

INTE 2014

Free problem posing cases of prospective mathematics teachers: Difficulties and solutions

Sare ŞENGÜL^a, Yasemin KATRANCI^{b*}

^aMarmara University, Education Faculty Primary Department, İstanbul, Turkey

^bKocaeli University, Education Faculty Primary Department, Kocaeli 41380, Turkey

Abstract

The aim of this study is to evaluate free problem posing studies of prospective mathematics teachers about Ratio and Proportion Subject¹, to determine the difficulties faced by the prospective teachers during problem posing process and to elicit suggestions regarding the experienced difficulties. For this purpose a data form was created by the researchers. This data form has three parts which were; *i) The task of posing free problems, ii) The difficulties faced during problem posing process and iii) Suggestions for solutions of the difficulties*. The data form was applied to 114 prospective primary mathematics teachers. During the analysis of the data regarding the first part of the data form, the following criteria were considered; *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*. In the analysis of the data obtained from the second and third parts of the form, content analysis was conducted and the program which is called as NVivo 10 was used. In conclusion, it was concluded that prospective mathematics teachers posed clear and understandable problems which were compatible with the mathematical principles in the form of exercise type and which can be solved by students. The difficulties faced during problem posing process determined as; lack of experience, lack of the content knowledge, not recognizing the cognitive levels of the students, lack of curriculum knowledge and difficulties in writing problem texts. The solutions which were suggested in the scope of this study were as the following; emphasizing problem solving and posing studies, in depth analysis of the curriculum, teaching special teaching methods in details and resorting to resources during problem posing process.

© 2015 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of the Sakarya University

Keywords: Free problem posing, difficulties, solutions

1. Introduction

Problem posing is a process of creating meaningful mathematical problems from interpretations established through concrete cases and based on mathematical experiences (Stoyanova & Ellerton, 1996). Students in problem posing process feel the necessity of demonstrating their reasoning skills, understanding the subject in details and connecting with real life situations (Cunningham, 2004). This process has the potential to provide students an understanding about what it means to “do mathematics” (Lavy & Shriki, 2009). Besides this process not only provides students to have different and flexible thoughts but also gives them responsibility for learning (Ergün, 2010).

When the previous research about this subject was analyzed, it was seen that there are various problem posing methods (Abu-Elwan, 2007; Dickerson, 1999; Grundmeier, 2003; Stoyanova, 2003). These methods are as in the following; *i) free problem*

* Corresponding author: Tel.: +90 (262) 303 2446
E-mail address: yasemin.katranci@kocaeli.edu.tr

posing, ii) semi-structured problem posing, iii) structured problem posing and iv) what if?...what if not?. In this study, it was only focused on the task of free problem posing. In this sense;

In free problem posing process, students are given a situation or a subject from daily life. Students generate a problem by using them (Akay, 2006). It is the case of asking students to pose problems about any subject without providing them any data, figure or problems (Ergün, 2010). In this process, students struggle to pose problems not only for their own understanding but also for their friends to understand and to solve (Lowrie, 2002). A task which is given with an instruction such as “Pose a problem by using your existing mathematical knowledge about Tables and Graphics” can be given as an example for free problem posing method. It is a process in which students are asked to blend their existing mathematic knowledge with a given situation or topic. It will be more beneficial, if the teacher asks students to pose new problems from these situations by correlating real life situations and learnt mathematical subjects in this process. By this way, the mathematical thinking of the students will also be supported (Akay, 2006).

Lin (2004) states the necessity that problem posing activities should be carried out and teachers should have a solid understanding regarding problem posing activities. It is thought that increasing students’ mathematical performances and their success in understanding the mathematics can be provided by giving an insight to teachers about problem posing (Crespo & Sinclair, 2008; Işık, 2011; Işık, Kar, Yalçın & Zehir, 2011; Stoyanova, 2003). Within this context, the studies about searching prospective primary mathematics teachers’ problem posing levels are getting importance. Işık and Kar (2012a) identified in their studies that primary mathematics teachers use problem posing activities in their lessons. In addition that, it was appeared that teachers during their lessons generally used structured or semi-structured problem posing activities and they did not carry out free problem posing activities. At this point, we have noticed a gap in literature and it was decided to focus on this gap.

In this regard, free problem posing levels of prospective mathematics teachers about Ratio and Proportion Subject’ was evaluated in this study and it was tried to determine their experiences during problem posing process and which solutions are suitable for the difficulties they faced during this process. In this sense, the answers of the following questions were searched.

1. What is the level of free problem posing skills of prospective mathematics teachers?
2. What are the difficulties that prospective mathematics teachers face during problem posing process?
3. What are the solutions related with difficulties that prospective mathematics teachers face (if any)?

2. Method

2. 1. Research Design

Qualitative research is a search for demonstrating perceptions and events in a holistic and realistic manner in natural environments and in which a qualitative process is followed (Yıldırım & Şimşek, 2008). In this sense, this study is a qualitative research which is aimed to demonstrate results of a particular situation.

2. 2. Working Group

The work group of this study consisted of 114 prospective third-year students who are studying in Marmara University, Teaching Primary School Mathematics department. 89 of the prospective teachers are female (78,07%) and 25 (21,93%) of them are male.

2.3. Data Collection Tools and Collecting Data

The data of this study was collected by using “Data Form” which was prepared by the researchers. This data form consisted of three sections. These sections are as in the following; i) free problem posing task, ii) difficulties faced in problem posing process and iii) suggestions for solutions. The data form used in this study showed in the following table.

Table 1: Data form

About ‘Ratio and Proportion’ Subject;
1. Pose a problem in middle school level (5 th , 6 th , 7 th , 8 th grade level) and then solve the same problem.
2. Write your experiences (e.g. what kind of difficulties you faced) you had during problem posing process.
3. Which solutions do you suggest for the difficulties you faced during problem posing process?

This data form which was prepared by the researchers distributed to prospective teachers and they were asked to fill in this form. Students were given 40 minutes to fill in this form.

2.4. Data Analysis

The data obtained from the first part was first evaluated by the researchers separately. As a result of this analysis it was determined that one of the prospective teachers did not pose any problems and 13 of the prospective teachers posed problems on different subjects (Sets, Algebraic expressions, Equations, etc.) other than Ratio and Proportion subject. For instance;

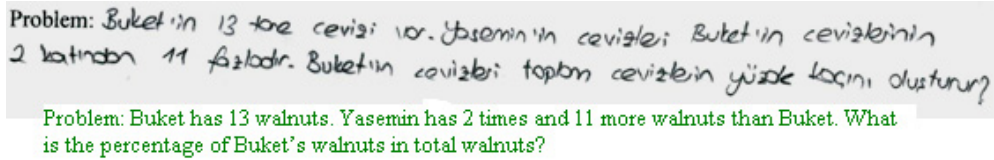


Fig. 1. Free problem posing task of prospective teacher with number 59

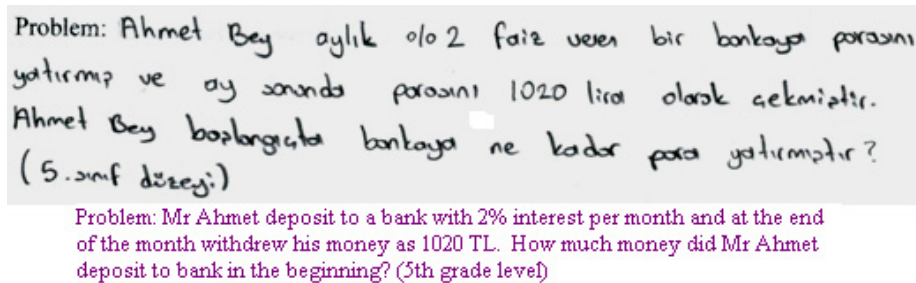


Fig. 2. Free problem posing task of prospective teacher with number 61

The remaining 100 problems from the first part were evaluated by the researchers by using an evaluation form which was developed in another study. 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. 100 problems were evaluated by using this evaluation form by the researchers separately and results of the evaluation were then compared. The differences appeared were discussed and then an agreement was reached. In conclusion, the evaluation results as being related with each sub-dimension was presented on the basis of frequency (f) and percentage (%).

Content analysis method was used in the analysis of the data regarding the second and third part of the data form. Content analysis means combining similar data around particular concepts and themes and editing and interpreting them as readers can understand. In this sense, first of all the data was coded. At this phase the researcher try to divide the data into meaningful parts by analyzing and to find what each part means conceptually (Yıldırım & Şimşek, 2008). A code list was created by reading the data by the researchers separately more than once. The codes were compared and a discussion was made on different codes.

It is necessary to find themes which can explain the data in general by considering the codes (Yıldırım & Şimşek, 2008). Secondly, researchers created themes separately by gathering similar codes together. The level of agreement between researchers was calculated by using the formula " $Agreement\ Percentage = [Agreement / (Agreement + Disagreement)] \times 100$ " as determined by Miles and Huberman (1994). In this regard, it was decided that the agreement percentage regarding the themes changed between 0,86 and 0,92. Later on, 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. NVivo 10 program was used in content analysis.

3. Findings and Comments

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

Table 2. The evaluation of the task of posing free 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.	12	12
	The text of the problem is clear and understandable.	88	88
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.	32	32
	The problem is suitable to Mathematical Principles.	68	68
The Type/Structure of the Problem	Exercise.	69	69
	Simple normal problem.	29	29

	Normal problem.	2	2
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.	100	100

When Table 2 was analyzed, it was seen that 88 (88%) of the posed problems had clear and understandable texts. It was determined that 12 (12%) problems had relatively clear and understandable texts. It was seen that 68 (68%) problems were suitable to mathematical principles and 32 (32%) problems were relatively suitable to mathematical principles. It was appeared that 69 (69%) posed problems were exercise type problems, 29 (29%) problems were simple normal type problems. It was understood that all the posed problems were solvable. For instance;

Problem: 50 tane kalem 3 öğrenci arasında paylaştırılacaktır. Kalemler öğrenciler arasında 2, 3 ve 5 ile doğru orantılı bir şekilde paylaştırılacak ise, en fazla kalem alan öğrenci toplam kaç kalem alır? → (6. sınıf olabilir ama bu konuda emin değilim çünkü müfredat hakkında yeterli bilgim yok.)

Çözüm: Kalemler 2, 3 ve 5 ile orantılı verilerek ise ;

$1. \text{öğrenci} = 2k$ $2. \text{öğrenci} = 3k$ $3. \text{öğrenci} = 5k$	}	kalem alır.	$2k + 3k + 5k = 50$ $10k = 50$ $k = 5$	en fazla kalem alan öğrenci $\Rightarrow 5k = 5 \cdot 5 = 25$ tane kalem alır.
--	---	-------------	--	--

Problem: 50 pencils will be divided among 3 students. If pencils are divided among students directly proportional as 2, 3 and 5, How many pencils will the student who will get most of the pencils, take?

(This can be for the 6th grade but I am not sure about this because I do not have enough information about the curriculum)

Solution: If the pencils will be given directly proportional as 2, 3 and 5;

1 student	= 2 pencils = 2k	$2k + 3k + 5k = 50$	the student who will take
2 students	will take = 3 pencils = 3k	$10k = 50$	most of the pencils
3 students	= 5 pencils = 5k	$k = 50$	$5k = 5 \cdot 5$

He/she will take 25 pencils

Fig. 3. Free problem posing task of prospective teacher with number 28

Findings and comments regarding the research problem which was specified as “What are the difficulties that prospective mathematics teachers face during problem posing process?” are as in the following;

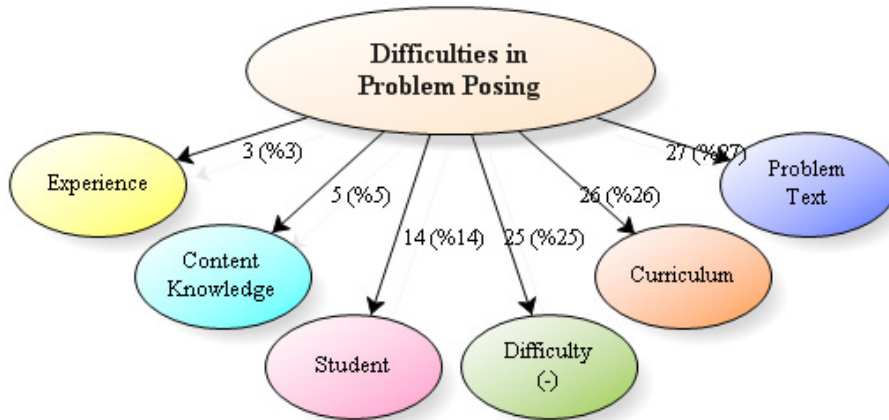
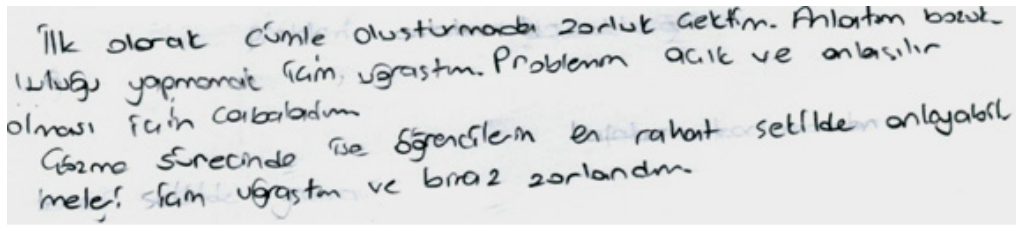


Fig. 4. Difficulties in problem posing

When Figure 4 was analyzed, it was understood that 3 (3%) prospective teachers expressed their opinions about “experience” theme. It was seen that prospective teachers stated that they had difficulties in posing problems as they had less experience about problem posing. 5 (5%) prospective teachers expressed their opinions about “content knowledge”. It was seen that prospective teachers could not completely remember the “Ratio and Proportion” subject for this reason they expressed that they had difficulties in posing problems. 14 (14%) prospective teachers expressed their opinions about “student” theme. Prospective teachers expressed that they could not completely understand the cognitive levels of students. For this reason, they stated that they did not know whether the posed problems were understood by students or not. In this sense, they had difficulties in posing problems. It was seen that 25 (25 %) prospective teachers stated that they did not face with any kind of difficulty.

Twenty six (26%) prospective teachers expressed that they did not know on which grade level “Ratio and Proportion” subject was covered at which level. They stated that since they did not have enough information about curriculum, they had difficulties in posing problems. 27 (27 %) prospective teachers expressed that they had difficulties in expressing problem texts. They indicated that they paid attention to pose problems which are suitable to everyday life, to have numbers that can be fully divided and to provide a language which is suitable to students’ level. For this reason, they had difficulties in creating problem texts. For instance;

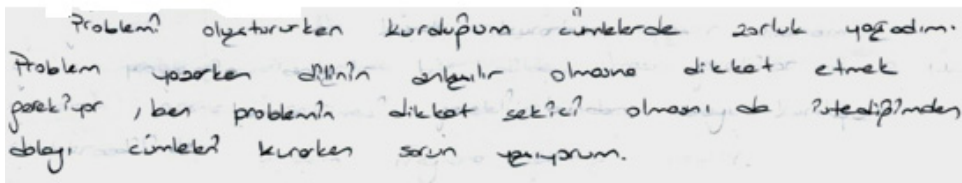


İlk olarak cümle oluşturmada zorluk çektim. Anlatım baskınlığı yapmama için uğraştım. Problemin açık ve anlaşılır olması için çalıştım. Çözme sürecinde ise öğrencilerin en rahat şekilde anlayabilmesi için uğraştım ve biraz zorlandım.

First of all, I had difficulties in creating sentences. I tried hard not to have ambiguous sentences. I tried to write clear and understandable texts.

During the solution process, I made an effort for having students to understand easily and I had a little difficulty.

Fig. 5. The difficulties of prospective teacher with number 71



Problem oluştururken kurduğum cümlelerde zorluk yaşadım. Problem yaparken dilin anlaşılır olmasına dikkat etmek gerek. Ben problemin dikkat çekici olması da istediğimden dolayı cümleler kurarken sorun yaşadım.

I had difficulties in writing sentences while posing the problem. It is necessary to pay attention to have an understandable language while posing problems, since I wanted to pose an outstanding problem; I had difficulties in writing sentences.

Fig. 6. The difficulties of prospective teacher with number 97

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

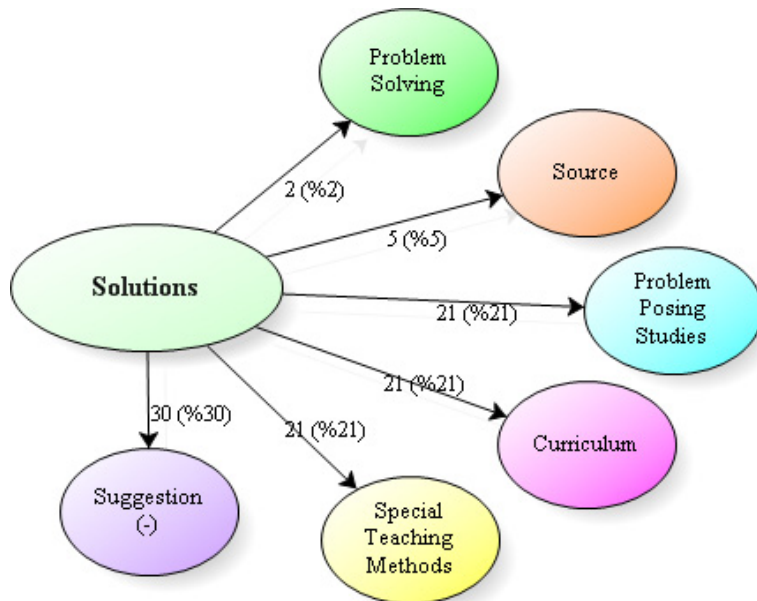
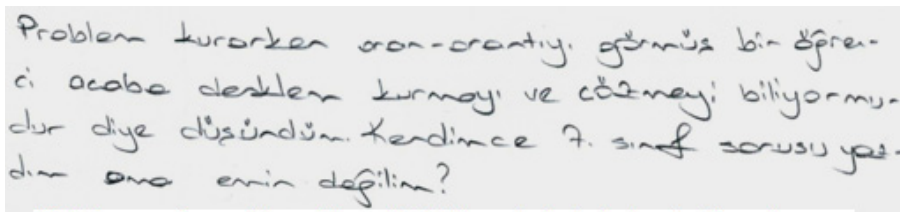


Fig. 7. Solutions

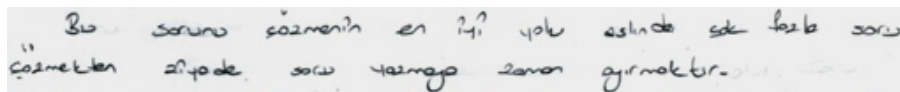
When Figure 7 was analyzed, it was occurred that 30 (30%) prospective teacher did not suggest any kind of solutions. It was determined that 2 (2%) prospective teacher indicated that in order to pose problems, it was necessary to give importance to problem solving. 5 (5%) prospective teachers expressed their opinions about “source” theme. In this sense, they mentioned that it was necessary to use additional resources while posing problems (books, colleagues etc.) 21 (21 %) prospective teachers expressed their opinions about “problem posing studies” theme. It was specified that prospective teachers thought that they could overcome the difficulties by conducting more problem posing studies.

Twenty one (21%) prospective teachers expressed their opinions about “curriculum” theme. Prospective teachers stated that it was necessary to know middle school curriculum very well. 21 (21%) prospective teachers expressed their opinions about “special teaching methods” theme. In this regard, they stated that it was necessary to focus more on how to teach middle school mathematics subjects when prospective teachers are students. They expressed that it was necessary to conduct various problem posing studies about subjects and to teach them how to teach these subjects, when they are students. For instance;



While I was posing problems, I thought whether a student who learnt ratio and proportion subject know how to equate and to solve equations or not. I wrote 7th grade question in my own way but I am not sure.

Fig. 8. Suggestions for solutions by prospective teacher with number 53



The best way for solving this problem is to spend time for posing problems rather than solving problems.

Fig. 9. Suggestions for solutions by prospective teacher with number 97

4. Conclusion, Discussion and Implications

As result of the analysis of the data obtained from the first part of the data form, it was determined that prospective teachers during free problem posing tasks posed problems which had clear and understandable texts. It was concluded that posed problems were suitable to mathematical principles. It was appeared that all the problems were solvable. In addition to that all the posed problems were in exercise type. In the previous studies (Albayrak, İpek & Işık, 2006; Crespo, 2003; Crespo & Sinclair, 2008; Işık, Işık & Kar, 2011) it was specified that prospective teachers posed predictable, simple and well-structured problems. In this case, it can be said that this study echoed with the previous studies stated above.

Korkmaz and Gür (2006) indicated that prospective teachers had misconceptions about problem concept and they got confused between the concepts of problem and exercise. They also expressed that prospective classroom teachers and mathematics teachers could not manage to go beyond mathematical problems given in text books. In their studies, they concluded that prospective teachers had difficulties in organizing the problems, understanding the features of problems and had common mistakes. It was also concluded in that study that prospective teachers posed problems in exercise type. In this sense, it can be said that they got similar results with our study. It can be said for the reason of this that prospective teachers remain dependent on the course books during their education and they do not face with problem solving studies. Besides Korkmaz and Gür (2006) also determined that prospective mathematics teachers posed verbal word problems. They expressed that they could not fulfil the expectations of mathematical thinking and reasoning. In their studies, open ended and creative problems were rarely recognized. In this sense, it can be said that two studies have similarities. It can be said that the finding obtained in this study as 'prospective mathematics teachers posed problems in exercise types' is overlapping with the finding obtained from the study of Işık and Kar (2012c) as they prefer problems that can be solved by using simple mathematical calculations.

It was concluded that prospective teachers had difficulties in five different themes during problem posing process. These themes were determined as; 'experience', 'content knowledge', 'student', 'curriculum' and 'problem text'. In this sense, the difficulties experienced during problem posing process appeared as; lack of experience, lack of content knowledge, not recognizing the cognitive experiences of the students, lack of curriculum knowledge and difficulties in writing problem texts. It was concluded that prospective teachers mostly had difficulties in creating problem texts. Işık and Kar (2012b) suggested that prospective teachers should be given opportunities to pose their own problems so that their problem posing skills could be improved. The reason of this finding can be seen as prospective teachers have rarely encountered with problem posing studies.

Secondly, it was determined that they did not know the curriculum of mathematics lesson and which subjects were taught in which grades. For this reason, it was decided that they had difficulties while posing problems. This difficulty may be related with the fact that prospective teachers are informed very little about mathematics curriculum during their training. The third difficulty was specified as prospective teachers did not know the cognitive levels of their students. This comes from the fact that they have not started their careers as teachers yet and they have not seen different student profiles. As their experiences as being teachers increased, they will be able to overcome this difficulty.

It was concluded that prospective teachers expressed their opinions about five different themes related with the difficulties mentioned above. These suggestions for solution were come up with as; 'special teaching methods', 'curriculum', 'problem posing studies', 'source' and 'problem solving'. It was appeared that prospective teachers stated that it was necessary to focus more on how to teach mathematical subjects during their training processes. In addition to that, it was come out that it was necessary to give information about curriculum in more details.

Besides, it was also seen that prospective teachers stated that the difficulties stated in this study could be overcome by conducting problem posing studies. In this sense, it was appeared necessary that problem posing studies should be carried out with teachers. In accordance with this necessity, it is suggested that compulsory and selective lessons about problem posing should be added to the teaching mathematics programs. It is seen important that prospective teachers should be informed about problem posing and they should be provided opportunities to get more information about problem posing. In this study only free problem posing was considered and the problems posed by prospective teachers during this process, the difficulties they faced and suggestions for solutions were brought into light. It is seen necessary to repeat this study by considering structured and semi-structured problem posing processes. Besides, it is important to detail this study which was carried out qualitatively with quantitative data in terms of generalizing this study.

References

- Abu-Elwan, R. (2007). The use of webquest enhance the mathematical problem-posing skills of pre-service teachers. *The International Journal for Technology in Mathematics Education*, 14(1), 31-39.
- Akay, H. (2006). The examination of the effect of mathematics instruction with problem posing approach on students' academic achievement, problem solving ability and creativity. Doctoral dissertation. Gazi University Institute of Educational Sciences: Ankara.
- Albayrak, M., İpek, A. S., & Işık, C. (2006). Problem designing-solving students in teaching of basic operation skills. *Journal of Erzincan Education Faculty*, 8(2), 1-11.
- Crespo, S. (2003). Learning to pose mathematical problems: Exploring changes in preservice teachers' practise. *Educational Studies in Mathematics*, 52(1), 243-270.
- Crespo, S., & Sinclair, N. (2008). What makes a problem mathematically interesting? Inviting prospective teachers to pose better problems. *Journal Mathematics Teacher Education*, 11, 395-415. doi: 10.1007/s10857-008-9081-0
- Cunningham, R. F. (2004). Problem posing: An opportunity for increasing student responsibility. *Mathematics and Computer Education*, 38(1), 83-89.

- Dickerson, V. M. (1999). The impact of problem-posing instruction on the mathematical problem-solving achievement of seventh grades. Doctoral dissertation, Faculty of Graduate School of Emory University, Department of Educational Studies: USA.
- Ergün, H. (2010). The effect of problem posing on conceptual learning and problem solving in physics education. Published doctoral dissertation. Marmara University Institute of Educational Sciences: Istanbul.
- Grundmeier, T. A. (2003). The effects of providing mathematical problem posing experiences for K-8 pre-service teachers: Investigating teachers' beliefs and characteristics of posed problems. Doctoral dissertation, University of New Hampshire, Durham: USA.
- Işık, C. (2011). Conceptual analysis of multiplication and division problems in fractions posed by preservice elementary mathematics teachers. *H. U. Journal of Education*, 41, 231-243.
- Işık, C., Işık, A., & Kar, T. (2011). Analysis of the problems related to verbal and visual representations posed by pre-service mathematics teachers. *Pamukkale University Journal of Education*, 30(11), 39-49.
- Işık, C., & Kar, T. (2012a). A qualitative study on teacher views of problem posing in mathematics lesson. *National Education*, 41(194), 199-215.
- Işık, C., & Kar, T. (2012b). An error analysis in division problems in fractions posed by pre-service elementary mathematics teachers. *Educational Sciences: Theory & Practise*, 12(3), 2289-2309.
- Işık, C., & Kar, T. (2012c). Pre-service elementary teachers' problem posing skills. *Mehmet Akif Ersoy University Journal of Education Faculty*, 23, 190-214.
- Işık, C., Kar, T., Yalçın, T., & Zehir, K. (2011). Prospectives teachers' skills in problem posing with regard to different problem posing models. *Procedia Social and Behavioral Sciences*, 15, 485-489.
- Korkmaz, E., & Gür, H. (2006). Determining of prospective teachers' problem posing skills. *Journal of the Institute of Science and Technology of Balikesir University*, 8(1), 64-74.
- Lavy, I., & Shriki, A. (2009). Small change - big difference. *The Montana Mathematics Enthusiast*, 6(3), 395-410.
- Lin, P. J. (2004). Supporting teachers on designing problem-posing tasks as a tool of assessment to understand students' mathematical learning. *Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education*. Bergen: Bergen Universtiy.
- Lowrie, T. (2002). Designing a framework for problem posing: Young children generating open-ended tasks. *Contemporary Issues in Early Childhood*, 3(3), 354-364. doi: 10.2304/ciec.2002.3.3.4
- Miles, M. B., & Huberman, M. A. (1994). *An expanded sourcebook qualitative data analysis*. London: Sage Publication.
- Stoyanova, E. (2003). Extending students' understanding of mathematics via problem posing. *Australian Mathematics Teacher*, 59(2), 32-40.
- Stoyanova, E., & Ellerton, N. F. (1996). A framework for research into students' problem posing. In P. Clarkson (Ed.), *Technology in mathematics education* (pp. 518-525). Melbourne: Mathematics Education Research Group of Australasia. Retrieved from http://www.merga.net.au/documents/RP_Stoyanova_Ellerton_1996.pdf
- Yıldırım, A., & Şimşek, H. (2008). *Sosyal bilimlerde nitel araştırma yöntemleri*. Ankara: Seçkin Publication.