficient for teaching mathematics.

Table 2

*Pre-service Elementary Class Teachers' Mean Scores in Each Sub-Scale of Beliefs about Problem Solving Scale*

Sub-Scale	MS (The maximum score of each sub-scale)	Pre-service Elementary Class Teachers	
		$X_c$ (Average of each sub-scale of pre-service class teachers)	$M_c = X_c/MS$ (Mean score of each sub-scales of pre-service class teachers)
S1	25	17.43	0.70
<b>S2</b>	<b>25</b>	<b>20.02</b>	<b>0.80</b>
<b>S3</b>	<b>20</b>	<b>13.56</b>	<b>0.68</b>
S4	25	18.11	0.72
S5	25	19.13	0.77
S6	30	20.84	0.69
Whole Scale	150	109.09	0.73 = (4.36)/6

The internal consistency of sub-scales of Cronbach Alfa were S1 (.90), S2 (.85), S3 (.69), S4 (.76), S5 (.82) and S6 (.79). SPSS 11.0 Statistical Program was used to analyze the data (Green, S.B., Salkind, N. J., & Akey, T. M., 2000). Data was analyzed through ANOVA and t-test.

### Findings

After the total scores of each case in Beliefs about Problem Solving Survey were calculated, the relative mean score ( $M=X/MS$ ) which is the ratio of the mean score to the possible maximum score (MS: maximum score) for each dimension, was calculated. This is also given in the second column of the tables below. (Example: If  $MS = 25$ ;  $X_c = 20,02$  then  $M_c = MS/XC = 20,02/25 = 0.80$ ). The mean scores of each subscale are given below for each of pre-service elementary class teachers (Table 2) and elementary mathematics teachers (Table 3).

The findings related with each question will be given in order.

Question 1: What are the pre-service class teacher's beliefs about mathematical problem solving?

The means of pre-service class teachers' scores of the present scales are displayed in Table 2.

The mean scores change from 0.68 to 0.80 out of 1 for the items of the scale. In terms of 5 point scale, the means indicate that the beliefs expressed toward the problem solving scale were positive. The mean of S2: “The characteristics of problem solving activities” is the higher mean. The second highest mean is S5: “The reasons for solving mathematical problems in mathematics classes”. And orderly, S4, S1; S6 and S3. It means that, the lowest mean is S3: “Constructing problems for teaching in class”. When we consider the entire scale, the average mean value is 0.73.

Table 3

*Pre-service Elementary Mathematics Teachers’ Mean Scores in Each Sub-Scale of Beliefs about Problem Solving Scale*

Sub-Scale	MS (The maximum score of each sub-scale)	Pre-service Elementary Class Teachers	
		$X_m$ (Average of each sub-scale of pre-service elementary mathematics teachers)	$M_m = X_m/M_S$ (Mean score of each sub-scales of pre-service elementary mathematics teachers)
S1	25	18.04	0.72
<b>S2</b>	<b>25</b>	<b>19.98</b>	<b>0.80</b>
<b>S3</b>	<b>20</b>	<b>13.76</b>	<b>0.69</b>
S4	25	18.41	0.74
S5	25	19.31	0.77
S6	30	21.85	0.73
Whole Scale	150	111.35	0.74 = (4.45)/6

The mean scores change from 0.68 to 0.79 out of 1 for the items of the scale. In terms of 5 point scale, the means indicate that the beliefs expressed toward the problem solving scale were positive. The order is from the highest relative mean scores to lowest relative mean scores, S2, S5, S4, S6; S1 and S3. The mean of S2: “The characteristics of problem solving activities” is the higher mean. The second highest mean is S5: “The reasons for solving mathematical problems in mathematics classes”. The lowest relative

Standard deviations are provided, respectively: S2 = 3.44; S5 = 3.33; S4 = 3.29; S1 = 2.91; S6 = 2.70; S3 = 2.41 (total standard division  $sdc = 18.08$ ). It means that pre-service elementary class teachers show positive beliefs to the problem solving general.

Question 2: What are the pre-service elementary mathematics teachers’ beliefs about mathematical problem solving?

The means of pre-service elementary mathematics teachers’ scores of the present scales are displayed in Table 3.

mean score is 0.69. The lowest relative mean scores are on S3: “constructing problems for teaching in class”. This means that the lowest mean is S3: “Constructing problems for teaching in class”. When we consider the entire scale, the average mean value is 0.74.

Standard deviations are provided respectively: S2 = 2.96; S5 = 2.86; S4 = 2.77; S6 = 2.68; S1 = 2.40; S3 = 2.12 (total standard division = 15.79). It means that pre-service elementary mathematics teachers show positive beliefs to the problem solving general.

Question 3: What are both kinds of pre-service teachers' beliefs about mathematical problem solving?

The mean scores of whole groups of pre-service teachers' scores of the present scales are displayed in Table 4.

Table 4

*Whole group of both kinds of pre-service teachers' mean and standard deviation of the sub-scales of beliefs about problem solving scale*

Sub-Scale	Average of X = $[(XC+XM)/2]$ (The average of each sub-scales of both pre-service teachers)	MS (The maximum score of each sub-scale)	Average of M= $[(MC+MM)/2]$ (The mean of each sub-scale of both pre-service teachers)	Average of Standard Deviation
S1	17.74	25	0.71	2.65
S2	20.00	25	0.80	2.70
S3	13.66	20	0.69	2.26
S4	18.26	25	0.73	<b>3.03</b>
S5	19.22	25	0.77	<b>3.01</b>
S6	21.31	30	0.71	2.69
Whole Scale	110.22	150	$(4.42)/6=0.74$	$(16.34)/6=2.72$

The mean scores change from 0.69 to 0.80 out of 1 for the items of the scale. In terms of 5 point scale, the means indicate that the beliefs expressed toward the problem solving scale were positive, respectively S2, S5, S4, S1 = S6, and S3. The whole group of both kinds of pre-service teachers' mean of the sub-scales of beliefs about problem solving scale is considered. The lowest mean is S3: "constructing problems for teaching in class" and the highest mean is S2: "the characteristics of problem solving activities". We consider the average of standard deviation from the highest to the lowest score (S4; S5; S2; S6; S1 and S3) respectively. The highest standard deviation is S4: "Teaching problem solving", next is S5 "The reasons for solving mathematical problems in mathematics classes", then S2, then S6: "The characteristics of

successful problem solvers", then S1 "What are the characteristics of mathematical problems", and S3: "Constructing problems for teaching in class". The two results, the average mean scores and average of standard deviation scores, differ from each other. The averages of standard deviations show that teacher trainees have done more emphasis on S4 and S5.

Question 4: What are the means of the group on each subscale? Is the test value the maximum score of those subscales?

As can be seen from the above tables (Table2, Table 3 and Table 4), for each subscale, the hypothesis, "The mean of the group on each subscale is the test value, which is the maximum score of that subscale" was tested by using one sample t-test at alpha 0.05 level (Table 5).

Table 5

*One-Sample t-test results regarding the sub-scales of beliefs about problem solving scale (BPS)*

Sub-Scale	Test value (The maximum score of each sub-scale (MS))	df	t	Significance
S1	25	150	-27.341	.000
S2	25	150	-23.671	.000
S3	20	150	-33.804	.000
S4	25	150	-27.022	.000
S5	25	150	-24.356	.000
S6	30	150	-33.832	.000

The mean of the two groups are examined, the difference between the calculated averages are statistically significant ( $p = .000 < .05$ , each subscale). Results indicated that beliefs of pre-service teachers in both of the groups are different from the positive beliefs about problem solving drawn from the literature.

#### **Question 5: What are independent t-test scores for both kinds of pre-service teachers?**

In general, six sub-groups were analyzed. The independent t-test results for groups of both kinds of pre-service teachers are displayed in Table 6. As can be seen from the Table 6, there is a significant difference between the mean scores of beliefs of the two kinds of pre-service teachers.

Table 6

*Both Kinds of Pre-Service Teachers' Mean and Standard Deviation*

Group	Mean	(sd)	Significance
Pre-service elementary class teachers	109.09	18.08	0.0159
Pre-service elementary mathematics teachers	111.35	15.79	

$p = 0.0159 < 0.05$  whether it is one tail testing as assumed above ( $p = 0.0159 < 0.05$ ) or two tails testing of hypothesis where the significance would be  $0.05/2 = 0.025$  and  $p = 0.0159 < 0.025$ ) and hence reject the hypothesis of no difference and conclude there is a difference and in your case is in favor of the pre-service elementary class teachers!

#### **Discussion and Conclusions**

Although there are some studies calling for a reform in Turkish educational system with various recommendations, mathematics education still reflects the characteristics of traditional approach and understanding. Pre-service teachers' beliefs about mathematics problems and problem solving have dominant effect on what and how to teach mathematics in schools. A number of studies highlighted that teachers should be well-educated

about mathematical problems and problem solving. Also, they have to apply these problem solving skills. The findings of the present study show that pre-service teachers' beliefs are not consistent with the positive beliefs in current literature (Table 2 and Table 3). In short, the main findings and interpretations are as follow:

Both pre-service mathematics teachers and pre-service class teachers understand the questions, which have the characteristics of seeing exercises as problems. Most of them think problems should include numerical quantities, and there has only one correct answer for a problem. Teacher candidates only aim to find the result. Teacher candidates' beliefs about problem solving just focus to find the result, but not the problem solving process.

At the end of the study, the following conclusions were reached. The pre-service class teachers' beliefs are positive about mathematical problem solving. The pre-service elementary mathematics teachers' beliefs are also positive to mathematical problem solving. Both kinds of pre-service teachers' beliefs about mathematical problem solving are positive. Pre-service mathematics teachers and pre-service classroom teachers believe that in order to be successful in problem solving (Kayan, 2007; Kartaş & Güven, 2004; Soylu & Soylu, 2007; Thompson, 1992), understanding the teachers' style and having the subject knowledge are adequate. It is probable that they will plan their lessons in a traditional manner in which memorization of information is promoted and this result parallels Kayan's findings. Also, teachers prefer working individually rather than in-groups in problem solving activities.

The non-significant difference between the beliefs of pre-service elementary class teachers and

pre-service elementary mathematics teachers points out the issues in mathematics teacher training. It is expected that pre-service mathematics teachers are closer to mathematics and problem solving. The reason of this could be the courses they all took about education in general and mathematics education in particular. Ninety-two percent of the participants think that the courses related to education, in particular, problem solving are inadequate for their professional development. In general, both pre-service mathematics teachers and pre-service class teachers show positive beliefs about mathematical problem solving. This result is similar to the Yılmaz & Delice (2007)' and Yılmaz & Şahin (2011)'s study. There were some moderate and negative beliefs about problem solving. These findings indicated that the pre-service elementary mathematics teachers in this study gave importance to problem solving in mathematics education. This result is parallel to Thompson (1992)'s study. The study's findings have implications for policy makers as they try to find effective ways and means to support high level learning for all teachers, teacher trainees and students.

Pre-service mathematics teachers and pre-service class teachers state that the questions in the books are not sufficient for the development of problem-solving skills. Since most of the textbooks are reflecting traditional approach (Kayan, 2007), it is probable that they don't have a clear sense about problem solving, and they have the notion that the results in mathematics should be always clear-cut (Gür et al., 2001). Besides, perceiving problem solving as an activity that should be placed after teaching a concept contradicts with their belief that problem solving activities should promote discovery and investigative approaches.

In conclusion, we can state that most of the pre-service teachers reflect the aspects of traditional instructional approach (Gür et al., 2001; Toluk & Olkun, 2001). As it is clear from the above statements, limited practice on problem solving lead pre-service teachers think problem solving as a set of rules to be memorized (Lester, 1980). They also state that, they cannot establish the relationship between the theoretical mathematics courses and school mathematics; and don't remember many of school mathematics topics. A majority of them have the feeling that they didn't learn anything extra after high school, which is required for the profession as a teacher. Since they will be forerunners on beliefs about mathematics and experience in the learning process, as it should be in literature, their beliefs will change. In short, the findings of the study showed that both kinds of pre-service teachers' problem solving beliefs were the predictors of beliefs about mathematical problem solving. The result of study stressed that these two kinds of pre-service teachers' belief systems are related.

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