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STRUCTURED PROBLEM POSING CASES OF PROSPECTIVE MATHEMATICS TEACHERS: EXPERIENCES AND SUGGESTIONS

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ABSTRACT

In problem posing, students are faced with complex situations or events and they feel responsible from these situations or events. It is stated from this perspective that it is necessary to carry out problem posing studies and teachers should have a strong perspective for problem posing activities. In this sense, the aim of this study is to evaluate structured problem posing cases of prospective mathematics teachers about Ratio and Proportion Subject', to determine the experiences (for instance; difficulties) of the prospective teachers during problem posing process and to elicit suggestions regarding the experienced difficulties (if any).

For this purpose the data was collected by the researchers through a data form. This developed data form was conducted to 42 primary school mathematics prospective teachers. Prospective teachers were given 40 minutes to fill in this form. In data analysis, 'Problem Posing Evaluation Form (PPEF)' which was developed by the researchers for the first part of the data form was used. At the end, the results of the evaluation were presented on the basis of frequency (f) and percentage (%). The content analysis was used for the analysis of the data obtained from the second and third parts. The obtained themes were presented on the basis of frequency (f) and percentage (%) through digitalizing the data for the interpretation of the findings. NVivo 10 software was used in content analysis.

In conclusion, it was concluded that prospective mathematics teachers posed clear and understandable problems which were compatible with the mathematical principles and which were in the form of simple and exercise type. Besides, it was concluded that posed problems had solvable problem features. The experiences/difficulties faced during problem posing process were determined as; having difficulties in deciding the numerical expressions that will be given in problems, in ability to construct a different problem other than stated in the example, in ability to construct the text of the problem, inability to recognize the cognitive levels of students and inability to correlate problems with daily life. The solutions which were proposed for the difficulties faced were determined as in the following; solving before the problem which is considered to be posed, constructing problems by using daily life, analyzing similar problems which are considered to be posed and taking them as example, carrying out activities for creating more meaningful problem texts by focusing on how to construct a problem and gaining experience about problem posing.

Key Words: Structured problem posing, experiences, difficulties, suggestions.

INTRODUCTION

"Each problem that I solved became a rule, which served afterwards to solve other problems"
Rene Descartes (1596-1650)

Problem is defined as the situations that an organism cannot solve with current reactions (Açıkgöz, 2006), something which is thrown in front of you and which blocks you (Adair, 2000), a situation in which one wants to do something but does not know or predict how to do it immediately (Altun, 2001), the difference between the

current situation and the desired situation (Kneeland, 2001), an event, subject or activity that students do not have a memorized or specific rule about the solution (Van de Walle, 2003). In order to be able to assess a situation or event as a problem, it should bring some challenges and some disturbance to an individual. The person who has faced with this challenge before will need to make some effort to overcome this difficulty and try to eliminate this problem (Akay, 2006). Once you face with a problem and solve it, the same situation loses its feature to be a problem anymore (Ergün, 2010). In this regard, problem can also be defined as a situation (Katrancı, 2014) which obscures someone's faith when he/she encounters it for the first time, which challenges him/her and which someone does not have a memorized or specified rule for the solution of this situation.

Considering the definitions stated above, when we say problem, the first thing that comes to one's mind can be every day problems that he/she faces in his/her daily life. In this regard, Gündüz (2008) classified problems in his study according to; *i) the easiness difficulty of the problems (complexity), ii) content of the problems, iii) characteristics of the problems, iv) to the strategy which is used in the solution of problems* and *v) structure of the problems*. Boran and Aslaner (2008) divided problems in to three as; well-structured, less structured and not well-structured problems. Altun (2008) classified problems as routine and non-routine problems and approached them mathematically. Zeits (2007, quoted from Şimşek, 2012) divided mathematical problems into three groups as; open-ended problems, fun and content problems. Foong (1990) in his literature scan about problem solving and using problems classified mathematical problems which were used in mathematics classes as 'closed' and 'open-ended' problems. In this sense, studying about mathematical problems results with mathematical thinking for creating strategies regarding rational solutions of the problems and helps to adapt these strategies to any kind of problems that can be encountered during every day (Israel, 2003). And this can be achieved by carrying out problem posing studies.

Problem posing which is a special case of problem solving (Christou, Mousoulides, Pittalis, Pitta-Pantazi & Sriraman, 2005) is re-formulating a given problem or creating new problems in accordance with the given situation. Problem posing is defined as a problem solving activity which includes producing new problems and questions that will be analyzed and discovered about a given situation (Akay, Soybaş & Argün, 2006), a process which is based on mathematical experiences and where comments generated by moving from concrete situations are transformed into meaningful mathematical problems (Stoyanova & Ellerton, 1996), a way of analytical thinking (Akay & Boz, 2010) and a process which includes for learners to produce new thoughts with the help of different methods (Kojima, Miwa & Matsui, 2009). In this process, students are encountered with a complicated situation or event and they feel responsible from this complicated situation or event (Gür & Korkmaz, 2003).

When the previous research was analyzed (Abu-Elwan, 2007; Dickerson, 1999; Grundmeier, 2003) it was seen that there are various problem posing methods. These methods are as in the following; *i) free problem posing, ii) semi-structured problem posing, iii) structured problem posing* and *iv) what if?...what if not*?. In free problem posing, the point is to ask students to pose problems about any subject without providing them any data, figure or problems (Ergün, 2010). In semi-structured problem posing, an open–ended situation is given to students and students are asked to generate problems about this situation by using their own skills, knowledge and mathematical experiences (Akay, 2006). In structured problem posing, the matter is posing a new problem by changing the known (Akay, 2006). In 'what if? ... what if not?' method; the point is to pose new problems from the problems that were solved before with a change in the conditions or purpose of the original problem (Abrams & Honeyman, 2002, quoted from Yaman & Dede, 2005).

It is stated that all these problem posing studies which helps students for their individual learning and reduces their dependence to course books (Işık, Kar, Yalçın & Zehir, 2011) cause a positive effect on students (Craig, 1999). The students participating in the activities which are carried out in this process have an opportunity to understand the meaning of 'doing mathematics' (Lavy & Shriki, 2009). As problem posing provides students to think different and flexible, it also helps them to get rid of their negative attitudes towards mathematics (Ergün, 2010). Besides, problem posing which helps teachers to learn to what extent the learning is realized informs us about how to improve teaching and learning environments and the problematic fields that are needed to be emphasized (Lin & Leng, 2008). From this perspective it is thought that problem posing activities

should be carried out and teachers should have a strong understanding about problem posing activities (Lin, 2004). It is predicted with help of this perspective that the opinions of prospective teachers on problem posing are also important.

When literature about problem posing is analyzed, it is seen that; the opinions of prospective teachers on problem posing (Akay & Argün, 2005; Akay & Boz, 2009), the effect of problem posing on the academic achievements of prospective teachers (Akay & Boz, 2008) were analyzed, the conceptual analysis of the problems posed by prospective teachers were conducted (Işık, 2011), the problems which were posed by mathematics prospective teachers for audio and visual representations were analyzed (Işık, Işık & Kar, 2011) and the problem posing skills of the prospective teachers about different problem posing models were searched.

Besides, studies in which the problem posing strategies used by classroom prospective teachers when they encountered with different problem posing situations and the difficulties they faced in this process are determined (Kılıç, 2013), in which the changes in problem posing strategies of prospective teachers are analyzed (Crespo, 2003) and in which the points that teachers and prospective teachers focus on while posing problems are determined (Stickles, 2006) have been found.

When the studies stated above are analyzed, it is seen that structured problem posing cases of prospective teachers are rarely analyzed or has never been analyzed and it is not focused on the difficulties that prospective teachers face. Besides, it has drawn attention that there are not any studies for determining the solutions proposed by prospective teachers regarding the difficulties appeared in this process. In this sense, the aim of this study is to evaluate structured problem posing cases of prospective mathematics teachers about Ratio and Proportion Subject', to determine the experiences (for instance; difficulties) of the prospective teachers during problem posing process and to elicit suggestions regarding the experienced difficulties (if any). The answers of the following research questions were searched in accordance with this purpose.

1. What is the level of structured problem posing skills of prospective mathematics teachers?
2. What are the experiences that prospective mathematics teachers have during problem posing process (for example the difficulties that they faced)?
3. Which solutions are proposed by prospective mathematics teachers regarding the difficulties that they face (if any)?

METHOD

The Research Design

The qualitative researches; are the studies where perceptions and events are demonstrated in a holistic and realistic manner in a natural environment (Yıldırım & Şimşek, 2008). In this sense, this study is a qualitative research which is aimed to demonstrate results regarding a particular situation. The document analysis which includes the analysis of written documents about the case or cases which are intended to study (Yıldırım & Şimşek, 2008) was carried out within the scope of this study.

Study Group

The study group of this study is consisted of 42 prospective sophomore students who are studying in Marmara University, Teaching Primary School Mathematics. 35 of the prospective teachers are female (%83,33) and 7 (%16,67) of them are male.

Data Collection Tools and Data Collection

The data was collected through a 'data form' which was prepared by the researchers. This data form is composed of three parts and these parts are as in follows: *i) the task of posing structured problems, ii) the experiences during problem posing process (for example; the difficulties faced)* and *iii) suggestions for solution strategies.* This data form was given in Table 1.

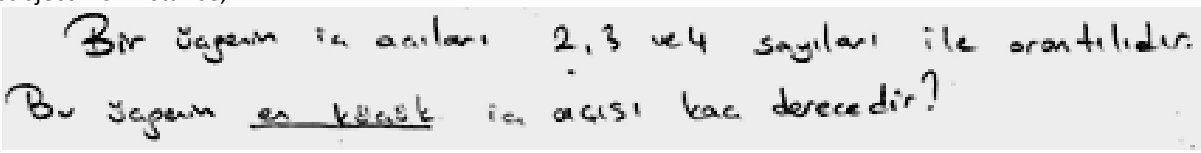
Table 1: The Data Form

About 'Ration and Proportion' Subject;
Pose a similar problem to the following one and solve the problem; ***"The side lengths of a triangular-shaped field, whose circumference is 512 meters, are proportional with the numbers of 4, 5 and 8. How long is the longest side of this field?"***
Please write your experiences that you had (for example; what kind of difficulties do you have?) during problem posing.
What are your suggestions for the solutions regarding the problems that you faced during problem posing process (If any)?

This data form which was prepared by the researchers was distributed to prospective teachers and they were asked to fill in this form. The prospective teachers were given 40 minutes for filling the form. In conclusion, all this collected data created the documents of the study.

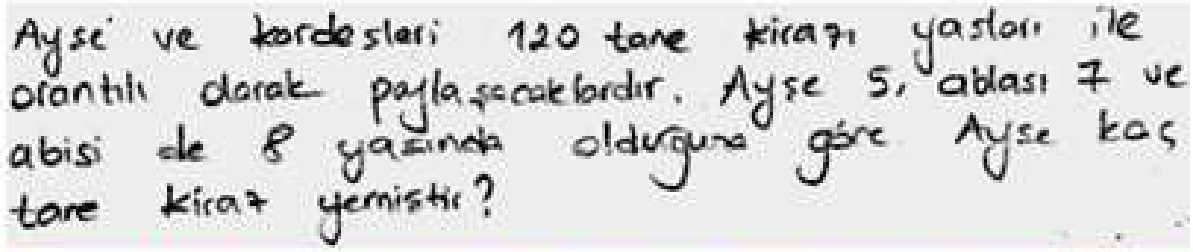
Data Analysis

First of all, the data obtained from the first part of the data form was evaluated by the researchers separately. As a result of this analysis, it was determined that all the posed problems were about 'Ratio and Proportion' subject. For instance;



The interior angles of a triangle 2, 3 and 4 is proportional to the number of regions. How many degrees is the smallest angle of this triangle?

Fig. 1. The Problem Posing Task of the Prospective Teacher with Number 2



Ayşe and her sisters will share 120 cherry in direct proportion to their age. Ayşe is 5 years old, her sister is 7 years old and her brother is 8 years old. Accordingly, how many cherries are eaten by Ayşe?

Fig. 2: The Problem Posing Task of the Prospective Teacher with Number 11

42 problems from the first part were evaluated by using 'Problem Posing Evaluation Form (PPEF)' which was developed by the researchers (Şengül & Katrancı, 2014). This evaluation form consists of four dimensions and each dimension consists of three sub-dimensions. It was determined that the agreement percentage regarding the compatibility of each dimension for evaluation changed between 0,89 and 0,92 and the agreement percentage regarding the compatibility of the sub-dimensions to dimensions changed between 0,86 and 0,90. 42 problems were evaluated by the researchers separately with this evaluation form and the results were compared. The differences appeared were discussed and a consensus was reached. In conclusion, the results of the evaluation which was conducted as being related with each sub-dimension were presented on the basis of frequency (f) and percentage (%).

Content analysis was used in the analysis of the data regarding the second and third part of the data form. In content analysis similar data is combined around particular concepts and themes and they are edited and interpreted as readers can understand (Yıldırım & Şimşek, 2008). In this sense, first of all the data was coded. At this phase, the researcher tries to divide the data into meaningful parts and to find what each part means conceptually by analyzing the collected data (Yıldırım & Şimşek, 2008). Researchers created a code list by reading separately the data more than once. The codes were compared and then discussion was made on different codes. Then, it is necessary to find themes which can generally explain the data by considering the codes appeared (Yıldırım & Şimşek, 2008). Secondly, researchers created themes separately by gathering similar codes together. The level of agreement between the evaluation of the researchers was set by using the formula as "*Agreement Percentage = [Agreement / (Agreement + Disagreement)] x 100"* (Miles & Huberman 1994). In this regard, it was decided that the agreement percentage of the researchers regarding the themes changed between 0,88 and 0,92. After calculating the agreement percentages, themes were edited and presented to readers. For the interpretation of the findings, the themes were presented on the basis of frequency (f) and percentage (%) by digitalizing the data. The qualitative data was digitalized to enable to repeat a small scale research or case study with a bigger sample later on by using instruments such as surveys (Yıldırım & Şimşek, 2008). NVivo 10 program was used in the conducted content analysis.

FINDINGS AND COMMENTS

Findings and comments regarding the research problem which was specified as *"What is the level of structured problem posing skills of prospective mathematics teachers?"* are as in the following.

Table 2: The Evaluation of Structured Problem Posing Task

Evaluation Criteria		**f**	**%**
Problem Text (Language and Expression)	The text of the problem is not clear and understandable.	0	0
	The text of the problem is relatively clear and understandable.	6	14,29
	The text of the problem is clear and understandable.	36	85,71
The Compatibility of the Problem with the Mathematical Principles	The problem is not suitable to mathematical principles.	0	0
	The problem is relatively suitable to mathematical principles.	4	9,52
	The problem is suitable to mathematical principles.	38	90,48
The Type/Structure of the Problem	Exercise.	34	80,95
	Easy Problem type.	8	14,05
	Difficult problem type.	0	0
The Solvability of the Problem	The problem cannot be solved.	0	0
	Problem can be solved but it is erroneous.	0	0
	It can be solved.	42	100

When Table 2 is analyzed, it is seen that 6 of the posed problems (%14,29) are relatively clear and understandable. It was determined that 36 (%85,71) problems are clear and understandable. It is seen that 4 of the posed problems (%9,52) are partially suitable mathematical principles and 38 (%90,48) problems are suitable to mathematical problems. While 34 (%80,95) of the posed problems are exercise type problems, 8 (%14,05) of them are easy problems. It is seen that there are not any difficult problems. It was determined that all the posed problems are solvable problems. For instance;

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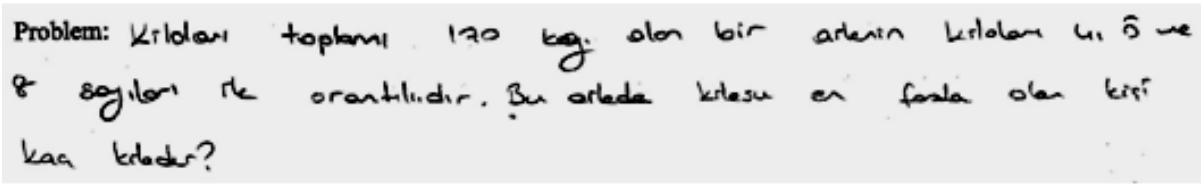
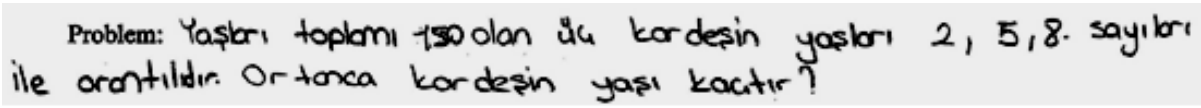


Problem: The total weight of a family is 170 kg and this is proportional with the numbers of 4, 5 and 8. How much weight is the person who has the maximum weight in this family?

Fig. 3: The Problem Posing Task of the Prospective Teacher with Number 15



Problem: The ages of three siblings whose sum of their ages are 150 are proportional with the numbers of 2, 5 and 8. How old is the middle child?

Fig. 4: The Problem Posing Task of the Prospective Teacher with Number 16

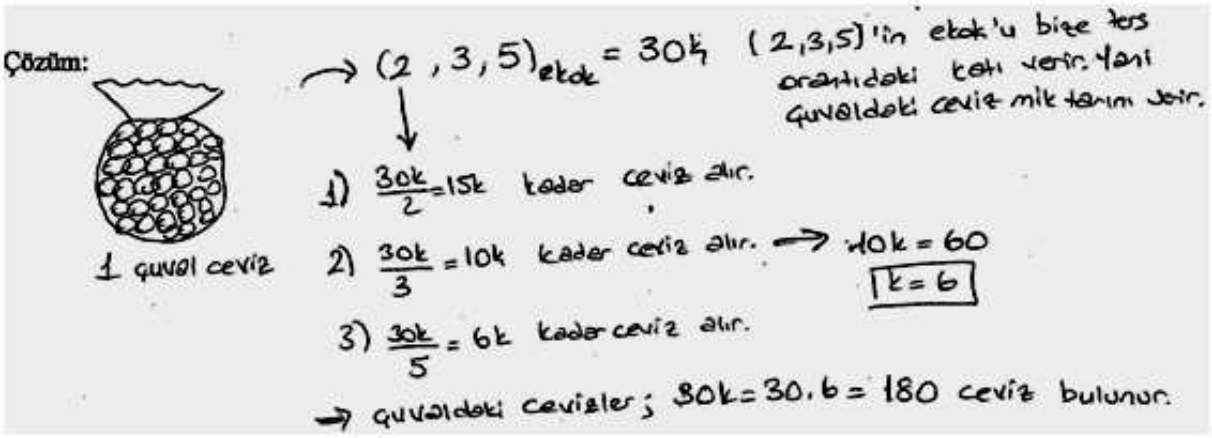


Fig. 5: The Problem Posing Task of the Prospective Teacher with Number 37

When the data regarding the research problem which was specified as *"What are the experiences that prospective mathematics teachers have during problem posing process (for example the difficulties that they faced)?"* were analyzed, it was determined that the prospective teachers focused on the points that they had difficulties. In this sense, the findings and comments are as in the following.

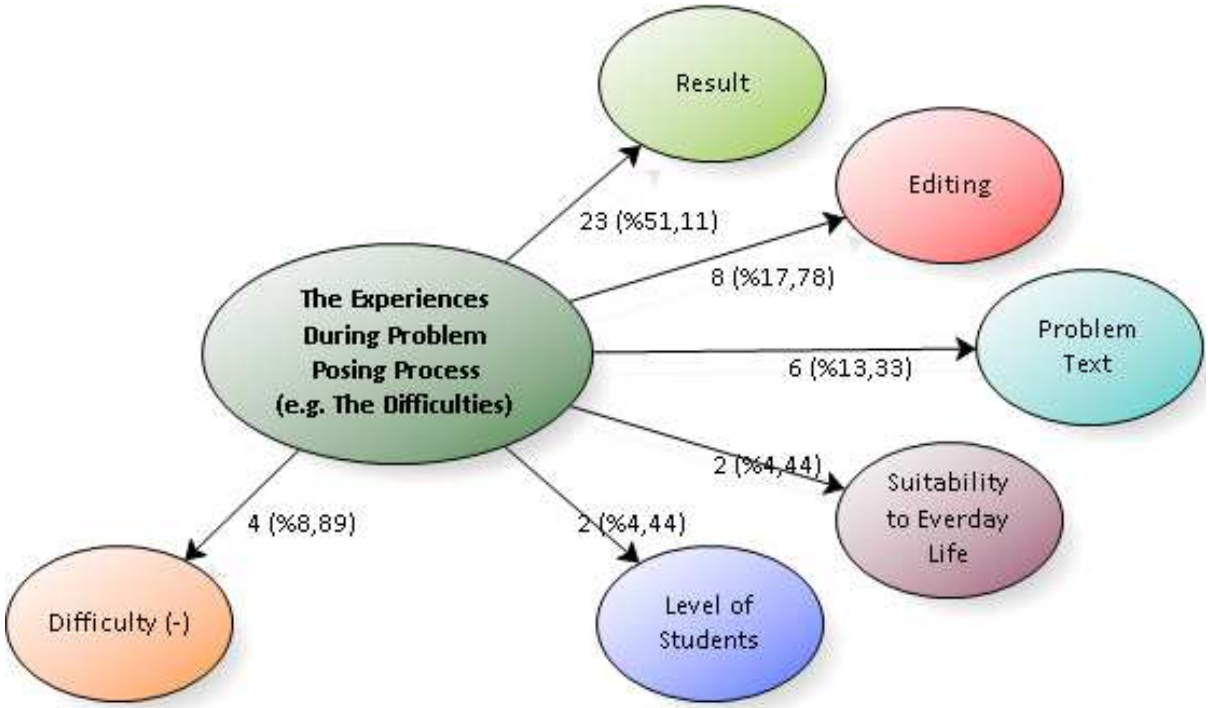
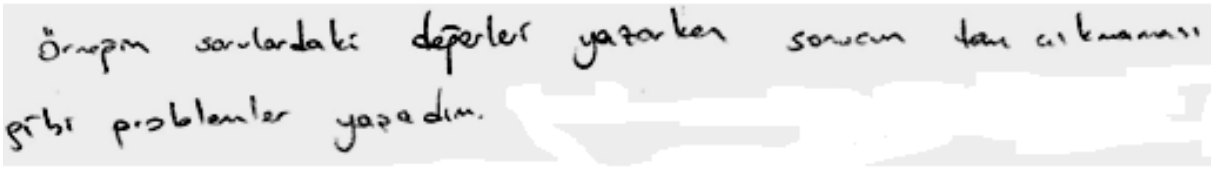


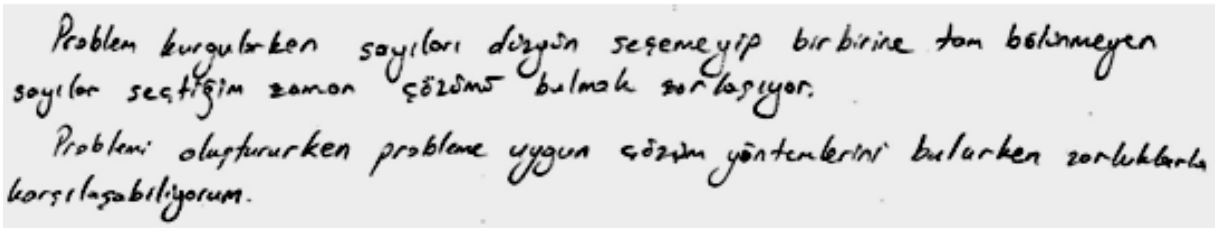
Fig. 6: The Experiences (e.g. difficulties) faced in Problem Posing Process

It is seen that the experiences (e.g. difficulties) that prospective teachers had in problem posing process grouped under five themes. It is seen that the prospective teachers mostly stated their opinions about the 'result' theme (23; %51,11). The prospective teachers stated that they had difficulties in deciding on the numbers to have a whole number in the result. They stated that they lost time for providing a whole number in the result. For instance;



For example, I had problems such as having a whole number in the result while writing the values in the questions.

Fig. 7: The Opinion of the Prospective Teacher with Number 2



It is getting difficult to find the result when I select numbers which cannot be fully divided instead of selecting proper numbers while constructing the problem.

I can have difficulties in finding proper solution strategies to problem while constructing the problem.

Fig. 8: The Opinion of the Prospective Teacher with Number 3

Secondly, the prospective teachers stated their opinions about 'editing' theme (8; %17,78). They stated that they had difficulties in deciding how to edit a problem while posing a problem. Thirdly, the prospective

teachers stated their opinions about 'problem text' theme (6; %13,33). They expressed that they hesitated in deciding whether the texts of the posed problems were understandable or not. Besides, it was seen that they stated their concerns on the points whether problem texts had misconceptions or not. They expressed that they had difficulties on the points whether the text of a problem was understandable or not. For instance;

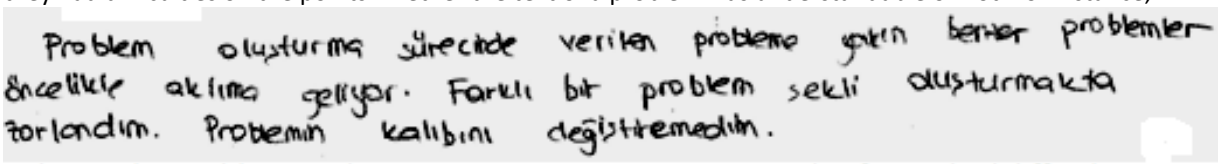


Fig. 9: The Opinion of the Prospective Teacher with Number 17

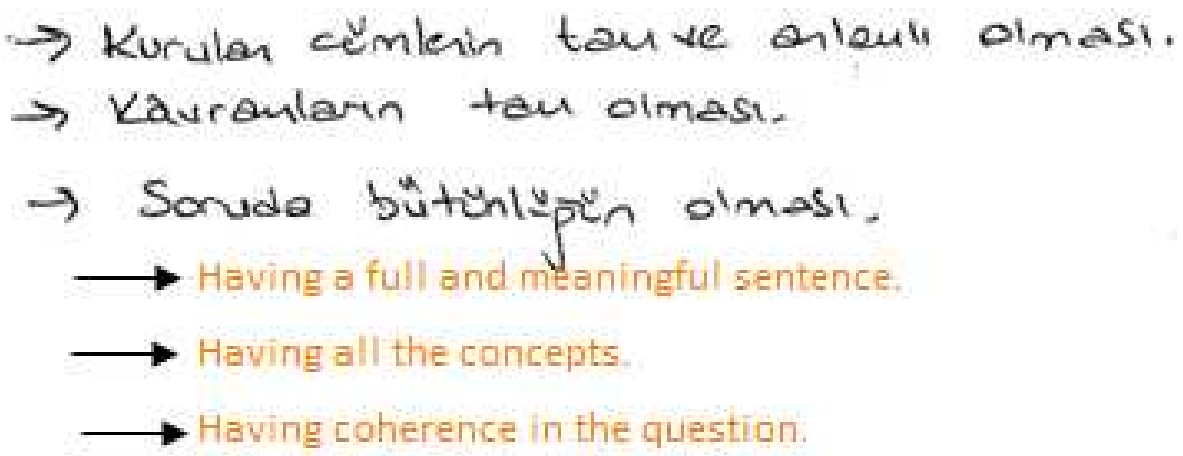


Fig. 10: The Opinion of the Prospective Teacher with Number 37

It was seen that the prospective teachers who stated their opinions on 'suitability to everyday life' had difficulties in deciding on whether the problems are suitable to everyday life or not. About the 'level of students', it was seen that they expressed that they could not realize whether the problems are suitable to the levels of the students or not. It was seen that they had concerns about having difficult problems for the students. It was also determined that there were prospective teachers who did not have any difficulty during problem posing process (4; %8,89).

The findings and comments regarding *'What are the solution strategies of the prospective mathematics teachers for the points that they had difficulties (if any)?'* are as in the following figure.

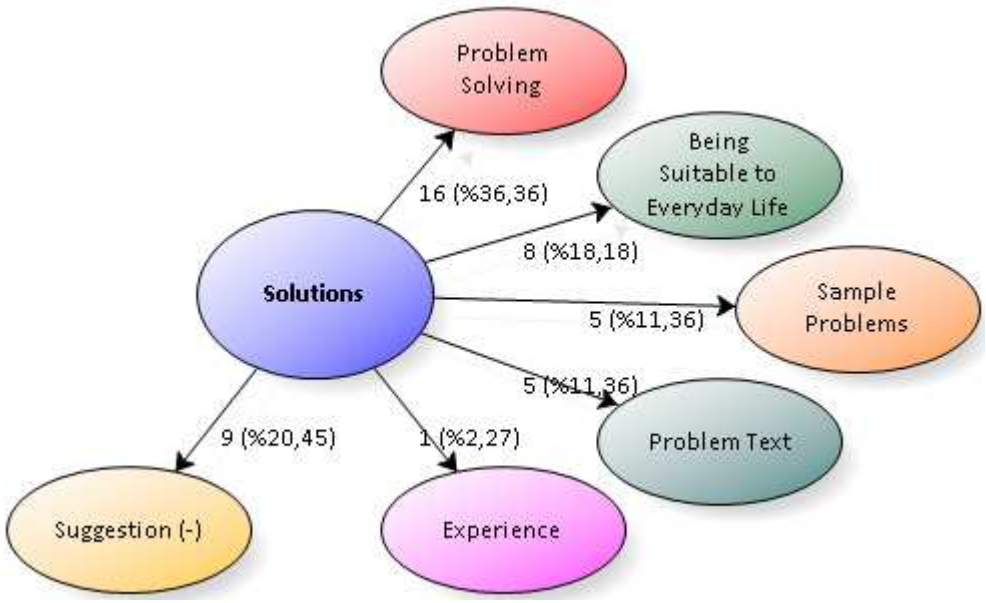
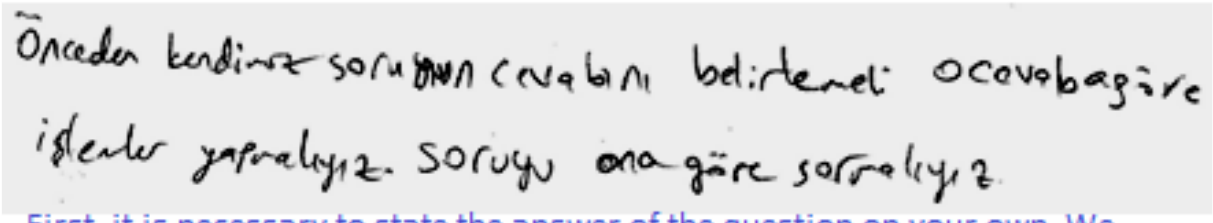


Fig. 11: The Solution Strategies for the Difficulties faced during Problem Posing Process

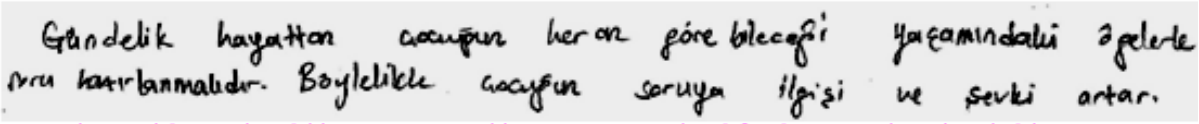
When Figure 11 was analyzed, it is seen that 9 of the prospective teachers (%20,45) did not suggest any solutions. It was seen that prospective teachers mostly suggested 'problem solving' (16; %36,36) for overcoming the difficulties faced in problem posing process. They stated that it is necessary first to solve the problem that is thought to be constructed. They stated that it is necessary to construct a problem by moving from the solution of the same problem. For instance;


Önceden kendimiz sorunun cevabını belirlemeli ocevabagöre işlemler yapmalıyız. Soruyu ona göre sormalıyız.

First, it is necessary to state the answer of the question on your own. We need to do according to that answer. We need to ask question according to that.

Fig. 12: The Opinion of the Prospective Teacher with Number 4

It was determined that they suggested 'suitability to everyday life' theme secondly (8; %18,18). They stated that it is necessary to pay attention to construct problems which are suitable to everyday life. For instance;


Gündelik hayattan çocuğun her an göre bilecegi yaşamındaki öğelerle ilgili kurulmalıdır. Böylelikle çocuğun soruya ilgisi ve şevki artar.

The problems should be constructed by using everyday life elements that the child can see any time in everyday life. Thus, the motivation of the child towards question will increase.

Fig. 13: The Opinion of the Prospective Teacher with Number 18

It is seen that the other solution strategies of the prospective teachers grouped under 'sample problems' (5; %11,36) and 'problem text' (5; %11,36). It was seen that prospective teachers stated that it is necessary to scan and use different resources for constructing problems. It was determined that they sated that the problems

occurred in constructing problem texts can be overcome by making meaningful sentences and reading a lot. For instance;

We can produce suitable problems to the ones that we found after searching and finding subroutine and different problems from different resources.

Fig. 14: The Opinion of the Prospective Teacher with Number 36

We can make meaningful sentences after reading again and again.

Fig. 15: The Opinion of the Prospective Teacher with Number 37

It was also determined that stated difficulties above can be overcome as one gains experience in time.

CONCLUSION, DISCUSSION AND SUGGESTIONS

As a result of the collected data, it is concluded that the texts of the problems which are posed by prospective teachers regarding problem posing task are clear and understandable. It is appeared that the posed problems are suitable to mathematical principles and rules. It is understood that all the problems are solvable and exercise type problems. Albayrak, İpek and Işık (2006), Crespo (2003), Crespo and Sinclair (2008), Işık, Işık and Kar (2011) determined in their studies that prospective teachers constructed predictable, simple and not well-structured problems. In this sense, it can be said that result obtained in this study such as '*prospective teachers posed exercise type problems'* is overlapping with the studies mentioned above.

Tirosh (2000), Toluk-Uçar (2009), Utley and Redmond (2008) and Zembat (2007) concluded that prospective teachers' skills for posing problems about divisions in fractions were low. It can be interpreted in this way that the fact that prospective teachers posed only exercise type problems about 'Ration and Proportion' subject in this study is showing parallelism with this case mentioned above. Besides, Korkmaz and Gür (2006) stated that prospective teachers were confused about the problem concept and the concept of doing exercises. They concluded that prospective teachers had difficulties in the editing and characteristics of their problems and had common mistakes and misconceptions about the problem concept. It is also determined in this study that prospective teachers constructed exercise type problems. At this point, it is thought that it is important to question the knowledge of prospective teachers regarding the concepts of problem and doing exercises. In this sense, it is suggested to carry out studies which are focused on this point.

It has been concluded that prospective teacher have difficulties in five different themes during problem posing process. These themes are appeared as; 'result', 'editing', 'problem text', 'suitability to everyday life' and 'student's levels'. In this regard, the difficulties faced during problems posing process were appeared as; having difficulties in deciding the numerical expressions that will be used in the problem, the inability to edit a new problem which is different from the sample problem, the inability to construct the problem text, the inability for students to recognize their own cognitive level and the inability to correlate problems to everyday life. Akay and Boz (2009) determined the difficulties of prospective teachers in problem posing process as; the inability to be creative, being introvert, feeling insecure, the lack of mathematical knowledge, the fact that problem posing activities are different approaches and the nature of posing problems. Although it is determined that prospective teachers have not faced with similar difficulties in the studies, it is concluded that the studies are parallel in terms of showing prospective teachers have faced with difficulties in problem posing process. Besides, Işık, Kar, Yalçın and Zehir (2011) determined in their studies that prospective teachers displayed a low achievement in problem posing. Işık and Kar (2012) claimed that prospective teachers should be provided opportunities to pose their own problems. Thus, they suggested that prospective teachers' skills about problem

posing can be improved. Stickles (2006) presented in her study that teachers and prospective teachers made some effort to pose their own problems. Also in this study, it is concluded that prospective teachers mostly have problems in deciding on the numerical expressions that will be used in the problem. It is thought that this difficulty can be overcome by providing opportunities to prospective teachers to pose their own problems. In this sense, it is thought that the findings of the previous studies are supported and it is necessary to let prospective teachers to pose their own problems.

It is emphasized in Teaching Primary School Mathematics Program (MEB, 2009) that concepts related with mathematics should be taught by correlating them with real life situations. It is stated that having correlations between real life situations and mathematical concepts has an important place. It is concluded in this study that prospective teachers think that they will have difficulties at this point. In this case, the necessity of raising prospective teachers' awareness about problem solving becomes important. In this sense, it is suggested that educational faculties should provide more information about problem posing to their studies.

It is concluded that prospective teachers stated their opinions about the solution strategies regarding the mentioned difficulties in five different themes. These solution strategies are; 'problem solving', 'suitability to everyday life', 'sample problems', 'problem text' and 'experience'. In this regard, the solution strategies are appeared as providing the solution of the problem which will be asked, posing problems by using everyday life, analyzing similar problems to one that will be asked and using it as an example, writing more meaningful problem texts by focusing on how to edit problem texts and having experience about problem posing. It is presented in Teaching Primary School Mathematics Program (2009) that problem posing can be one of the steps of problem solving. In this case, it can be said that prospective teachers provided a meaningful solution strategy. However Dede and Yaman (2005) determined that prospective teachers can solve problems on the contrary they are not able to pose new problems by moving from solutions. At this point it is thought that it is necessary to provide opportunities to prospective teachers to pose problems by moving from solutions in addition to let them pose their own problems.

It is found that prospective teachers stated that they need to use everyday situations so that they can pose problems. Akay and Boz (2008), Crespo and Sinclair (2008), Dickerson (1999), Yuan and Sriraman (2010) concluded in their studies that problem posing is an important tool to connect everyday life with mathematics and to attract students' attention. At this point, it can be said that prospective teachers have realized the correlation between everyday life and problem posing in this study. It is determined that prospective teachers expressed that it was necessary to analyze similar problems to the ones that would be asked. In this sense, it can be said that the necessity for carrying out studies for raising prospective teachers' awareness about problem posing is once again appeared. In this case, it is suggested to provide prospective teachers to analyze different problem types and to carry out problem posing studies for those problem types.

In this study, only structured problem posing process was considered. Besides, this process was only dealt with Ration and Proportion subject. At this point, it is seen as necessary to repeat this study with different mathematical subjects. It is suggested to have a more comprehensive study group so that opinions about different themes can also be obtained. Besides, it is suggested that it is necessary to elaborate this qualitative study in terms of its generalizability by supporting it with quantitative data.

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