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SEMI-STRUCTURED PROBLEM POSING ABILITIES OF PROSPECTIVE PRIMARY SCHOOL TEACHERS: A CASE OF TURKEY

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Abstract:
The purpose of this case study is to examine the problems that prospective primary school teachers posed related to the basic mathematical operations with whole numbers and to determine their problem posing abilities. The data was collected from seventy-two prospective primary school teachers through the Semi-Structured Problem Posing Questionnaire consisting of two questions. The descriptive analysis approach was used to analyze the data. According to the findings of the study, some prospective primary school teachers posed problems, which are not suitable to the learning outcomes. Additionally, some of them posed problems with lack of information due to having difficulty in analyzing and discovering the mathematical situation in the problem posing situation. On the other hand, the types of solvable problems were join and separate problems, especially, result unknown problems. State differently, prospective teachers had a tendency towards posing easiest and low level problems.

Keywords: basic mathematical operations, join problems, prospective primary school teachers, semi-structured problem posing situations, separate problems, whole numbers

1. Introduction

Problem solving is one of the important aims of mathematics education and improving problem solving abilities has been set at the heart of the mathematics curriculum and mathematics lessons. One of the ways of improving problem solving ability is to be capable of problem posing (Abu-Elwan, 1999). Therefore, many researchers have identified that enhancing problem posing ability is at least as important as enhancing problem solving ability (Kilpatrick, 1987; Silver, 1994). In their publications, they emphasized that problem posing is an effective tool for teaching and learning

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mathematics conceptually since it has many benefits for students, teachers and prospective teachers. From the point of students, problem posing helps them develop their mathematical understanding, mathematical reasoning, creative thinking and creativity (English, 1998; Silver, 1994; Stoyanova, 2003). While posing a problem, students discover the relationship among the mathematics concepts, formulate existing situations to the new situations, and use their perception and interpretation of real life situation (Abu-Elwan, 1999; Silver, 1994; Ticha & Hospesova, 2009). Further, they have to think about their problems in terms of solvability, linguistic complexity and mathematical complexity rather than finding the solutions (Stoyanova, 2003). Due to these benefits, problem posing has a positive effect on problem solving and it helps students increase their problem solving ability. On the other hand, problem posing also has many advantageous for both teachers and prospective teachers. For instance, it helps them improve their content knowledge and pedagogical content knowledge, discover students' misconceptions and their reasons, assess students' learning, and promote students' problem solving ability (Lin, 2004; Ticha & Hospesova, 2009).

By virtue of its importance, many countries have included problem posing activities in their curriculum. National Council of Teachers of Mathematics (NCTM) (2000) emphasized that problem posing is a crucial component of problem solving and school curriculum should provide opportunities for students to establish problems with in-school and out-of-school situations. In a similar vein, Australia Education Association reported that students should be encouraged to pose problems for conceptual mathematical understanding (Australian Education Council and Curriculum Corporation, 1991). Like other countries, problem posing activities were included in the Turkish mathematics curriculum renewed in 2005, especially from first to fifth grade. One of the aims of the Turkish curriculum is to develop students' problem posing abilities by using mathematical situations and daily life situations as well as developing problem solving abilities (Ministy of National Education, [MoNE], 2009). In order to achieve this aim, problem posing activities are included in measurement and numbers learning areas at every grade level (MoNE, 2009). With these activities, mathematics curriculum aimed at improving students' abilities such as deciding, establishing relationships between situations, revealing cause-effect relationship and enhancing their mathematical competence through understanding and interpreting abilities (MoNE, 2017).

Problem posing situations were classified to understand problem posing process and to identify problem posing performance of someone (Christou, Mousoulides, Pittalis, Pitta-Pantazi & Sriraman, 2005; Silver, 1994; Silver & Cai, 1996; Stoyanova & Ellerton, 1996). Silver (1994) stated that problem posing is "both the generation of new problems and the re-formulation of given problems" (p.19) and emphasized that it can take place before, during or after the problem solving. Within this context, he defined:

a) pre-solution, posing as generating problems from a given situation,
b) within-solution, posing as generating problems while it is being solved
c) post-solution, posing as change the goals and conditions of a problem which is already solved.

Additionally, Stoyanova and Ellerton (1996) presented three categories, which classify problem posing by task: a) free problem posing, b) semi-structured problem posing, and c) structured problem posing. In *free problem posing*, it is expected students to pose a problem based on a natural situation. That is, students pose problem without any restraint. For instance, "pose a problem for your friend to solve" or "write a problem for the mathematics exam". In *semi-structured problem posing*, students pose problems similar to given problems or write problems using table, diagram or pictures. "Write a problem using the given picture" is an example of this category. In *structured problem posing*, students are given a problem or the solution of the problem, and then they change the conditions or the numbers of the given problem to pose a problem. An example of this category can be "Write a problem using the following equations: 4x5=20; 20 + 35=55".

Another classification that includes semi-structured and structured problem posing activities by adopting the cognitive processes of the students has four categories: editing, selecting, comprehending, and translating (Christou et al., 2005). While editing and translating are related to the semi-structured problem posing, selecting and comprehending are relevant to the structured problem posing. In *editing*, it is expected students to write a problem using a specific picture or diagram, which involves a large amount of information. In *selecting*, students pose a problem, which is restricted by the given answer. The answer of the problem that they pose should be the same as the stated answer. Because of this restriction, selecting is more difficult than editing. In *comprehending*, the activities require students to pose problems from given mathematical equations or calculations. To do this, students should comprehend the meaning of operations and follow the algorithmic process. Lastly, in *translating*, students use graphs, diagrams or tables while posing a problem. In other words, the translating activities require understanding and interpreting of the different representations.

Further, Silver and Cai (1996) investigated problems that middle school students posed in terms of complexity and asked the students the following question: *"Jerome, Elliot, and Arturo took turns driving home from a trip. Arturo drove 80 miles more than Elliot. Elliot drove twice as many miles as Jerome. Jerome drove 50 miles."* (p. 525). Silver and Cai categorized the problems posed by students as assignment, relational and conditional propositions. The problem, which includes only one statement such as "How many miles did Elliot drive", is an *assignment*. On the other hand, the problem such as "How many more miles did they drive in all than Arturo?" is a *relational*. Terminally, the problem "If Elliot drove twice as many miles as Jerome, then how many miles did Elliot drive?" is a *conditional*. Mayer, Lewis and Hegarty (1992) stated that it is more difficult for students to solve the relational and conditional problems than the assignment problems.

In recent years, researchers' interest in problem posing has increased and consequently, they carried out various research studies. For instance, English (1998) examined 3rd grade students' problem posing abilities and concluded that students have difficulties in problem posing although they are successful in problem solving. Also, English concluded that the 3rd graders were capable of generating change/part-part-whole problems by changing the contexts of the original problems. In contradiction to this finding, Tertemiz and Sulak (2013) reported that 5th graders did not change the context of the problem. Further, students posed problems, which could be solved by using the same solution strategy of the original problem. The only thing that they altered was the information presented in the given problem such as the numbers or the names. In another study, whose participants were high school students, Van Harpen and Sririman (2013) aimed at revealing high school students' creativity in mathematics by means of analyzing their problem posing abilities. The result of the study let them to conclude that some problems posed by the students did not have adequate information for reaching the solution. Although some problems were appropriate to find a solution, they were not challenging. In other words, Van Harpen and Sririman reported that mathematically advanced high school students had difficulty in posing good quality and novel problems. In contradistinction to the results of Van Harpen and Sririman, Van Harpen and Presmeg (2013) asserted that students who have more knowledge of mathematics are more successful in problem posing.

Due to the fact that problem posing has a vital role in teaching mathematics, as it is in learning mathematics, teachers' and prospective teachers' problem posing abilities should be investigated. Therefore, many researchers examined teachers and prospective teachers' problem posing abilities from the point of different perspective. For instance, Korkmaz and Gür (2006) investigated prospective teachers' difficulties in problem posing process. They found that the problems posed by prospective teachers were very similar to the problems presented in mathematics textbooks. Moreover, prospective teachers have posed simple problems that do not require mathematical thinking and reasoning abilities. Accordingly, Crespo (2003) stated that the problems posed by prospective teachers included single-step and simple calculations. Further, prospective teachers are having difficulty in posing problems, which include multiplication and division with fractions (Luo, 2009; Rizvi, 2004). On the contrary, Kar and Isik (2015) asserted that teachers had high performance in posing problems related to the addition and subtraction of fractions.

Based on the results of the previous studies, students and teachers' performance on problem posing is not high even though problem posing has an important role for effective mathematics education. Thus, many of these studies focused on investigating students' abilities, performances and their difficulties in problem posing. However, there are only a few studies, which examine prospective teachers' problem posing abilities in terms of different aspects. Further, there are insufficient studies on investigating the types of the problems posed by prospective teachers. Based on the accessible literature, not many previous studies have focused on how prospective teachers performances in semi-structured problem posing situations. Thus, this research finds out insights into problems posed by prospective primary teachers in semi-structured problem posing situations. Furthermore, the problems posed by prospective primary teachers related to the basic mathematical operations (addition, subtraction, multiplication and division) with whole numbers are the focus of this study. Basic mathematical operations were chosen since it is crucial part of the primary and middle school mathematics curriculum in grades 2 to 6 (Van de Walle, 2003). However, mathematics teachers do not have robust knowledge of the conceptions of basic mathematical operations (Ball, 1990; Carpenter, Fennema, Peterson & Carey, 1988). In light of this information, it would be significant to reveal prospective primary school teachers' problem posing abilities related to basic mathematical operations with whole numbers.

Starting from this point of view, in this study, the following questions were sought in order to examine the types of problems that prospective primary school teachers posed and to determine their problem posing abilities in basic mathematical operations with whole numbers in semi-structured problem situations.

1. What types of problems are posed by prospective primary school teachers related to the basic mathematical operations with whole numbers?
2. How is prospective primary school teachers' problem posing abilities that require basic mathematical operations with whole numbers?

2. Method

2.1 Design of the Study

A case study method, which is one of the qualitative approaches, was used to reveal the findings and to support methodological perspective of the study. Creswell (2007) stated that the aim of conducting case study is to develop an in-depth description and analysis of a case or multiple cases within a bounded system. Due to the fact that this research study aims to gain deeper understanding about prospective primary school teachers' problem posing abilities, a qualitative case study method is the most appropriate to use. The cases were prospective primary school teachers whose boundary was being enrolled in the fourth year of their teacher education program.

2.2 Participants

In the study, the participants were 72 4th Year students in a primary school education (grades 1-4) degree program in a public university in Central Anatolia, Turkey. The Primary School Education Program, designated by Higher Education Institution (HEI, 2007), offers content courses (mathematics, biology, chemistry, physics, etc.), education courses (introduction to educational sciences, education psychology, teaching principles and methods, etc), and content education courses (science and technology teaching, mathematics teaching, social studies teaching, etc). The students in this program mostly take content courses and education courses in the first 2 years; they take content education courses such as the methods of teaching mathematics, school experience, and teaching practice in the subsequent years. At the time of the data collection, the participants had already taken Basic Mathematics I-II and Methods of Teaching Mathematics I-II and they have been taking the course, Teaching Practice I. While The Basic Mathematics lessons comprise numbers, concepts related to four operations and basic geometry issues, Methods of Teaching Mathematics I-II include examining the learning outcomes related to the mathematics topics belong to primary mathematics lessons (grade 1-4 at primary school) and preparing activities regarding problem types, problem solving stages, problem solving strategies, basic mathematical operations, etc (MoNE, 2009).

Moreover, prospective teachers have the experience of observing the lessons of experienced teachers and lecturing in the real classes. The basic mathematical operation with whole numbers, which is the focus of the study, is taught at the first semester of the 4th grade at primary school. From this point of view, the prospective teachers observed the guidance teachers in the internship schools before the data was collected and gained the experience of presentation about the subject. Thus, it is expected prospective teachers to have more knowledge of the problems, which require basic operations with whole numbers. For these reasons, it will be eligible to study with the 4th Year students of the Primary School Education Program at the Faculty of Education. Each participant was given a pseudonym such as P1, P2, ……P72 instead of using their real names.

2.3 Data Collection Tool

A questionnaire (Semi-Structured Problem Posing Questionnaire, [SSPPQ]) consisted of 2 questions was used to investigate prospective primary school teachers' abilities in problem posing related to basic mathematical operations with whole numbers. It was prepared by the researchers according to the semi-structured problem posing situation from the classification of Stoyanova and Ellerton's (1996). Moreover, SSPPQ was developed considering the learning outcomes related to the basic mathematical operations with whole numbers in the Turkish primary school 4th grade mathematics curriculum (MoNE, 2009). The related learning outcomes were given in Table 1.

Table 1: The related learning outcomes of
Semi-Structured Problem Posing Questionnaire (SSPPQ)

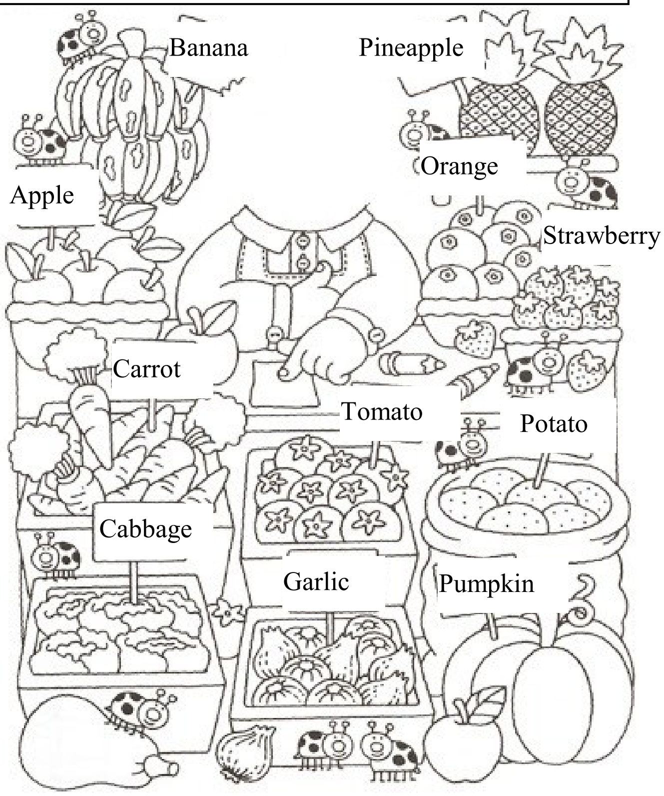
1) "Solves and poses problems that require addition of whole numbers." (MoNE, 2009, p.195).
2) "Solves and poses problems that require subtraction of whole numbers." (MoNE, 2009, p.195).
3) "Solves and poses problems that require multiplication of whole numbers." (MoNE, 2009, p.196).
4) "Solves and poses problems that require division of whole numbers." (MoNE, 2009, p.197).

Semi-structured problem posing situations include open situations such as similar problems, tables, diagrams, pictures etc. (Stoyanova & Ellerton, 1996). It is expected someone to explore the structure of that situation and then pose a problem using the situation. In the study, a picture and a table with some information were presented to the prospective teachers in order to write a problem, which is appropriate to the level of 4th grade students at primary school. The questionnaire, applied to the primary school prospective teachers, was presented in Table 2.

Table 2: Semi-Structured Problem Posing Questionnaire (SSPPQ)

1) Write a problem related to the picture presented below.

Grocer of Neighborhood



2) Write a problem using the given in the table.

Name	Quantity
Ali	30
Ayşe	15
Can	45

2.4 Data Analysis

Data was analyzed through the frequency analysis and the descriptive analysis approach developed by Strauss and Corbin (1990). They (1990) stated that descriptive analysis is used in situations where there is sufficient conceptual and theoretical explanation of the research topic. The stages of descriptive analysis are establishing a framework for descriptive analysis, processing of data according to this framework, identification and interpretation of findings. At the end of the data analysis, the researcher reaches some general themes (Strauss and Corbin, 1990). Moreover, Wolcott (1994) described descriptive analysis as the presentation of the data to the reader as closely as possible to the original form of the collected data and directly quoting from what the participants said. Starting from these points of view, a theoretical explanation was stated to analyze the data. That is, the problems that prospective primary school teachers posed were analyzed based on the problem classifications of Carpenter, Fennema, Franke, Levi and Empson (1999). In this classification, Carpenter et al. (1999) identified four basic types of problems for addition and subtraction: *Join, Separate, Part-*

Part-Whole, and Compare. Although the items are added to a given set in join problems, items are removed from a given set in separate problems. There is a relationship between a set and both subsets in part-part-whole problems, whereas two disjoint sets are compared in compare problems. Carpenter et al. extended their analysis of addition and subtraction problems to provide the types of multiplication and division problems. These types are named as *Multiplication, Measurement Division, and Partitive Division*. In a Multiplication Problem, the number of sets and the number in each set are given and the total number is asked. In a Measurement Division Problem, the total number and the number in each set are known and the number of sets is asked. In Partitive Division Problem, the total number and the number of sets are known and the number in each set is asked (Carpenter et al., 1999). The example for each problem type is presented in Table 3 and Table 4.

Table 3: Basic Types of Addition and Subtraction Problems

Join	**(Result Unknown)** Connie had 5 marbles. Juan gave her 8 more marbles. How many marbles does Connie have altogether?	**(Change Unknown)** Connie had 5 marbles. How many more marbles does she need to have 13 marbles altogether?	**(Start Unknown)** Connie had some marbles. Juan gave her 5 more marbles. Now she has 13 marbles. How many marbles did Connie have to start with?
Separate	**(Result Unknown)** Connie had 13 marbles. She gave 5 to Juan. How many marbles does Connie have left?	**(Change Unknown)** Connie had 13 marbles. She gave some to Juan. Now she has 5 marbles left. How many marbles did Connie give to Juan?	**(Start Unknown)** Connie had some marbles. She gave 5 to Juan. Now she has 8 marbles left. How many marbles did Connie have to start with?
Part-Part Whole	**(Whole Unknown)** Connie has 5 red marbles and 8 blue marbles. How many marbles does she have?	**(Part Unknown)** Connie has 13 marbles. 5 are red and the rest are blue. How many blue marbles does Connie have?	
Compare	**(Difference Unknown)** Connie has 13 marbles. Juan has 5 marbles. How many more marbles does Connie have than Juan?	**(Compare Quantity Unknown)** Juan has 5 marbles. Connie has 8 more than Juan. How many marbles does Connie have?	**(Referent Unknown)** Connie has 13 marbles. She has 5 more marbles than Juan. How many marbles does Juan have?

(Carpenter, Fennema, Franke, Levi & Empson, 1999, p.12)

Table 4: Basic Types of Multiplication and Division Problems

Multiplication	Megan has 5 bags of cookies. She puts 3 cookies in each bag. How Many bags can she fill?
Measurement Division	Megan has 15 cookies. There are 3 cookies in each bag. How many cookies does Megan have all together?
Partitive Division	Megan has 15 cookies. She puts the cookies into 5 bags with the same number of cookies in each bag. How many cookies are in each bag?

(Carpenter, Fennema, Franke, Levi, & Empson, 1999, p.34)

Before classifying the problems posed by prospective primary school teachers, the statements were analyzed whether they were a problem or not. Then, the problems were examined whether they were suitable to learning outcomes, presented in Table 1, or not. If they were not suitable, then it was thought that the problems were not appropriate for the level of the 4th grade primary school students. Thus, these problems have not been analyzed in terms of problem types anymore. In the following step, the problems, suitable to the learning outcomes, classified based on the types of problems proposed by Carpenter et al. (1999). Lastly, frequency analysis was carried out in order to reveal the number of problems in each problem type.

For the reliability of data analysis, the formula of Miles and Huberman (1994), presented below, was used.

$$The\ Inter - Rater\ Reliability\ \frac{\text{the number of agreements between raters}}{\text{the sum of the total number of agreements and disagreements}}\ x100$$

The ratio between the coders was 91%, which is acceptable since an inter-rater reliability of over 70% indicates that data analysis is reliable (Miles and Huberman, 1994). In addition, the suitability of the learning outcomes of the problems was also assessed by two researchers in the field of primary school education.

3. Findings

The aim of this study was to investigate problems posed by prospective primary school teachers and to determine their problem posing ability in basic mathematical operations with whole numbers. Two problem situations in semi-structured problem posing questionnaire was analyzed to achieve the purpose of the study. The examples of problems that prospective primary school teachers posed for each problem situation and the frequency table for each category were presented in the tables below.

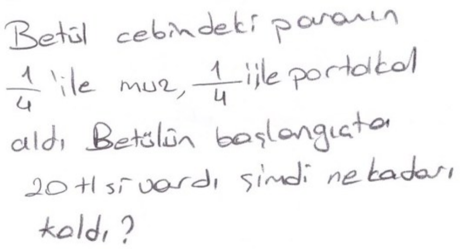
3.1 Findings Related to First Semi-Structured Problem-Posing Situation

In the first problem posing situation in the SSPPQ, it was asked prospective teachers to pose a problem using the picture presented. Accordingly, the findings obtained from the analysis of the statements that prospective teachers were wrote are given in Table 5.

Table 5: Frequency Analysis of the 1st Problem Posing Situation

	Frequency (percent)
Problem	
Not suitable to the learning outcomes	18 (25)
Suitable to the learning outcomes	
Unsolvable	6 (8.3)
Solvable	44 (61.1)
Not Problem	4 (5.6)

According to Table 5, all prospective teachers wrote a statement based on the information presented in the 1st semi-structured problem posing situation. However, 4 of these statements (5.6%) were not considered as problem. Except those, 68 (94.4%) statements were interpreted as problem. Among the problems, 18 of them (25%) were not suitable to the learning outcomes according to primary school 4th grade mathematics curriculum (MoNE, 2009). The problem that P6 was posed was given in Figure 1 as an example of problem that are not suitable to the learning outcomes.

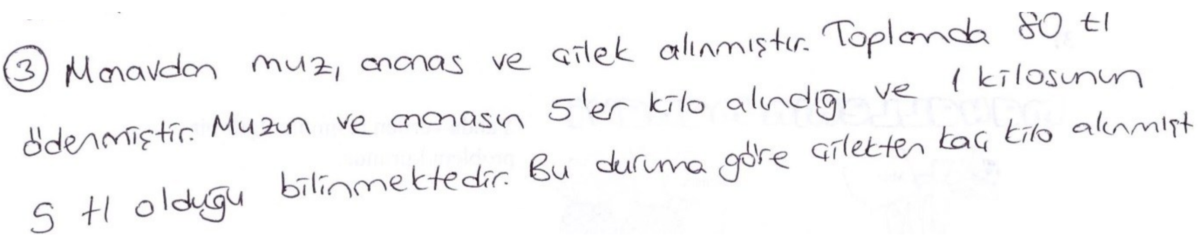


Betul bought bananas with one fourth of her money and she bought orange with one fourth of her money. Betül had 20 Turkish liras at the beginning. How much money does she have now?

Figure 1: The Problem Posed by P6 for the 1st Problem Posing Situation

As it can be seen from the Figure 2, the problem posed by P6 is related to the fractions. However, fractions are taught at the 4th grade at primary school after teaching how to solve the problems related to the basic mathematical operations with whole numbers. In other words, while 4th grade primary school students are learning problem solving with whole numbers, they have not yet learned fractions. For this reason, this and similar problems were regarded as problems not suitable to the learning outcomes.

On the other hand, based on the analysis of the data gathered from the 1st problem posing situation in the SSPPQ, 50 (69.9%) prospective teachers posed problems which were suitable to the learning outcomes. Among these problems, 6 of them were unsolvable. As an example of unsolvable problems, the problem posed by P18 was presented in Figure 2.



Banana, pineapple and strawberry were purchased from the grocery. Eighty Turkish liras have been paid on aggregate. It is known that banana and pineapple were each bought 5 kg and 1 kg of both fruit costs 5 Turkish liras. According to this, how many kilos of strawberry was purchased?

Figure 2: The Problem Posed by P18 for the 1st Problem Posing Situation

In this problem, it is not known how much Turkish liras of 1 kilo of strawberry. For this reason, how many kilos of strawberry are taken cannot be calculated. Likewise, 5 prospective teachers' problems were similar to the problem of P18.

The problems that 44 prospective teachers posed are interpreted as solvable problems. These problems were categorized based on the classification of Carpenter et al. (1996). Analysis of the data showed that there is not any problem related to part-part-whole, compare, multiplication, measurement division and partitive division. For this reason, these problem types are no longer the focus of this study. In other words, problems that prospective teachers posed were regarded as join and separate problems. Accordingly, the frequency table of types of problems that prospective teachers posed and examples of these problems were given in Table 6.

Table 6: The Frequency Table of Types of Problems and Examples

Problem Type	**Frequency (Percent*)**	**Example problems posed by prospective primary school teachers**
Join	20 (45.5%)	**1) The problem posed by P1** (3) Pazardan; tanesi 2 ₺'den 3 adet lahana, tanesi 6 ₺'den 2 adet ananas ve tanesi 10 ₺'den 1 adet balkabağı aldım. Pazarda toplam kaç ₺ harcadım? *I bought 3 units of cabbage for each amounting to 2 Turkish lira, 2 units of pine apple for each amounting to 6 Turkish lira and 1unit of pumpkin amounting to 10 Turkish lira in the bazaar. How much did I spend in the bazaar?* **2) The problem posed by P65** 3) Pazar günkü manava giden Büşra'nın annesi, sebzelerden 2 kg patates, 4 kg domates, 3kg havuç almıştır, meyvelerden 5 kg elma ve 2 kg portakal almış. Büşra'nın annesi meyve ve sebzelerden toplamda kaç kg almıştır? *Büşra's mother who goes to the bazaar on Sunday bought 2 kg potato, 4 kg tomato,3 kg carrot as vegetables. She bought 5 kg apple and 2 kg orange as fruits. How many kilos did Büşra's mother buy as vegetables and fruits?*

Separate 24 (54.5%)

3) The problem posed by P5

3-) Bir manavcı meyve ve sebzelerin fiyatlarının yazılı olduğu listeyi yandaki gibi asmıştır. Manava alışverişe giden Selma, manavdan 3kg havuç, 4 kg elma, 2 kg muz, 1 kg portakal, 10 kg patates ve 4 kg domates alıp eve dönmüştür. Geri kalan paralarını saydığında 170 TL kaldığını görüyor. Sizce Selma manava giderken kaç TL parayla gitmiştir?

Havuç =	3TL
Elma =	5TL
Muz =	7TL
Portakal =	4TL
Patates =	2,5 TL
Domates =	2 TL

A grocery has hanged the list of prices of fruit and vegetables as written in the next. Selma who went to the grocery for shopping bought 3 kg of carrot, 4 kg of apples, 2 kg of bananas, 1 kg of orange, 10 kg of potatoes and 4 kg of tomatoes and returned home. When she counts the rest of her money, she sees that she has 170 Turkish liras left. With how much money did she go to the grocery at the beginning?

Vegetable/Fruit	Price
Carrot	3
Apple	5
Banana	7
Orange	4
Potato	2.5
Tomato	2

4) The problem posed by P42

3) Mahalle manavından alışveriş yapmak isteyen Öykü ve annesi; kilosu 5 tl olan çilekten 2 kilo, kilosu 2 tl olan havuçtan 4 kilo ve kilosu 6 tl olan muzdan 3 kilo almıştır. Elinde 25 tl'si bulunan Öykü ve annesinin ödemeyi yapması için kaç tl'ye daha ihtiyacı vardır?

Oyku and her mother, who want to shop in the neighborhood grocery store, bought 2 kilos of strawberry that is 5 Turkish liras a kilo, 4 kg of carrot that is 2 Turkish liras a kilo and 3 kg of banana that is 6 Turkish liras a kilo. In order to pay, how much more liras do Oyku and her mother, who has 25 liras already, need?

5) The problem posed by P22

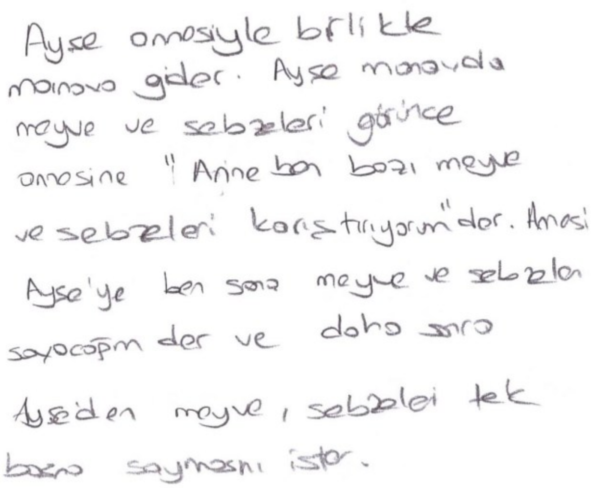
3) Meltem annesiyle pazara gitmiştir. Pazardan kilosu 3 ₺ olan 2 kg havuç ve kilosu 4 ₺ olan 3kg patates aldılar. Ceplerinde 20 ₺ olduğuna göre kaç lira paraları kalmıştır?

Meltem went to the bazaar with her mother. They bought 2 kg of carrot that is 3 Turkish lira a kilo and 3 kg of potato that is 4 Turkish lira a kilo. They have 20 Turkish lira. How much money is left from 20 lira?

*percent is calculated based on the number of solvable problems (44)

As it can be seen from the Table 6, 20 problems posed by prospective teachers were join problems, which is defined as "a direct or implied action in which a set is increased by a particular amount" (Carpenter et al., 1996, s.7). Among the categories of join problems, all of them were result unknown problem. In this type of problems, the quantities come together to get final quantity. The result unknown problems that prospective teachers posed were very similar to two problems presented in Table 6. On the other hand, 24 problems posed by prospective teachers were separate problems. In this type of problems, the initial quantity is reduced rather than raised. Contrary to the join problems, prospective teachers posed problems that involve three sub-categories of separate problems. Among 24 prospective teachers, two prospective teachers posed start unknown separate problem. In this type of question, start quantity is not known. The problem posed by P5 is given as an example of this type of problem in Table 6. In addition, three prospective teachers posed change unknown separate problems, which refers to not knowing the change quantity. Regarding this, the problem of P42 is presented as an example. Nineteen of the 24 teachers posed result unknown separate problems. In this type of problem, result quantity is not known. The problems posed by prospective teachers were very similar to the problem posed by P22 that is given in Table 6.

Apart from the aforementioned findings, four prospective teachers (5.6%) could not pose a problem related to the 1st semi-structured problem posing situation. Actually, each of them wrote statements, however the statements were not coded as a problem. In relation to this, the statement that P50 wrote was presented in Figure 3.


Ayşe annesiyle birlikte manava gider. Ayşe manavda meyve ve sebzeleri görünce annesine "Anne ben bazı meyve ve sebzeleri karıştırıyorum" der. Annesi Ayşe'ye ben sana meyve ve sebzeleri sayacağım der ve daha sonra Ayşe'den meyve, sebzeleri tek tek saymasını ister.

Ayşe goes to the grocery with her mother. When Ayşe sees the vegetables and fruits, she says her mother that " Mum, I confuse some fruits and vegetables." Her mother says her that "I will tell the fruits and vegetables" and then she wants Ayşe to say the fruits and vegetables one by one.

Figure 3: The Statement Posed by P50 for the 1st Problem Posing Situation

As it can be realized from the example, the statement that P50 wrote did not involve a problem statement. Similar to P50, other three prospective teachers presented a statement that did not contain any problem statement.

As a semi-structured problem-posing situation, it was asked prospective primary school teachers to pose a problem based on the given picture. Data gathered from this problem-posing situation, most of the prospective teachers posed solvable problems, which were suitable to the learning outcomes. Among the solvable problems, half of them were join problems and the rest of them were separate problems. On the other hand, although all of the prospective teachers have taken Methods of Teaching Mathematics I-II course, some of them have posed problems that are not suitable to the learning outcomes or are not solved.

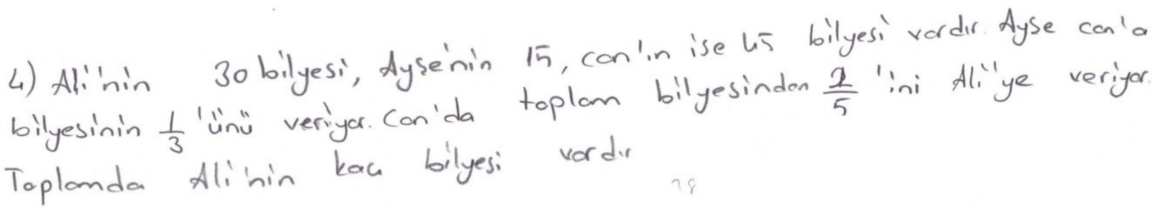
3.2 Findings Related to Second Semi-Structured Problem-Posing Situation

In the second problem-posing situation in the SSPPQ, a table was presented for prospective teachers to pose a problem. The findings related to this problem-posing situation are given in Table 7.

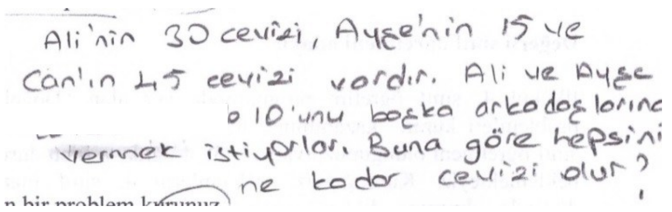
Table 7: Frequency Analysis of the 2nd Problem Posing Situation

	Frequency (percent)
Problem	
Not suitable to the learning Outcomes	11 (15.2)
Suitable to the learning outcomes	
Unsolvable	4 (5.6)
Solvable	56 (77.8)
Blank	1 (1.4)

The Table 7 shows that only one prospective teacher could not write any statement related to the given table in the 2nd problem posing situation. Among the prospective teachers who pose a problem, 11 of them (15.2%) could not write problem suitable to the learning outcomes presented in Table 1. As an example, the problems posed by P23 and P66 were presented respectively in Figure 4.


4) Ali'nin 30 bilyesi, Ayşe'nin 15, can'ın ise 45 bilyesi vardır. Ayşe can'a
bilyesinin $\frac{1}{3}$'ünü veriyor. Can'da toplam bilyesinden $\frac{2}{5}$'ini Ali'ye veriyor.
Toplamda Ali'nin kaç bilyesi vardır

Ali has 30 marbles, Ayşe has 15 marbles, Can has 45 marbles. Ayşe gives one third of his marbles to Can. Can gives two fifth of his marbles to Ali. How many marbles do Ali has in total?

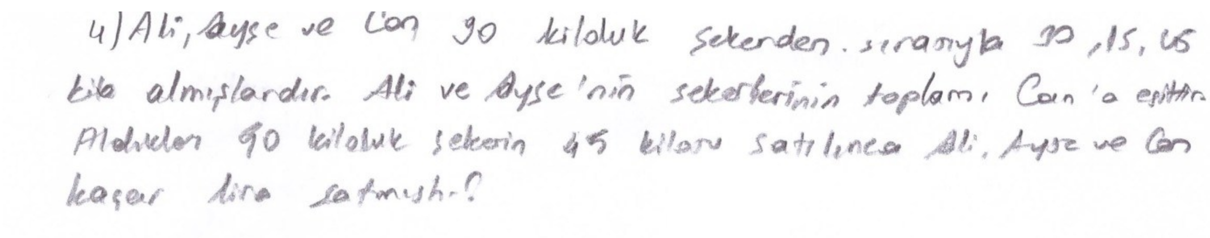

Ali'nin 30 cevizi, Ayşe'nin 15 ve
Can'ın 45 cevizi vardır. Ali ve Ayşe
o 10'unu başka arkadaşlarına
vermek istiyorlar. Buna göre hepsini
ne kadar cevizi olur?

Ali has 30 walnuts, Ayşe has 15 walnuts, Can has 45 walnuts. Ali and Ayşe want to give 10% of their marbles to their friends. Accordingly, how many walnuts do have each?

Figure 4: Examples for the 2nd Problem Posing Situation

Based on the Figure 4, the problems posed by P23 and P66 are related to the fraction and percent, respectively. According to primary school 4th grade mathematics curriculum, fractions are taught at when the students are 4th grade at primary school, but it was taught after teaching basic mathematical operations with whole numbers. Moreover, percent is topic of 5th grade. For this reason, 4th grade primary school students have not learnt percent yet. On that account, the problems similar to the problem of P23 and P66 were interpreted as problems not suitable to the learning outcomes.

On the other hand, most of the problems posed by prospective primary school teachers were suitable to the primary school 4th grade mathematics curriculum. Regarding the problems suitable to the learning outcomes, it was found that four (5.6%) teachers posed unsolvable problems and 56 (77.8%) teachers wrote solvable problems. As an example of unsolvable problems, the problem posed by P15 was presented in Figure 5.


4) Ali, Ayse ve Can 90 kiloluk sekerden sırasıyla 30, 15, 45 kilo almışlardır. Ali ve Ayse'nin sekerlerinin toplamı Can'a eşittir. Aldıkları 90 kiloluk sekerin 45 kilosu satılınca Ali, Ayse ve Can kaçar lira satmıştır?

Ali, Ayşe and Can bought 30,15, 45 kilos from 90 kilos sugar, respectively. The total of Ali and Ayşe's sugar is equal to Can's sugar. When they sold 45 kilos of sugar from 90 kilos, how many kilos did Ali, Ayşe and Can sell?

Figure 5: Examples for the 2nd Problem Posing Situation

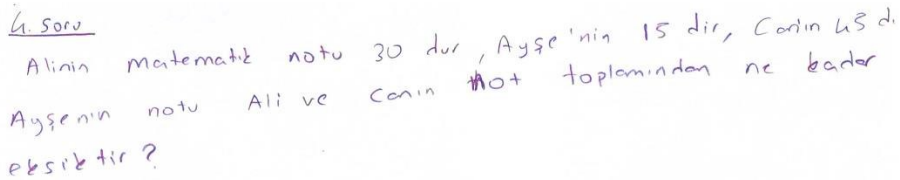
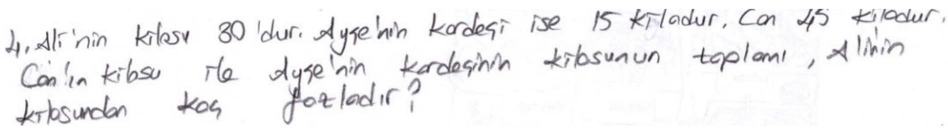
In this problem, there is no sufficient information to solve the problem. Similarly, other three prospective teachers posed the problems like P15.

Among 72 prospective teachers, 56 of them posed solvable problems. As indicated before, these problems were categorized based on the classification of Carpenter et al. (1996). Analysis of the data showed that the problems posed by prospective teachers were not part-part-whole, multiplication, measurement division and partitive division problem. Put differently, prospective teachers posed join, separate, and compare problems for the 2nd semi-structured problem posing situation.

To the extent that, the frequency table of types of problems that prospective teachers posed and examples of these problems were presented in Table 8.

Table 8: The Frequency Table of Types of Problems and Examples

Problem Type	Frequency (Percent*)	Example problems posed by prospective primary school teachers
Join	35 (62.5%)	**1) The problem posed by P4** 4) Alinin 30 bilyesi vardır. Ayşe'nin bilyesi ise Alinin bilyelerinin yarısı kadardır. Can'ın bilyesi ise Ayşenin bilyelerinden 30 fazladır. Buna göre toplam kaç bilye vard *Ali has 30 marbles. Ayşe's marbles are half of Ali's marble. Can's marble is 30 more than Ayşe's marble. Accordingly, how many marbles are there?* **2) The problem posed by P48** 4.) Ali'nin 30, Ayşe'nin 15, Can'ın ise 45 bilyesi vardır. Hepsi bilyesin eşit sayıda olmasını istemektedir. Bu durumda kim Ayşe'ye kaç bilye verecek veya alacaktır? *Ali has 30marbles, Ayşe has 15 marbles, Can has 45 marbles. They all want to have an equal number of marbles. In this case, how many marbles will Ayşe take and from whom?*
Separate	11 (19.6%)	**3) The problem posed by P63** 4) Alinin 30 tane oyuncak arabası, Ayşe'nin 15 tane kalemi ve Can'ın da 45 tane sakızı vardır. Ali oyuncak arabalarını Ayşe ve Can'a 5'er 5'er vermiş, Can da 10'ar 10'ar sakızlarından Ali ve Cana vermiştir. Ayşe ise 2'şer 2'şer kalemlerinden Ali ve Can'a vermiştir. Ali, Ayşe ve Can'ın elinde kalan ürün sayısı kaçtır? *Ali has 30 car toy, Ayşe has 15 pencil and Can has 45 gum. Ali gave 5 to 5 his car toys to Ayşe and Can. Can gave 10 to 10 his gum to Ali and Can. Ayşe gave 2 to 2 her pencil to Ali and Can. How many materials have Ali, Ayşe and Can?* **4) The problem posed by P3** 4) Ali, Ayşe ve Can'ın 105 metrelik bir ipe ihtiyaçları vardır. Alinin elindeki ip 30 m, Ayşe'nin elindeki ip 15m, Can'ın elindeki ip 45 metredir. 105 metreye nasıl ulaşabilirler? *Ali, Ayşe and Can need rope with a length of 105 meters. Ali's rope is 30 m, Ayşe's rope is 15 m, Can's rope is 45 m. How can they reach 105 meters?*

Compare	10 (17.9%)	**5) The problem posed by P16**  4. Soru Alinin matematik notu 30 dur, Ayşe'nin 15 dir, Canın 45 di. Ayşenin notu Ali ve Canın not toplamından ne kadar eksiktir? *Ali's math note is 30. Ayse's is 15, Can's is 45. How much is Ayse's math note missing from Ali and Can's sum of notes?* **6) The problem posed by P10**  4. Ali'nin kilosu 30'dur. Ayşe'nin kardeşi ise 15 kilodur. Can 45 kilodur. Can'ın kilosu ile Ayşe'nin kardeşinin kilosunun toplamı, Ali'nin kilosundan kaç fazladır? *Ali's kilos is 30. Ayse's brother is 15 kilos. , Can is 45 kilos. How much is the sum of Can and Ayse's brother's kilos over than Ali's kilos?*

*percent is calculated based on the number of solvable problems (56)

Based on the data presented in the Table 8, 35 prospective primary school teachers posed join problems. Among these, 33 of them were result unknown problems and 2 of them were change unknown problems. As it can be realized from the problem posed by P4, in the result unknown problems, someone add the quantities to get final quantity. On the other hand, in order to solve the change unknown problems, someone calculate the change quantity. Regarding the separate problems, there were two prospective teachers who posed result unknown problems and nine teachers who wrote change unknown problems. Lastly, 10 prospective teachers compared two disjoint sets, as it can be seen in the examples presented in Table 8. Thus, the problems posed by 10 teachers were regarded as compare problems.

In the 2nd semi-structured problem posing situation, prospective teachers posed problems based on the given table. According to the data analysis, it was realized that most of the prospective teachers posed solvable problem, which were suitable to the learning outcomes presented in Table 1. Among the solvable problems, the vast majority of them were result unknown join problems. On the other hand, as in the 1st semi-structured problem posing situation, some prospective teachers posed problems that are not suitable to the learning outcomes or are not solved although they have taken Methods of Teaching Mathematics I-II course.

4. Discussion

The aim of this study was to investigate prospective primary school teachers' problem posing abilities. To achieve this aim, semi-structured problem posing situations were presented to the teachers and asked them to pose problems related to basic mathematical operations with whole numbers.

Based on the analysis of the data, it could be concluded that vast majority of prospective teachers posed a problem, however approximately 20% of them posed problems, which were not suitable to the primary school 4^{th} grade mathematics curriculum. The reasons for this might be that prospective teachers do not have enough curriculum knowledge. In other words, they do not know the order of the topics in the curriculum. More specifically, their vertical curriculum knowledge, which is the knowledge of topics or issues that were taught in the preceding, year have been taught at the same year and will be taught in later years, was limited (Shulman, 1986). Similar result was presented by Basturk and Donmez (2011). In their study, they expressed that some prospective teachers did not have any idea about the place of the subjects in the curriculum. Moreover, Maxedon (2003) stated that prospective teachers did not know the topics taught in the grades preceding and following years.

Another remarkable point in the current study was that although half of the prospective teachers posed a problem, approximately 6% of them could not pose solvable problems. When the unsolvable problems were analyzed, it was realized that these problems did not contain enough information to be solved. The reason for posing problems with lack of information might be that prospective teachers had difficulty in analyzing and discovering the mathematical situation in the problem posing situation. More specifically, they could not make relationship among the mathematical concepts and formulate given situations to the new situations. However, the researchers emphasized that making relationship; analyzing, discovering and formulating the given situations are the basis of problem posing activities (Abu-Elwan, 1999; Silver, 1994; Ticha and Hospesova, 2009). Furthermore, this result let us to conclude that prospective teachers did not think about their problems in terms of solvability, which coincides with the result of the study of Kılıc (2013). In her study, she concluded that prospective teachers were not capable of choosing the right numbers and establishing relationship between these numbers. Moreover, similar result was also stated by Van Harpen and Sririman (2013). They claimed that the problems posed by high school students did not have adequate information for reaching the solution. Additionally, another reason for posing unsolvable problems might be that prospective teachers might not have enough content knowledge since Ball (1990) and Chapman (2002) emphasized that problem posing ability is highly correlated with teachers’ content knowledge.

Interestingly, but perhaps not surprisingly, all the prospective teachers posed join and separate problems, none of them posed multiplication and division problems. More specifically, most of them posed result unknown problems among the types of join and separate problems. Previous research studies specified that result unknown problems are easier than other types of problems. In his study, Cankoy (2003) explored the prospective teachers’ perceptions about the difficulty level of mathematics problems. He stated that result unknown problems are the easiest problems and start unknown problems are the most difficult problems. Also, Carpenter and Moser (1984) emphasized that someone who solves addition and subtraction problems has the lowest mathematical level. Based on the findings of the present study, it can be concluded that prospective teachers had a tendency towards posing easiest and low level problems.

The same conclusion has also been reached by Sarıbas and Arnas (2017) who conducted the study to examine the types of addition and subtraction problems presented by teachers and educational materials. One of the reasons for posing and presenting low level of problems might be that teachers' beliefs about students' problem solving ability. Most of the teachers considered that students have difficulty in solving high level of problems, however, many studies reported that children can solve these problems by developing different solution strategies (Carpenter, Carey & Kouba, 1990; Carpenter et al., 1996). For this reason, teachers should present all types of problems to encourage students to solve high level of problems, such as compare, part-part-whole, multiplication, measurement division and partitive division problems.

As discussed above, some of the prospective primary school teachers posed problems that are not suitable to the learning outcomes because they may not have adequate curriculum knowledge. Also, the reasons for posing result unknown problems, interpreted as low-level problems, might be that the prospective teachers may have superficial content knowledge, inadequate problem-solving and problem posing experience, and insufficient creativity ability. In light of this information, it can be considered that prospective primary teachers' content knowledge and curriculum knowledge should be increased. In order to do this, the hours of the lesson containing content knowledge should be increased. Moreover, the opportunities should be provided to prospective teachers to get experience in problem solving and problem posing during Methods of Teaching Mathematics I-II course.

Although the present study provided interesting findings that contribute to the literature and teaching practices, there is still more to do. In the present study, it was studied prospective primary school teachers' semi-structured problem posing abilities in basic mathematical operations with whole numbers and the types of problems posed by them. It is suggested that similar studies could be conducted with in-service teachers and students to investigate their free, semi-structured and structured problem posing abilities. Moreover, future studies could be carried out with different mathematics topics to portray larger picture of students, teachers and prospective teachers' problem posing abilities. Also, the quality of the problems could be analyzed in terms of various dimensions such us complexity, linguistic structure and solvability. As a final point, data might be collected via semi-structured interviews to get in-depth analysis. In this way, participants' thinking while posing a problem or participants' difficulties in posing a problem could be revealed.

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