Pre-service primary school teachers’ preference of the problem solving strategies for word problems

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Abstract

The purpose of this study was to investigate the pre-service primary school teachers’ problem solving skills and their preferences of problem solving strategies in the word problems. There were a total of 200 pre-service primary school teachers enrolled in teacher education programs in three different universities in Turkey. In the collection of the data, researchers developed the open ended word problems, usually in at least two strategies. This instrument was administered to the participants. All pre-service teachers were told to use any strategies that they would like to use, in solving the problems. After the collection of the data, strategies used by pre-service teachers in solving the problems were identified and categorized. The researchers used the descriptive statistics in analysis of the data. The results showed that pre-service primary school teachers preferred various problem solving strategies, such as algebraic strategy, arithmetic strategies, use a model for solving of the word problems © 2011 Published by Elsevier Ltd.

Keywords: Problem solving strategies, word problems, mathematics teaching, pre-service primary school teachers.

1. Introduction

In many countries, problem solving is a critical subject in the school mathematics curriculum. According to Stanic and Kilpatrick (1989), problems have occupied a central place in the school mathematics curriculum since antiquity. Because, mathematics teachers, students and parents beliefs that doing mathematics is solving problems (Kaur, 1997). In Turkey, the new elementary mathematics curriculum (1-8th grades), which is prepared by the Ministry of National Education, [MNE] (2005a, 2005b), emphasized the importance of problem solving and problem solving strategies. Also, the Ministry of National Education determines that one of the most important aims of the elementary mathematics curriculum is to enable students to develop their abilities in mathematical problem solving. Similarly, National Council of Teachers of Mathematics [NCTM] reported that mathematics instruction programs from pre-kindergarten through grade 12 should enable all students to use a variety of suitable problem solving strategies (NCTM, 2000).

Additionally, because of the importance of the problem solving, many research were conducted by mathematics educators related to the problem solving and preferred strategies for the problem solving and the importance of problem solving in mathematics courses were pointed out (Arslan & Altun, 2007; Contreras, 2002; Van Dooren, 2005).

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Verschaffel & Onghena, 2002; Huntley, Marcus, Kahan & Miller, 2007; Ishida, 2002; Jiang & Chua, 2010; Peker, 2009). In the vast majority of these studies, students’ understanding and performance, students’ difficulties and their preference in problem solving strategies was investigated (Arslan & Altun, 2007; Van Dooren et al., 2002; Fuchs & Fuchs, 2002; Huntley, Marcus, Kahan & Miller, 2007; Ishida, 2002; Jiang & Chua, 2010; Rhymer and Cates; 2006; Soylu & Soylu, 2006). For example, Soylu & Soylu (2006) explored the students’ difficulties and errors in problem solving. They found that the students did not have difficulty in answering the exercises that required operational knowledge related to addition-subtraction-multiplication, while they had a difficulty in solving the problems that required conceptual and operational knowledge. Jiang & Chua (2010) and Ishida (2002) investigated strategies used by students in problem solving. Jiang & Chua (2010) explored strategies used by 1070 Chinese students and 1002 Singaporean students from primary grade 6 to secondary year 2 in solving three fraction-related problems. Results of their study indicated that the Chinese students used the traditional methods like arithmetic and algebraic strategies more frequently than the Singaporean students, whereas the Singaporean students used the model and unitary methods more frequently than the Chinese students.

Some research which is related to our research investigated problem solving preferences of pre- and in-service teachers (Contreras, 2002; Van Dooren et al., 2002; Leikin, 2003). For example, Van Dooren et al. (2002) explored the arithmetic and algebra word problem solving skills and strategies of pre-service primary and secondary school teachers. The results of their research showed that the pre-service secondary school mathematics teachers preferred the use of algebraic strategies, even when an arithmetic solution was more straightforward. Also, they reported that the pre-service primary school teachers’ preferred various problem solving strategies.

Teacher plays an important role in apply and adapt a variety of appropriate strategies to solve problems because many studies have indicated that teachers’ content-specific knowledge, beliefs and attitudes influence students’ learning outcomes (Baki; 1996; Calderhead, 1996; Pajares, 1992; Shulman, 1986; Thompson, 1992). Today, 26% of Turkey’s population (about 19 million) is in the 0-14 age group (Turkish Statistical Institute [TSI], 2010). Pre-service primary school teachers, who are considered as future educational leaders, will become these children’s teacher and they will teach problem solving to these children in the future. Therefore, it is important to understand the pre-service primary school teachers’ problem solving preferences for the word problems. For this reason, the aim of this study is to examine and explore the pre-service primary school teachers’ problem solving skills and preferences for the word problems.

2. Methodology

In the study, the main characteristics of different problem-solving strategies, as used by the teachers, were identified. Therefore, descriptive design was used in current study since descriptive design provides a summary of an existing phenomenon, in which the researchers interest, by using numbers to characterize individuals or a group. The purpose of it is to observe, describe and assess the nature of existing condition. (McMillan and Schumacher, 2006).

2.1. Participants

Insert your heading text and choose the appropriate heading level from the style menu. Insert your heading text the participants were 200 pre-service primary school teachers, ages 20-25 years, who attend three different universities Faculty of Education, and Department of Primary Education in Turkey. Primary teacher education programs provide a four-year professional education to students. Pre-service primary school teachers are trained to teach all courses (including mathematics) to primary school children. The four years of education for pre-service primary school teachers consist of a mixture of content courses, educational and instructional sciences and content teaching courses. For example, the Basic Mathematics I - II and Mathematics Teaching I-II are compulsory courses for pre-service primary school teachers. The participants took the Basic Mathematics I-II and Mathematics Teaching I courses. The researchers followed the convenience sampling procedure in which the participants are not randomly selected. According to McMillan and Schumacher (2006), a convenience sample is a group of subjects selected on the basis of being accessible or expedient and it is appropriate to use the group as subjects.
2.1.1. Instrument

The researchers used one the questionnaire consisted of 4 open-ended questions (word problems), in the collection of the data. The word problems could be solved using several strategies. In the preparation of word problems in the questionnaire was benefited from the related to literature (Altun, 2008; Ishida, 2002; Jiang & Chua, 2010) and the elementary school mathematics curriculum (MNE, 2005). In the open ended questions, the pre-service teachers were asked to solve according to primary school-level students. The problems used in the study were given in the following.

**Problem 1:** Rice was transported using one large size truck and one small size truck. The total weight of the rice was 64 ton. The large size truck transported 5 ton of rice each time, and the small size truck transported 2 ton of rice each time. In total there were 20 trips. How many trips did each truck make?

**Problem 2:** Using small equilateral triangles, you can construct a large triangle as shown in following. How many small triangles do you need to construct a large triangle of seventh figure?

First figure Second figure Third figure Fourth figure ...... Seventh figure

**Problem 3:** On Sunday, the students of one class went out for a picnic. At first, they traveled in the crowded city 40 min at a speed of 27 km/h. Then, they covered 1/5 of the remaining journey at a speed of 54 km/h. Finally, they traveled 2/3 of the whole journey in 1 h on the expressway. Find the average speed for the whole journey.

**Problem 4:** Ahmet’s uncle cultivated tomatoes 3/8 of the whole infield, and pepper 1/3 of the remaining infield. 15 acres of the infield was uncultivated. Accordingly, the whole infield, how many acres?

2.1.1.1. Procedure and Data Analysis

Participation was voluntary, with consent obtained from participants. Two hundred (200) pre-service primary school teachers solved given problems in the questionnaire, which was administered by the researchers. There was no time limitation for the testing session, however most pre-service teachers solved problems in the instrument in less than 40 minutes. In data analysis, both quantitative and qualitative techniques were used. All of the pre-service teachers’ responses to open-ended questions were divided into categories and strategies used by pre-service in solving the problems were identified. The pre-service teachers’ responses were scored using a 1a-1b-2a-2b-3a-3b-4a-4b-5a-5b-6a-6b-7 scale. For example, arithmetic strategy is used when, if the pre-service teachers’ response is correct, 1a was given. If the pre-service teachers’ response is incorrect, 1b was given. The strategies used by students in problem solving were given in table 1.

| Number | Strategy category | Definition |
|--------|-------------------|------------|
| 1      | Arithmetic        | The pupil writes down a mathematical statement involving one or more operations on the numbers given in the problem (Van Dooren et al., 2002; Jiang & Chua, 2010) |
| 2      | Algebraic         | One or more unknowns as variables were selected and the verbal problem statement is translated to algebraic statement and equations. The equations are solved to find a answers (Altun, 2008; Van Dooren et al., 2002; Koedinger and Tabachneck, 1994) |
| 3      | Model             | The word problem is translated into a model. Then the problem is solved with the help of the model. The model can be a picture, a figure, a diagram, or even a graph (Koedinger and Tabachneck, 1994; Jiang & Chua, 2010). |
| 4      | Guess-and-check   | Problem solver makes a guess and then he/she checks to see whether it is a solution (Altun 2008; Fan & Zhu, 2007). This strategy described by some researchers as trial and error strategy (Ishida, 2002) |
| 5      | Find a pattern    | Problem solvers seek for patterns in the data given in the problem in order to solve the problem. Pupils seek for relationship or numbers which are repeated, or a series which regularly repeated. (Altun 2008; Fan & Zhu, 2007). |
6 Model and Algebraic In this category, the pre-service teachers firstly translated the word problem into a model then they wrote equations with the help of the model. Finally, they solved the equation in order to find an answer.

7 Unresponsive “Unresponsive” category was added since it was seen that pre-service teacher did not give any response.

3. Results and Discussion

Table 2 shows the distribution of the pre-service teachers’ response in word problems. It was shown that the problem solving strategies of the pre-service primary school teachers for the word problems were different. The future primary school teacher used two different (algebraic and Guess-and-check) strategies in solving the first problem. In solving of the first problem, 41% of the pre-service teachers used the algebraic strategy. While 36.5% of these pre-service teachers solved the first problem correctly, remaining 4.5% of the pre-service teachers could not solve this problem correctly. More than half of the participants (57.5%) preferred using guess-and-check strategy in solving of the first problem. It was seen that 53% of these pre-service teachers’ solved this problem correctly, but 4.5% of the pre-service teachers, who preferred using guess-and-check strategy, could not solve correctly. Shortly, as seen in table 2, the most of the pre-service teachers (89.5%) solved the first problem correctly, 9% of the participants gave wrong answers and 1.5% of the participants did not give any response for solving.

As seen in table 2, the pre-service teachers used two different problem solving strategies in the second problem. Most of the pre-service primary school teachers (88.5%) preferred the using find a pattern strategy. 70.5% of these pre-service teachers who preferred the using find a pattern solved this problem correctly, remaining 18% of them could not solve correctly or gave wrong answers. 6% of the pre-service teachers used model strategy in solving the second problem. 5.5% of these pre-service teachers who preferred the using model strategy solved correctly. In total, 76% of the participants solved the second problem correctly, 18.5% of the participants could not solve correctly, and 5.5% of the participants did not give any response to solve this problem.

Table 2. Distribution of strategies used in the solving of problems

| Used Strategy       | Problem 1 |      | Problem 2 |      | Problem 3 |      | Problem 4 |      |
|---------------------|----------|------|-----------|------|-----------|------|-----------|------|
|                     | Problem 1 | %    | Problem 2 | %    | Problem 3 | %    | Problem 4 | %    |
| Arithmetic          |          |      |           |      |           |      |           |      |
| Correct             |          |      | 100       | 53   | 1         | 51   | 1         | 51   |
| Incorrect           |          |      | 0         | 49   | 0         | 49   | 0         | 49   |
| Algebraic           |          |      |           |      |           |      |           |      |
| Correct             | 73       | 36.5 | 1         | 5.5  | 2         | 11   | 1         | 5.5  |
| Incorrect           | 9        | 4.5  | 0         | 0    | 39        | 17.5 | 16        | 8    |
| Model               |          |      |           |      |           |      |           |      |
| Correct             | 0        | 0    | 141       | 70.5 | 0         | 0    | 0         | 0    |
| Incorrect           | 0        | 0    | 36        | 18   | 0         | 0    | 0         | 0    |
| Guess-and-check     |          |      |           |      |           |      |           |      |
| Correct             | 0        | 0    | 0         | 0    | 2         | 11   | 1         | 5.5  |
| Incorrect           | 0        | 0    | 0         | 0    | 0         | 0    | 0         | 0    |
| Find a pattern      |          |      |           |      |           |      |           |      |
| Correct             | 0        | 0    | 141       | 70.5 | 0         | 0    | 0         | 0    |
| Incorrect           | 0        | 0    | 36        | 18   | 0         | 0    | 0         | 0    |
| Model and Algebraic |          |      |           |      |           |      |           |      |
| Correct             | 0        | 0    | 0         | 0    | 2         | 11   | 1         | 5.5  |
| Incorrect           | 0        | 0    | 0         | 0    | 0         | 0    | 0         | 0    |
| Unresponsive        | 0        | 0    | 0         | 0    | 0         | 0    | 0         | 0    |

According to the findings, the pre-service primary school teachers preferred four different strategies in solving the third problem. More than one-third of the pre-service teachers (36.5%) used both model and algebraic strategies in solving this problem. These pre-service teachers convert the problem to model, then they wrote the equations with the help of the model, and tried to solve the problem. 14% of these pre-service teachers solved correctly, but remaining 22.5% of them could not solve correctly. One of the most popular strategies preferred by pre-service teachers is algebraic strategy. 31% of the pre-service teachers preferred algebraic strategy in solving the third problem. 17.5% of these pre-service teachers could not solve correctly this problem, while 13.5% of them successfully solved. 23% of the participants preferred the using model strategy. 17.5% of the pre-service teachers who preferred using model strategy could not solve correctly, while 5.5% of them could solve correctly this problem. The last strategy used by pre-service teachers is arithmetic strategy in solving the third problem, 6% of the participants used this strategy in solving the third problem, but 3% of these pre-service teachers could not solve
correctly. Shortly, in the third problem, one-third of the pre-service teachers (36%) could solve correctly, while more than half of them (60.5%) did not solve correctly. 3.5% of the participants did not give response.

In the last problem, similarly, it was seen that the pre-service teachers preferred different strategies in solving of the problem. The most popular strategy used by pre-service teachers is algebraic strategy. This strategy used by 49% of the pre-service teachers. It was seen that most of the participants correctly solved using this strategy. 72% of the pre-service teachers solved correctly this problem using various strategies.

In this study, we investigated the pre-service primary school teachers’ problem solving preferences in the word problems. The study showed that the pre-service primary school teachers preferred various problem solving strategies, such as arithmetic, algebraic, use a model, guess-and-check, find a pattern, model and algebraic strategies for solving of the word problems. In the first problem, pre-service teachers used the algebraic strategies less successfully than the others who preferred guessing-and-checking strategy. The first problem can be easily solved using both strategies. In the second problem, pre-service teachers preferred finding a pattern strategy has more mistakes than the others who preferred using a model. But, 80% of the pre-service teachers used finding a pattern strategy solved correctly this problem. The second problem can be easily solved using both strategies. In the third problem, pre-service teachers preferred four strategies to solve it. These strategies were arithmetic, algebraic, use a model, model and algebraic strategies. But, many of the pre-service teachers who preferred these strategies could not solve this problem correctly. This problem cannot be easily solved using guess-and-check and find a pattern strategy. Similarly, in the fourth problem, pre-service teachers preferred the same strategies, but many of them could solve the fourth problem correctly using each strategy. 49% of the pre-service teachers used algebraic strategy in solving the fourth problem. %42 of them solved correctly. The results of this study confirm several research findings (Van Dooren et al., 2003; Jiang & Chua 2010; Leikin, 2003).

Peker (2009) reported that having a good understanding of a problem solving process was the first step in learning how to teach it, and the instruction using problem solving strategies gave the pre-service teachers a chance to learn the way how to teach. Therefore, this study suggests that it is necessary to introduce various strategies to pre-service primary school teachers so that they can use these strategies in solving problems.

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