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

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ABSTRACT

Problem posing which a way of analytical thinking is a process which is based on mathematical experiences and in which interpretations which are created by moving from concrete situations are transformed into meaningful mathematical problems. Problem posing which helps teachers about to what extent the learning is realized informs us about the problematic fields that needed to be improved and emphasized in teaching-learning environments. For this reason, it is necessary for teachers to have a deep understanding about problem posing activities.

In this sense, the aim of this study is to evaluate semi-structured problem posing cases of prospective mathematics teachers about Ratio and Proportion Subject', to determine the experiences of the prospective teachers during problem posing process and to elicit suggestions regarding the experienced difficulties (if any). For this purpose a data collection form was created by the researchers. This data collection form has three parts which were *i) The task of posing semi-structured problems, ii) The experiences during problem posing process (for example; the difficulties faced)* and *iii) Suggestions for solutions.*

The data collection form was carried out with 59 prospective primary mathematics teachers. The prospective teachers were given 40 minutes to fill in this form. 'Problem Posing Evaluation Form (PPEF)' which was developed by the researchers was used during the analysis of the data obtained from first part of the data collection form. This evaluation form is consisted of four main dimensions and three sub-dimensions for each dimension. The main dimensions are as in the following: i) Problem text (language and expression), ii) The compatibility of the problem with the mathematical principles, iii) The type/structure of the problem and iv) The solvability of the problem. The first part data was evaluated with this evaluation form by the researchers separately and then the results were compared. The differences appeared were discussed and an agreement was reached between the researchers. At the end the evaluation results created regarding the each sub-dimension were given on the basis of frequency (f) and percentage (%). Content analysis was used for the analysis of the data obtained from the second and third parts of the form, and the program which is called as NVivo 10 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 easy problem types. Besides, it was concluded that posed problems had solvable problem features. The experiences/difficulties faced during problem posing process determined as; inability to construct the problem, finding the data as insufficient, inability to pose creative problems, in ability to provide a whole number for the solution and inability to arrange the level of problem according to the levels of the students. The solutions which were proposed for the difficulties faced were determined as in the following; no data limitation, carrying out problem solving and problem posing studies, having a sound content knowledge and using additional sources.

Key Words: Semi-structured problem posing, experiences, solutions.

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INTRODUCTION

The study of mathematics is, if an unprofitable, a perfectly harmless and innocent occupation!...
Godfrey Harold Hardy (1877-1947)

Problem posing which has not been fully understood yet and which is a complex learning activity (Christou, Mousoulides, Pittalis, Pitta-Pantazi & Sriraman, 2005; Crespo & Sinclair, 2008; English, 2003; Mamona-Downs & Downs, 2005) is stated as the focal point of teaching mathematics (English, 1997; Silver & Cai, 1996). It includes re-formulating a given problem and/or creating new problems in accordance with the given situation (Mestre, 2002). Besides, problem posing which is a way of analytical thinking (Akay & Boz, 2010) and which includes for learners to produce new thoughts by using different ways (Kojima, Miwa & Matsui, 2009) is a process which is based on mathematical experiences and in which interpretations which are created by moving from concrete situations are transformed into meaningful mathematical problems (Stoyanova & Ellerton, 1996).

In this so called process, students face with a complicated situation or event and they feel personally responsible from this situation or event (Gür & Korkmaz, 2003). In this way, problem posing in addition to helping students' individual learning (Işık, Kar, Yalçın & Zehir, 2011) provides critical perspectives for them to understand mathematical concepts and processes (Van den Heuvel Panhuizen, Middleton & Streefland, 1995). Besides, in addition to helping teachers about to what extent the learning is realized, problem posing informs us about the problematic fields that needed to be improved and emphasized in teaching-learning environments (Lin & Leng, 2008). For this reason, it is expected that teachers need to have a deep understanding about problem posing activities. In this sense, the aim of this study is to evaluate semi-structured problem posing cases of prospective mathematics teachers, to determine the experiences of the prospective teachers during problem posing process and to elicit suggestions regarding the experienced difficulties (if any).

When related literature was analyzed within the scope of this purpose, it was seen that there are various problem posing methods (Abu-Elwan, 2007; Dickerson, 1999; Grundmeier, 2003). These methods are as follows; '*free problem posing', 'semi-structured problem posing', 'structured problem posing'* (Stoyanova, 2003) and *iv) 'what if?...what if not*?' (Abu-Elwan, 2007).

In free problem posing process, students are given a situation or subject from daily life. Students are expected to produce a problem by using them (Akay, 2006). In addition to that it is the case of asking students to pose problems about any subject without providing them any data, figure or problems (Ergün, 2010). 'Pose/write a problem about Numbers subject by using your existing knowledge' can be given as an example for this method. *In semi-structured problem posing method,* an open–ended situation is given to students. Students are asked to generate problems about this situation by using their own skills, knowledge and mathematical experiences (Akay, 2006). For example, Christou, Mousoulides, Pittalis, Pitta-Pantazi and Sriraman (2005) gave figures and tables as a problem posing task in their studies to students and they were asked from students to pose problems by using the information stated in those figures and tables. Grundmeier (2003) gave students a story as a problem solving task in his study and asked from students to pose problems by using this story.

In Structured problem posing, the matter is posing a new problem by changing the known (Akay, 2006). It is stated that 'what if?...what if not?' method is deal within the scope of structured problem posing method (Brown & Walter, 1993). In this sense, it was seen that there are little differences between the implementations of these two methods.

In the analysis of literature regarding problem posing, it was determined that semi-structured problem posing method was in the centre of interest among researchers and they were focused on 'Fractions' subjects (Bunar, 2011; Işık, 2011; Işık & Kar, 2012a; Işık & Kar, 2012b; Kar & Işık, 2013). In this regard, it was seen as necessary to carry out this study by moving from the thought that it can contribute to literature since there are not enough studies about 'Ration and Proportion' subject in accordance with the specified method. Therefore the answers

of the following research questions were searched by considering the specified purpose, subject and the points highlighted in the literature.

1. What is the level of semi-structured problem posing skills of prospective teachers?
2. What are the experiences that prospective mathematics teachers face during posing semi-structured problems process (for example the difficulties that they faced)?
3. What are the solutions related with the difficulties that prospective mathematics teachers 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 work group of this study is consisted of 59 prospective sophomore students who are studying in Marmara University, Teaching Primary School Mathematics. 41 of the prospective teachers are female (69,49%) and 18 (30,51%) 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 semi-structured problems, ii) the experiences during problem posing process (for example; the difficulties faced)* and *iii) Suggestions for solution strategies.* The data form stated above was given in Table 1.

Table 1: The Data Form

About 'Ration and Proportion' Subject;
1. Pose and solve a problem about direct or inverse proportion by using the following expressions ***"2, master, apprentice, 12, 6, time"*** as much as you want.
2. Please write your experiences that you had (for example; what kind of difficulties do you have?) during problem posing.
3. 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. The prospective teachers were asked to fill in this form and given 40 minutes for filling the form. In conclusion, the documents of the study were composed of all this collected data was and they were used in document analysis.

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 semi-structured problems were about 'Ratio and Proportion' subject. For instance;

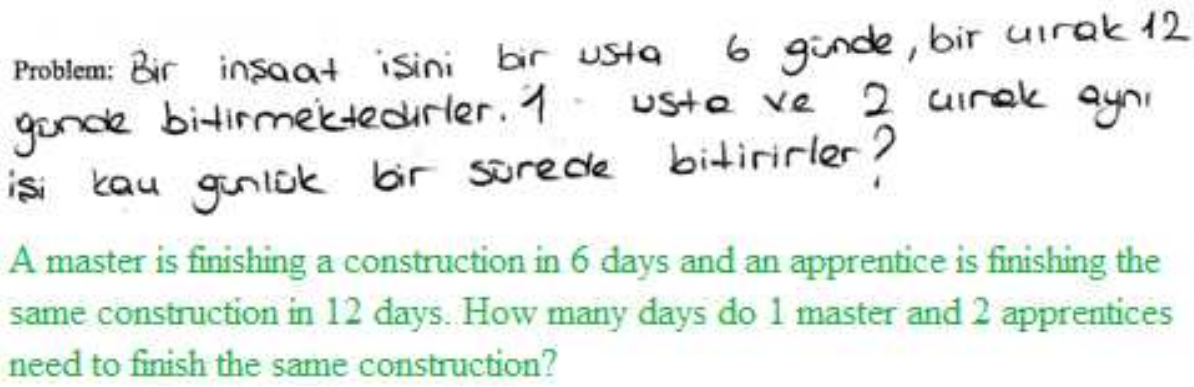

Figure 1: Semi-Structured Problem Posing Task of Prospective Teacher with Number 16

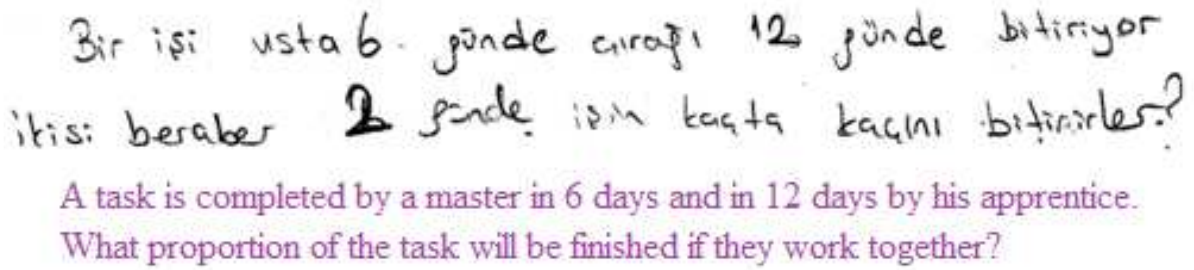

Figure 2: Semi-Structured Problem Posing Task of Prospective Teacher with Number 46

These 59 posed problems from the first part were evaluated by using 'Problem Posing Evaluation Form (PPEF)' which was developed by the researchers (Şengül & Katrancı, 2014a). This evaluation form consists of four dimensions and each dimension consists of three sub-dimensions. It was decided 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. 59 problems which were created in a semi-structured method were evaluated by the researchers separately with this evaluation form. The results were compared and then the differences appeared were discussed, finally the researchers reached an agreement about the differences. 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 by analyzing the collected data the researcher tries to divide the data into meaningful parts and to find what each part means conceptually (Yıldırım & Şimşek, 2008). For this reason, a code list was created by reading the data by the researchers separately more than once. The codes were compared and then discussion was made on different codes. In content analysis, it is necessary to find themes which can generally explain the data by considering the codes appeared. (Yıldırım & Şimşek, 2008). In this regard, researchers secondly created themes separately by gathering similar codes together. The level of agreement between 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 0,90 and 0,92. After calculating the agreement percentages, themes were organized 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 content analysis.

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FINDINGS AND COMMENTS

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

Table 2: The Evaluation of the Tasks of Posing Semi-Structured Problems

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.	17	28,81
	The text of the problem is clear and understandable.	42	71,19
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.	9	15,25
	The problem is suitable to mathematical principles.	50	84,75
The Type/Structure of the Problem	Exercise.	28	47,46
	Easy Problem.	30	50,85
	Difficult problem.	01	1,69
The Solvability of the Problem	The problem cannot be solved.	0	0
	Problem can be solved but it is erroneous.	01	1,69
	It can be solved.	58	98,31

When Table 2 was analyzed, it was seen that 42 (71,19%) of the problem texts were clear and understandable and 17 (28,81%) of them were relatively clear and understandable. It was determined that 9 (15,25%) of the posed problems were relatively suitable to mathematical principles and 50 (84,75%) of them were suitable to mathematical principles. It was appeared that 28 (47,46%) of the posed problems were exercise type problems, 30 (50,85%) of them were easy problems and 1 (1,69%) of them was a difficult problem. According to Table 2, there were not any problems which did not have any solution. It was understood that 1 (1,69%) of the posed problems was solvable but there were mistakes at the solution. It is seen that 58 (98,31%) of the problems are solvable problems. For instance;

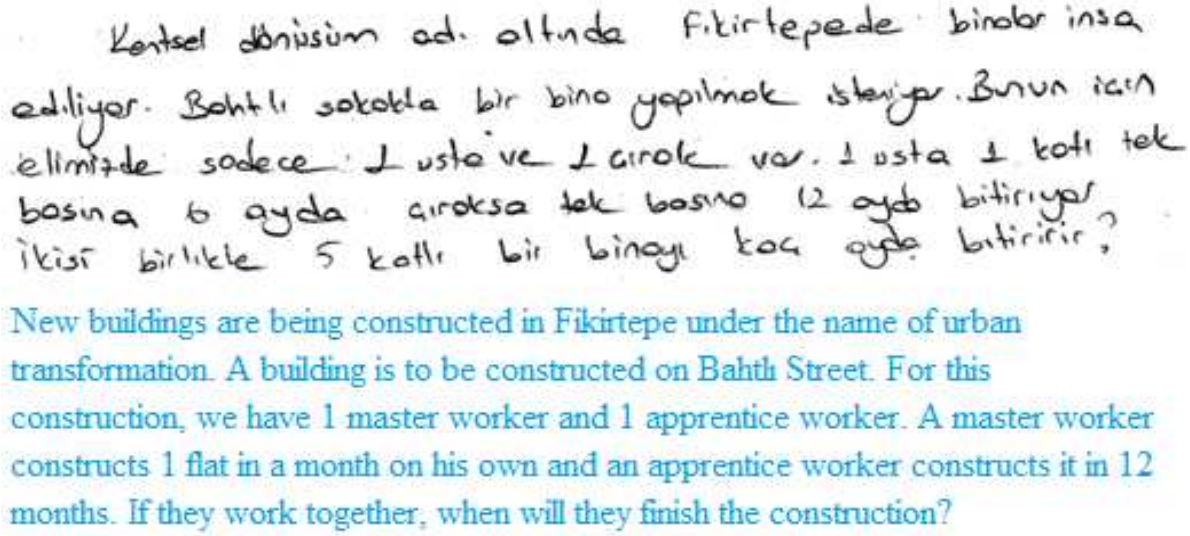


Figure 3: Semi-Structured Problem Posing Task of Prospective Teacher with Number 6

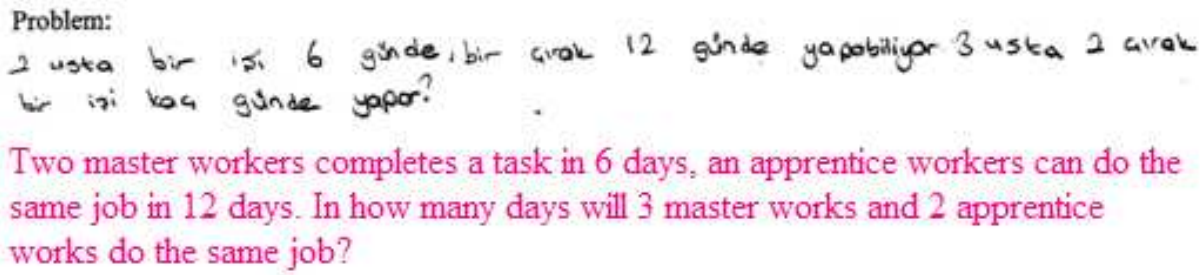


Figure 4: Semi-Structured Problem Posing Task of Prospective Teacher with Number 35

Findings and comments regarding the research problem which was specified as *"What are the experiences that prospective mathematics teachers have during posing semi-structured problems process (for example the difficulties that they faced)?"* are as in the following;

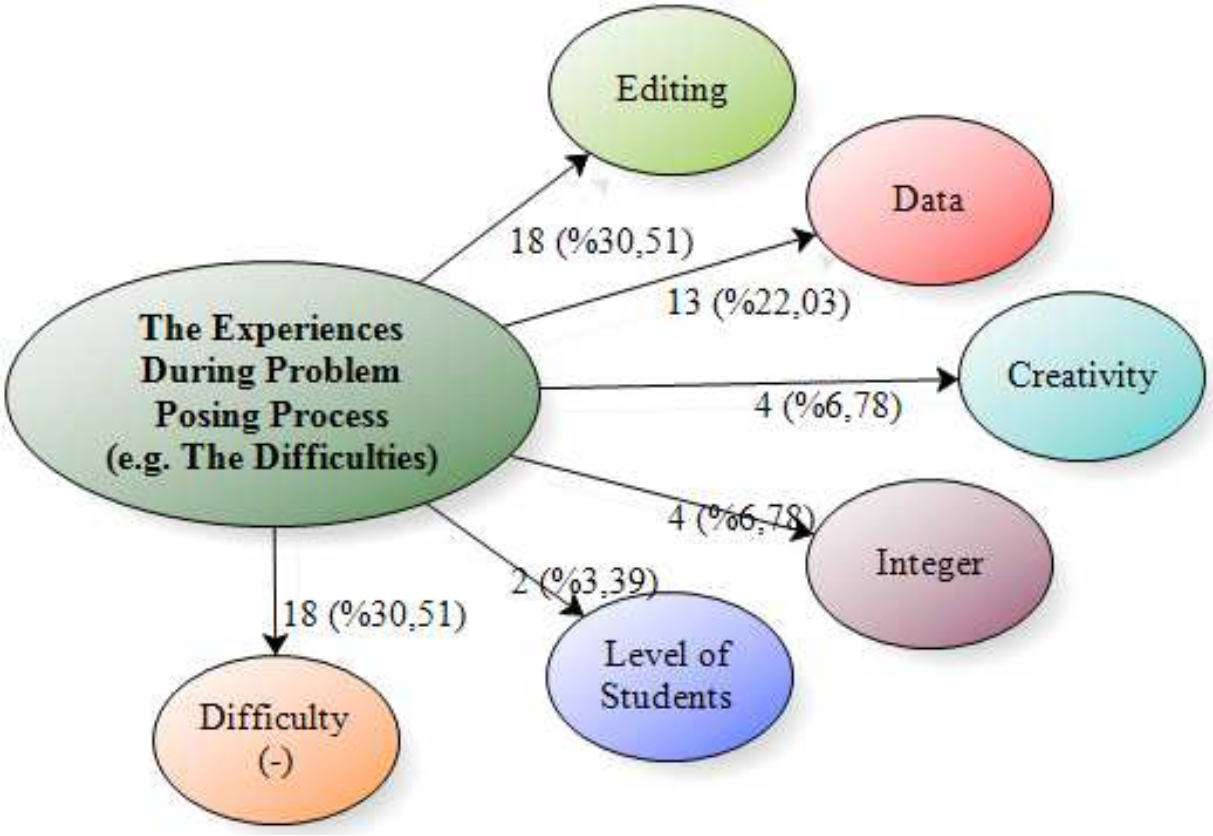


Figure 5: The Experiences in the Process of Posing Semi-Structured Problems

As result of the analysis, it was determined that prospective teachers mostly focused on points that they had difficulties regarding the experiences in this process. In this sense, when Figure 5 is analyzed, it is seen that 18 (30,51%) of the prospective teachers stated that they did not face with any kind of difficulty during semi-structured problem posing process. It was determined that 18 (30,51%) of the prospective teachers stated their opinions about 'editing' theme. In this regard, it was appeared that prospective teachers could not construct the problem. It was also understood that they had difficulties in deciding about the kind of the problem that they need to construct and they stated that they had difficulties in constructing the problem with given statements. For instance;

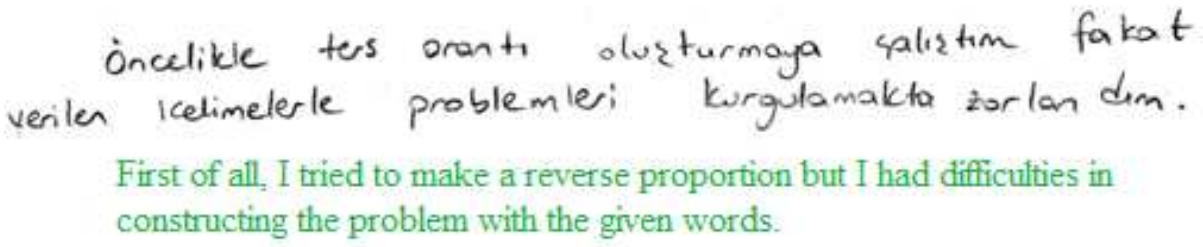


Figure 6: The Experiences of Prospective Teacher with Number 28 in the Process Posing Semi-Structured Problems

When Figure 5 is analyzed, it is seen that 13 (22,03%) of the prospective teachers stated their opinions about 'data' theme. In this regard, it was determined that prospective teachers found the data which was provided for posing problems as insufficient. For this reason, it was determined that they stated that they had difficulties in posing problems. For instance;

Figure 7: The Experiences of Prospective Teacher with Number 3 in the Process Posing Semi-Structured Problems

Besides, it was appeared that 4 (6,78%) of the prospective teachers were stated their opinions about 'creativity' theme, 4 (6,78%) of them stated about 'integer' and 2 (3,39%) of them about 'the level of students'. In this regard, it was concluded that prospective teachers thought that their problems were not creative, they were not able to conclude the result with a integer and they had hesitations whether the level of the problems were suitable to students' levels or not. For instance;

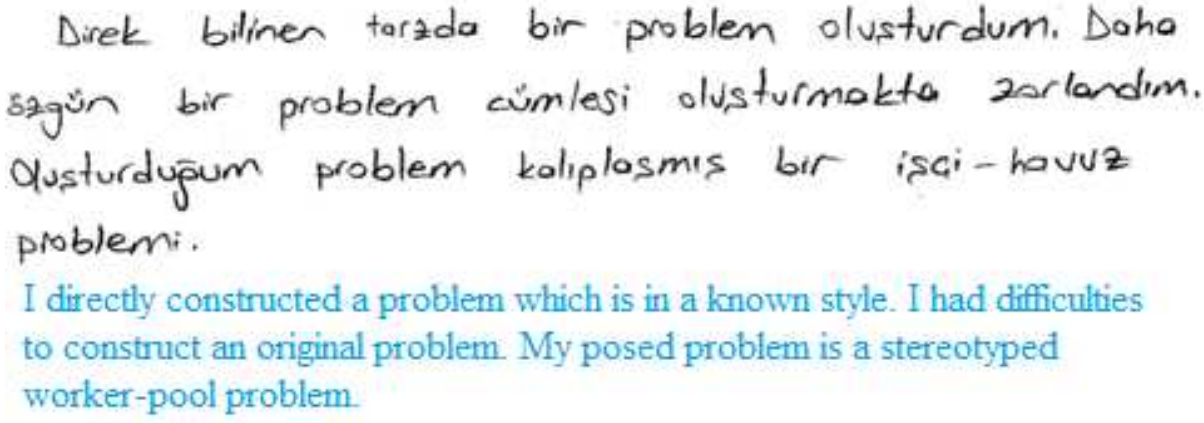
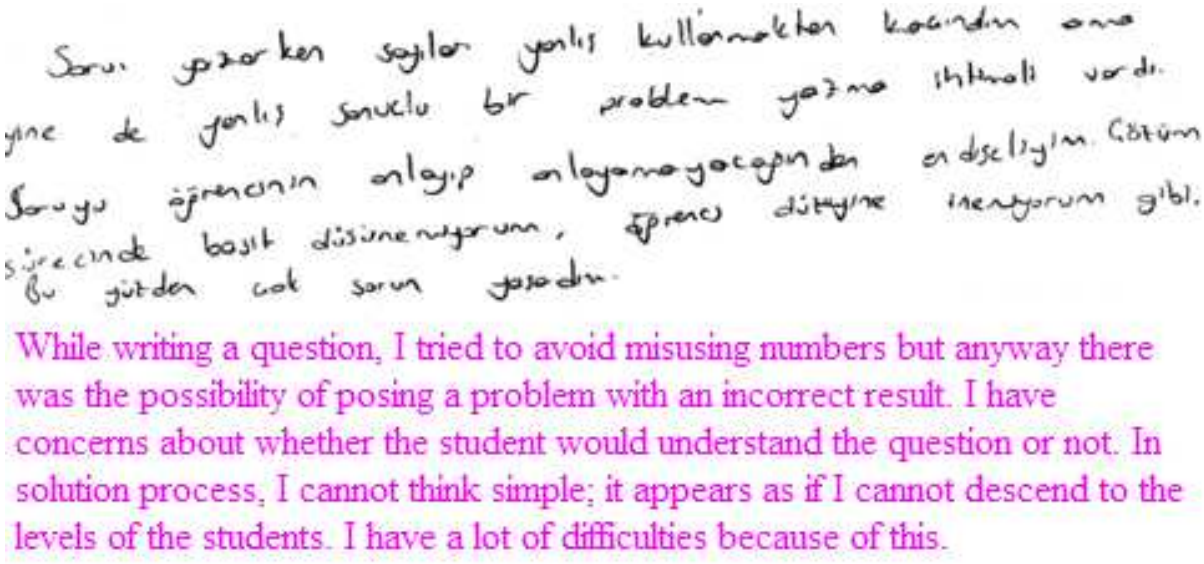


Figure 8: The Experiences of Prospective Teacher with Number 40 in the Process Posing Semi-Structured Problems



While writing a question, I tried to avoid misusing numbers but anyway there was the possibility of posing a problem with an incorrect result. I have concerns about whether the student would understand the question or not. In solution process, I cannot think simple; it appears as if I cannot descend to the levels of the students. I have a lot of difficulties because of this.

Figure 9: The Experiences of Prospective Teacher with Number 20 in the Process Posing Semi-Structured Problems

Findings and comments regarding the research problem which was specified as *"What are the solutions related with difficulties that prospective teachers face (if any)?"* are as in the following.

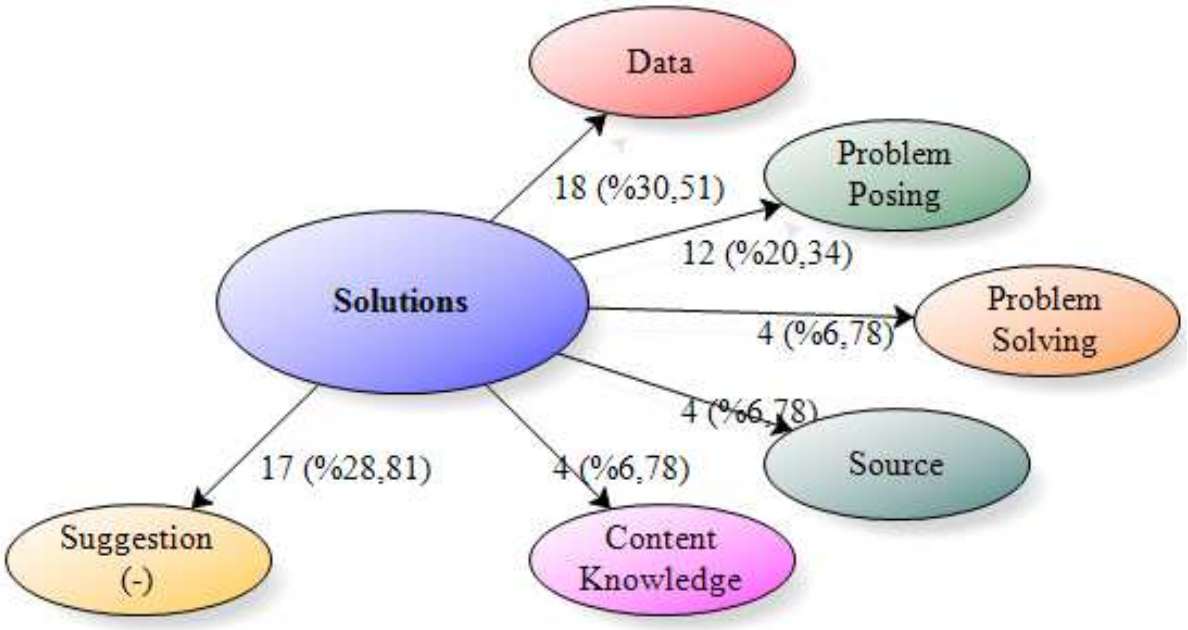


Figure 10: Suggestions for Solution

When figure 10 is analyzed, it is seen that prospective teachers proposed solutions about five different themes. It was determined that 17 (28,81%) of the prospective teachers did not propose any solutions about the difficulties. 18 (30,51%) of the prospective teachers proposed solutions about 'data' theme. In this regard, it was determined that prospective teachers found the given data insufficient so they proposed a solution in accordance with the necessity to provide more data. For instance;

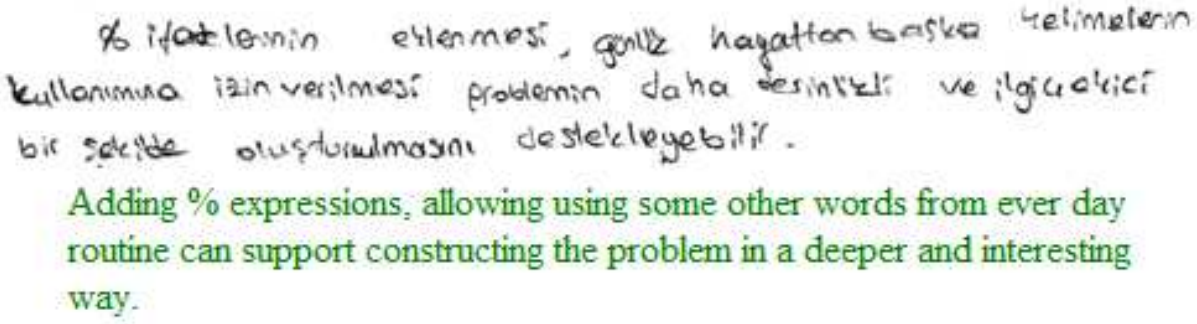


Figure 11: The solution of the Prospective Teacher with Number 8

It was determined that the other proposed solution for the difficulties faced in posing semi-structured problems is the theme of 'problem posing'. In this sense, it was appeared that prospective teachers proposed to carry out problem posing studies for overcoming the stated difficulties. It is seen that the other proposed solution is the theme of 'problem solving'. In this regard, it was determined that prospective teachers stated their opinions in favour of carrying out problem solving studies for overcoming the stated difficulties. For instance;

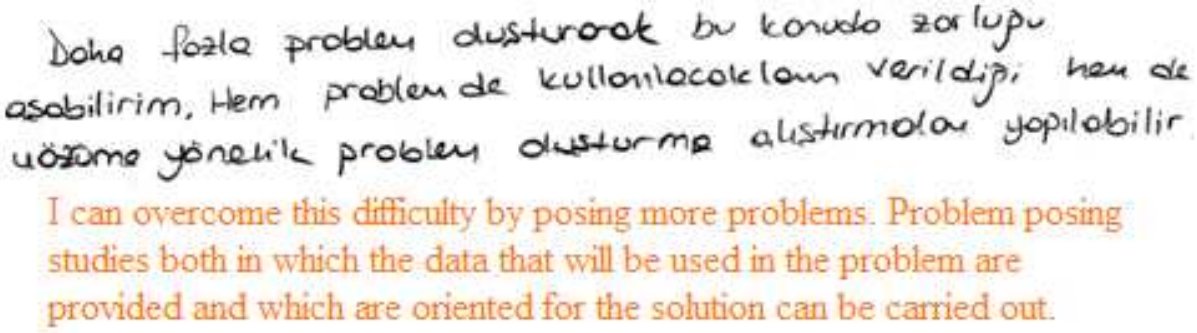


Figure12: The solution of the Prospective Teacher with Number 16

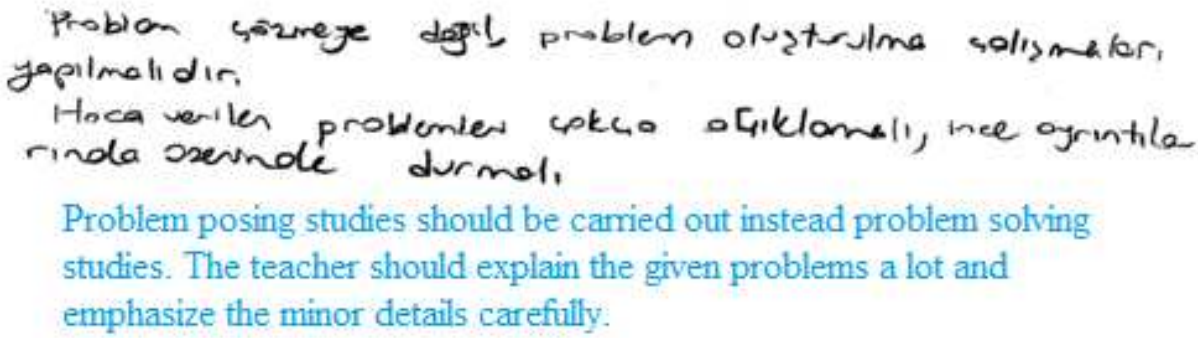
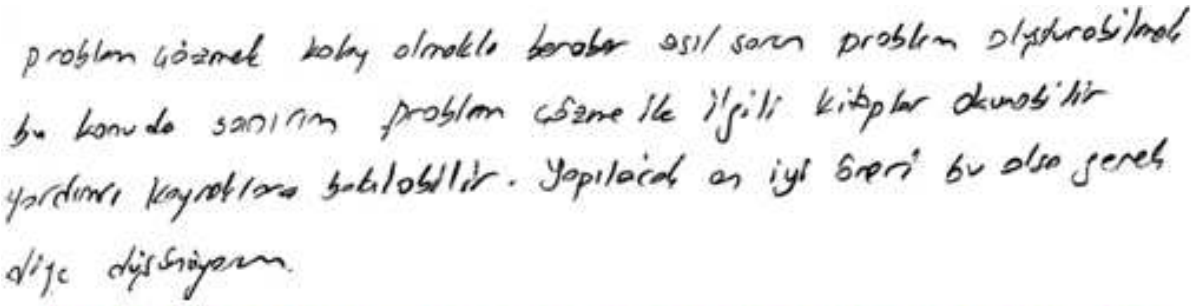


Figure 13: The Solutions of the Prospective Teacher with Number 33

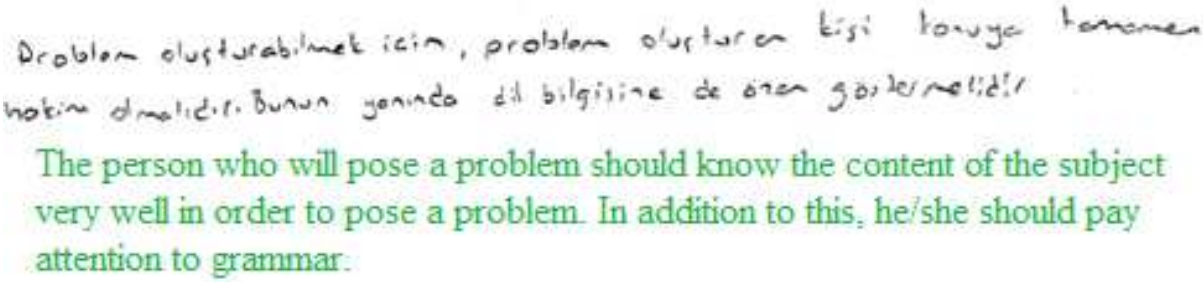
It was determined that another solution which was propped by the prospective teachers is related with the theme of 'sources' and the other one is related with the theme of 'content knowledge'. In this regard, it was seen that prospective teachers stated their opinions about using different sources in the process of posing problems and the necessity of having a sound content knowledge for posing problems. For instance;



problem çözmek kolay olmakla beraber asıl soru problem oluşturabilmek bu konuda sanırım problem çözme ile ilgili kitaplar okunabilir yardımcı kaynaklara bakılabilir. Yapılacak en iyi öneri bu olsa gerek diğe düşünüyorum.

Although solving a problem is easy, the actual difficulty is posing problems. For this a book about problem solving can be read and additional resources can be searched. I think this is the best solution one can propose.

Figure 14: The Solution of the Prospective Teacher with Number 50



Problem oluşturabilmek için, problem oluşturan kişi konuya tamamen hakim olmalıdır. Bunun yanında dil bilgisine de özen gösterilmelidir

The person who will pose a problem should know the content of the subject very well in order to pose a problem. In addition to this, he/she should pay attention to grammar.

Figure 15: The Solution of the Prospective Teacher with Number 15

CONCLUSION, DISCUSSION AND SUGGESTIONS

The purpose of this study is to evaluate prospective teachers' levels in posing semi-structured problems about the subject of 'Ratio and Proportion'. As a result of the analysis in accordance with this purpose, it is concluded that the texts of the problems which were posed by prospective teachers are clear and understandable. While it was determined that the problems are suitable to mathematical rules and principles, it was appeared that all the problems are solvable problems. Besides, it was concluded that the posed problems are in the type of easy problems. It was also determined that the problem texts of the prospective teachers were clear and understandable in the study which Şengül and Katrancı (2014b) analyzed the free problem posing levels of the prospective teachers. It was appeared that problems were suitable to mathematical principles and solvable problems. In this regard, it can be said that the problems within the scope of the same subject posed by prospective teachers have same features both in free problem posing and semi-structured problem posing methods. It was found out that prospective teachers posed exercise type problems in free problem posing studies (Şengül & Katrancı, 2014b). In this sense, it can be said that that these two studies have differences. It is thought for the reason of this situation that in free problem posing method students are not provided any kind of data. At this point, it is suggested to focus on this situation and to search the reasons in the future studies.

The other purpose of the study is to determine the experiences of prospective teachers in semi-structured problem posing process. At this point, it was concluded that prospective teachers mainly expressed their experiences mostly by focusing on the points that they have difficulties. In this sense, it was found out that prospective teachers have difficulties in five different themes. These themes are appeared as; *"editing", "data", "creativity", "integer"* and *"the level of students"*. The difficulties faced in this process are appeared as; *the inability to construct the problem, finding the data as insufficient, the inability to pose creative problems, in ability to provide a whole number for the solution and the inability to arrange the level of the problem*. While Şengül and Katrancı (2014b) found the difficulties faced by the prospective teachers as; the lack of experience, the lack of the content knowledge, not recognizing the cognitive levels of students, the lack of curriculum knowledge and the difficulties in writing problem texts, Akay and Boz (2009) were determined the faced

difficulties as; not being creative, being shy, not feeling confident, the lack of mathematical knowledge, the fact that problem posing activities are different approaches and the nature of posing problems. Although it is determined in the studies which were carried out before that the difficulties faced by the prospective teachers have parallel features, it is obvious that they have difficulties in posing problems. Besides, it is expressed that posing different problems is related with the creativity (Fetterly, 2010; Silver & Cai, 2005; Yuan & Sriraman, 2010). At this point, the expression of prospective teachers about having difficulties in 'creativity' subject can be interpreted as they recognized the correlation between problem posing and creativity. In this sense, it is suggested to provide opportunities for prospective teachers to pose creative problems.

Yet another purpose of this study is to set for the solutions proposed by the prospective teachers for the difficulties (if any) that they faced in the process of posing problems. As a result of the analysis carried out within the scope of this purpose, it was determined that the solutions for the stated difficulties were expressed in five different themes. The themes regarded the proposed solutions were appeared as; *"data", "problem posing", "solving problems", "source"* and *"content knowledge"*. In this regard, the proposed solutions were appeared as; *not limiting the data, carrying out problem posing and problem solving studies, having a sound content knowledge* and *using additional sources*. Şengül and Katrancı (2014b) determined the proposed solutions in their studies as; emphasizing problem solving and problem posing studies, the in depth analysis of the curriculum, teaching special teaching methods in detail and resorting to resources during problem posing process. It can be said that these two studies have parallel outcomes in terms of focusing problem solving and problem posing activities and the necessity for consulting resources. In this regard, it suggested that problem posing studies about different mathematics subjects should be carried out with prospective teachers. Işık and Kar (2012b) stated the necessity that prospective teachers should be allowed to have opportunities to pose their own problems. Thus, they expressed their thoughts that prospective teachers could improve their own skills regarding posing problems. Besides it was found by Stickles (2006) that teachers and prospective teachers made an effort to pose their own problems. At this point, it is suggested to provide opportunities for the prospective teachers to pose problems their own problems. It is thought that this can be ensured with the help of elective lessons in education faculties.

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