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EXAMINATION OF ACTIVITIES AND PROBLEMS ORIENTED TOWARD ALGEBRA READINESS INDICATORS PROPOSED BY PRE-SERVICE MATHEMATICS TEACHERS[1]

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Abstract: Algebra, which is one of the learning domains of mathematics, is one of the most difficult ones for students as operative and semantic. For this reason, it is necessary to emphasize required importance on teaching algebra from early periods. Teachers have major roles in this process. The courses, taken by pre-service teachers in undergraduate, about teaching algebra in the learning environments and the studies done with them about teaching algebra have importance. In order to deal with the difficulties about teaching and learning algebra, Bottoms (2003) claims that students should become ready for further topics about algebra from middle school to until the duration of high school period. In regard to this view, five different process indicators and 12 different content indicators were determined. Three levels were determined for the indicators as basic, proficient and advanced (SREB, 2008). The purpose of this study is to examine the activities and problems oriented toward algebra readiness indicators, proposed by pre-service mathematics teachers in terms of levels introduced by SREB (2008). The study is based on qualitative research methodology. Participants of the study are 23 pre-service mathematics teachers from a public university in Turkey. The study was done in 2017-2018 fall term. The data was analyzed with respect to content analysis and descriptive statistics. Findings showed that whereas 65.22% of pre-service mathematics teachers proposed activities in the level of basic and proficient, 56.23% of them developed activities in advanced level. Besides, it was also reached that pre-service teachers proposed at least one activity for each level. Yet, proposed activities and problems were not related to daily life contexts.

Key words: Algebra teaching, readiness to algebra, mathematics education, mathematical activities.

1. Introduction

Algebra, one of the learning domains of mathematics, is among the branches having most density of relations between operation and the meaning (Baki, 2015). Algebra has been defined as a language used for explaining ideas in mathematics and other fields (Sutherland & Rojano, 1993). The learning domain, Algebra, has been considered important by the National Council of Mathematics Teacher (NCTM) (2000), in terms of developing students' reasoning skills and problem solving abilities. Furthermore, its crucial role in learning mathematical concepts has been pointed out by researchers (Baki, 2015; Kieran, 1992; Van Dooren, Verschaffel & Onghena, 2002). In this regard, required attention should be paid towards teaching algebra from the early periods.

Research shows that learning domain of algebra is one of the leading fields in which students experience trouble. In a study with vocational high school students, for instance, it has been found that

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the students had difficulties in the solution of an equation of first degree with one variable (Cortes & Paff, 2000). Lee (2002), in his study about developing an interactive homework system, has identified students to make distinct types of mistakes in algebraic problems and in operations. For wxample, 16.57% of the students exhibited miscalculation, 16.16% used wrong numbers in calculation, 6.06% skippeda number, 4.24% misrepresented of the number in fraction, 3.23% left the sign unchanged when sending the number to other side of the equation, 2.63% misrepresentied the sum, 2.63% misrepresented the difference, and 2.02% made sign errors. Stafylidou and Vosniadou (2004), in their study with 200 students whose ages ranged between10 to 15, found out that the students tried to comprehend fractions in natural number logic, behaved intuitively in ordering fractions, were unable to designate a systematic method and ended up in misconceptions. Tsamir and Bazzini (2003), in their study which was conducted with 148 high school students, found out that students had certain problems in inequalities and equations. Vlasis (2004), in his study with 8th graders, stated that students experienced problems being flexible in negative sign and operations with negative numbers due to their struggle in conception of integers with arithmetic assumptions. It was found that the students had difficulties in algebraic expressions, identities, and equations, interpreting the concept of variable or unknown, and perceiving as generalized form of arithmetic (Graham & Thomas, 2000; Stacey & MacGragor, 1997; Steinberg & Sleeman Ktorza, 1990). Numerous studies reaching similar findings have been found in the literature (Işık, 2011; Işık & Çelik, 2017; Kaya, 2017; Kılıç, 2013; Toluk Uçar, 2009; Ünlü & Ertekin, 2012).

In order to overcome these difficulties, Bottoms (2003) stated that students should be prepared for more advanced topics in algebra starting from secondary school and this process of preparation should continue also in high school periods. Five distinct process indicators and 12 distinct content indicators regarding it have been identified (Bottoms, 2003). Levels have been identified being fundamental (basic), proficient, and advanced and student behaviors of each level have been tried to be defined (SREB, 2008). For basic level, it has been stated that students are able to perform verbal problems of one or two steps and arithmetic operations, identify mathematical definitions, but unable to conceptually understand mathematical operations and objects, and that they fail in reasoning and problem solving (Bottoms, 2003). For the level of proficient, it has been stated that students start to understand many fundamental mathematical ideas to interpret and execute concepts, and to come up with abstract ideas and that they are able to study with problems involving one or more mathematical knowledge as well as making deduction of knowledge (Bottoms, 2003). As for the students with performances on the advanced level, it was stated that they can work confidently with abstract representations about fundamental mathematical concepts, are able to effectively operate on integers, rational numbers and equivalent matters, develop mathematical reasoning processes and use the analytical techniques (Bottoms, 2003).

Prior to the identified 12 readiness indicators, the five process readiness indicators which were crucial were identified as following: being problem solving, reading and communicating, estimating and confirming the answers and solutions, logical reasoning, and using technology. Thesefive indicators were pointed out to be essential for all subjects of algebra (Bottoms, 2003). Subsequently, following indicators for content were identified:

1. Reading, writing, comparing, ordering and representing integers, fractions, decimals, percentages and numbers written in scientific and exponential forms in different forms,
2. Making calculations (addition, subtraction, multiplication, division), with or without technology, fluently with integers, fractions, decimals, percentages, numbers written in scientific and exponential representations,
3. Definition of the greatest common divisor, the least common multiple, and prime factorization of numbers,
4. Using ratio and proportion to identify cases and solve problems, and writing it,
5. Constructing with proper tools the geometric shapes and classifying them using their features,
6. Measuring length with proper tools and calculating perimeter, area, surface area and volume with proper units, techniques, formulas and precisions,
7. Understanding and using the Pythagorean equation to solve the problems,
8. Collecting, organizing, presenting and interpreting the knowledge,

9. The identification of probability of an event, and related probabilities,
10. Writing and solving algebraic equations with substitution, operation order, operation properties and equality properties,
11. Representing, analyzing, generalizing and expanding sequences,
12. Algebraically and graphically analyzing functions and understanding them (Bottoms, 2003, p. 11).

Bottoms (2003) states that students should acquire ability for the content identified in indicators of readiness for algebra in secondary and high school periods. Thus, conceptual learning of advanced subjects in mathematics to be encountered in high school and latter periods would be provided. It is seen that importance of the five readiness indicators for the process was also highlighted in the curriculum (MoNE, 2018). In the Curriculum of Mathematics, it was stated the need for qualified individuals have changed due to the rapid developments, therefore, individuals who search for access to knowledge, think critically, have communication skills, are enterprising, solve problems and are capable of using information in real life must be raised (MoNE, 2013). It can be said that teachers has the greatest mission on this matter. They play a crucial role in implementing ongoing innovations (Battista, 1994). This gives significance to education and training processes of the teachers that they pass to succeed in their professional life. Ünlü and Sarpkaya Ataş (2017) advocate that undergraduate period of teacher candidates were stated to be indirectly influence teaching activities which were to be carried out later in their classes. In this sense, pre-service teachers should design educational activities to be capable of predicting possible errors by students and guessing existing misconceptions. Thereby, effective education in high school can enable students to gain skills about topics of algebra in later periods. In this sense, it may be said that studies conducted with pre-service teachers are important.

The purpose of this study is to evaluate the activities, and exercises/problems to be used in those, designed by pre-service secondary school mathematics teachers for algebra readiness indicators, with respect to the levels (basic, proficient, advanced) specified by SREB (2008). For this purpose, following research questions were determined:

1. Did the pre-service mathematics teachers suggest activities in different levels for algebra readiness indicators?

2. Did the pre-service mathematics teachers suggest exercises/problems in different levels for algebra readiness indicators?

3. What are the opinions of pre-service mathematics teachers regarding the work to design activities and problems for algebra readiness indicators?

2. Method

Case study screening model was adopted in the research. Case study screening models are screening designations aiming to arrive at the depth and breadth of a specific unit (individual, family, school, hospital, association, etc.) in the universe, and at a judgment about that unit by identifying it and its relations with the environment (Karasar, 2014, p. 86). It was expressed that the data obtained by such designations are valid only for the unit being researched and that it has no purpose of generalization (Karasar, 2014).

2.1. Study Group

The research was conducted with 23 pre-service teachers, studying in the faculty of education, department of mathematics education of a public university, registered to the course on teaching of algebra in the fall semester of the academic year 2017-2018. The participants were determined by purposeful sampling, which is a non-random sampling method. Purposeful sampling enables reviewing circumstances and researching the group which is able to give rich information depending on the purpose of the research (Büyüköztürk et al., 2017).

2.2. Data Collection Tools

Data of the study was collected through the end of term assignments of the course on algebra, and through semi-structured interviews. Questions were set by using the literature, and (necessary seen additions were made by the researchers). Three experts were referred on the compatibility of the questions with the aim, content, language and expression. Necessary arrangements in line with expert opinions were made and pilot study was conducted.

2.3. Data Collection Process

The algebra teaching course was taught as planned, and additionally in lecture, information about the five processes and 12 content indicators which were identified on the scope of Bottoms (2003) were presented. Relations of the indicators among themselves and with the subjects, acquisitions, purposes in the curriculum were tried to be pointed out. Debates on the sample activities of simple (basic), proficient and advanced levels prepared for each content indicator were made in the academic term. At the end of term assignment, 10 groups of 2 to 3 students were formed and were asked to give sample questions and activities for an arbitrary content indicator in basic, proficient and advanced levels. After studying the samples, to gather more comprehensive and in-depth information, semi-structured interviews were made with four groups selected from students. Specifications of the groups were defined as follows:

1. Students being able to correctly produce activity and question samples,

2. Students with correct activity samples, but incorrect question samples,

3. Students with incorrect activity samples, but correct question samples,

4. Students with both incorrect activity and question samples.

2.4. Analysis of the Data

To examine written and oral data obtained from the study in depth, the technique of content analysis was used. Content analysis is defined as a systematic method in which a data source is summarized in smaller content categories by certain coding (Büyüköztürk et al., 2017). For the themes to be used in the analysis of activity and sample questions from the research, Bottoms (2003) and SREB (2008) theoretical frameworks were used. In addition, to provide more detailed information, descriptive statistics were also used.

Pre-service teachers stated the level of each learning application suggested by them. Suggested learning activities, to be in which of the levels simple, proficient and advanced were studied by the researchers and evaluated as “crrect” or “incorrect”. Results were given in tables with frequencies and percents. Further, the pre-service teachers were asked to suggest threeexercises or problems of each of the levels. For each group, suggested exercises/problems were studied and subjected to evaluation by the researchers. The score to be made from problems for each different level were defined as 3 at maximum, and 0 at minimum. Suggested exercises/problems for levels by pre-service teachers which were identified by researchers to be improper for those levels were qualified as incorrect. In the evaluation phase, researchers made content analysis independently, and later the results were discussed in the scope of dissensus and consensus. The formula *Reliability = Consensus / (Consensus + Dissensus)*, suggested by Miles and Huberman (1994) was used. In the result, reliability was found as 83.72%. Considering the research with calculations 70% and over is acknowledged as reliable (Miles & Huberman, 1994), so it is possible to tell the results of the research are reliable.

Following the document analysis, semi-structured interviews were made with the students of the mentioned four different groups. Questions planned to be in the interview were set by the researchers. The exact writing of the statements was paid attention through transcriptions of the data from the interviews. The names of participations were coded as T1, T2, T3 and T4.

3. Findings

In this section, findings about the activities and suggested exercises/problems by pre-service teachers regarding algebra readiness indicators were included. For the suggested sample activities and exercises/problems, descriptive statistics were given first, and then findings of the semi-structured interviews were presented.

Table 1. Frequency and Percentages About the Activities of Pre-Service Teachers for Algebra Readiness Indicators

Proficiency Levels	**Basic Level**		**Proficient Level**		**Advanced Level**	
	f	%	f	%	f	%
	15	65.22	15	65.22	13	56.53

In the study, pre-service teachers were asked to think of distinct activities of three different levels for one readiness indicator of their choice. Upon evaluation, while 65.22% of the pre-service teachers suggested activities were at basic and proficient levels, 56.53% of the suggested sample activities were at advanced level. Table 1 shows the number of pre-service teachers' designing advanced level activities is lower when compared to the proficient and basic levels.

Table 2. Frequencies and Percentages of the Pre-Service Teachers Regarding Exercises/Problems for Algebra Readiness Indicators

Proficiency Levels/Evaluation	**Basic Level**		**Proficient Level**		**Advanced Level**	
	f	**%**	**f**	**%**	**f**	**%**
3 suggestions	12	52.17	13	56.52	14	60.86
2 suggestions	5	21.73	10	43.47	7	30.43
1 suggestion	6	26.08	0	0	2	8.69

After the examination of the suggested exercises/problems by the pre-service teachers separately, each level was categorized respectively. Table 2 shows that at basic level, 12 pre-service teachers offered three suggestions, five pre-service teachers offered two suggestions and six pre-service teachers offered only one suggestion. At proficient level, 13 pre-service teachers offered three suggestions and 10 pre-service teachers offered two suggestions. Lastly, at advanced level, 14 pre-service teachers offered three suggestions, seven pre-service teachers offered two suggestions and two pre-service teachers offered only one suggestion. It was observed that each pre-service teacher suggested at least one exercise/problem for each level.

According to the data from the research, each group who was able to suggest an activity, suggested at the same time, separate exercises/problems for each level. Suggested problems for advanced level were appropriate for that level in terms of difficulty, content, associations, etc. However, it was observed that pre-service teachers didn't utilize scenarios of daily life in those, and rather used questions expressed in mathematical language.

Basic level examples suggested by pre-service teachers are rather in the rank of exercise (routine problem). When the examples of proficient and advanced levels were examined, the difficulty of the examples increased. However, it is seen that, operational knowledge was rather used in suggested examples, and that the difficulty is associated with the increase of the number of steps and the complexity between those steps. Many of the pre-service teachers, specifically for the problems of advanced level, didn't involve contexts related with daily life.

Interviews with the pre-service teachers for in-depth knowledge acquirement were transcribed and evaluated.

The research revealed that pre-service teachers have no knowledge regarding algebra readiness indicators at the beginning of the study. The question *"Previously did you have any knowledge of algebra readiness indicators?"* was asked in the semi-structured interview, pre-service teachers gave responses such as *"No", "Earlier, I knew these indicators were progressive, however I didn't know they were separately evaluated in the levels like basic, proficient and advanced.", "I was not sufficiently knowledgeable." , "I was aware teaching should go from easy to difficult but with this study I gained detailed knowledge." , "Before this study, I was uninformed."*

17.39% of the pre-service teachers were able to design activities and problems appropriate for each level. The dialogue performed with one of these pre-service teachers was as follows.

Researcher: *Previously did you have any knowledge of algebra readiness indicators?*

T1: *No.*

Researcher: *Do you think that the work you did contributed to your mathematical content knowledge for learning domain of algebra and your pedagogical knowledge about mathematics teaching?*

T1: *It might have contributed to my pedagogical knowledge about mathematics teaching. We researched about points where students have difficulties and how to overcome them and naturally this improves us.*

Researcher: *Do you think the algebra readiness indicators that you were taught will be of use in your professional life?*

T1: *Of course, I think that they will be useful. For every activity and sample question we designed will guide us in the future.*

Researcher: *Did you yourself design the problems set?*

T1: *We used another source.*

Researcher: *What were the points you had trouble in the process of preparing activities and problems?*

T1: *In proficiency improvement indicators, it was hard to distinguish the proficient level from the other two.*

In Figure 1, there is an example for each level from the suggested problems by the pre-service teacher.

$(a-3)x^3 + 2x^{b-1} + 5x - 1 = 0$ **ifadesi II. dereceden bir denklem belirttiğine göre, a . b değeri kaçtır?**	**Basic Level**
	If the expression above denotes an equation of degree II, what is the value of a.b?
$2x^2 - 4x + m - 5 = 0$ **denkleminin iki farklı gerçek kökü olduğuna göre, m nin alabileceği en büyük tam sayı değeri kaçtır?**	**Proficient Level**
	If the equation above has two distinct real roots, what is the greatest possible integer value of m?
100 cm uzunluğunda ve çerçeve yapımında kullanılan alüminyum bir çubuktan en büyük alanlı olacak şekilde bir çerçeve yapılmak isteniyor. Buna göre yapılmak istenen çerçevenin alanının kaç cm^2 olacağını bulalım.	**Advanced Level**
	A frame having the greatest possible area is to be made of an aluminum rod of length 100 cm. Let us find respectively the area in cm^2 of the desired frame.

Figure 1. Problem samples of T1

From the dialogue, we see that the pre-service teacher presented problems by using another source. She stated that the most challenging part of the study was to identify the problems of proficient level when deciding the levels of problems. Upon investigation of the samples presented by the pre-service teacher in the basic and proficient levels, we see that they are samples from exercise books. In the interview, this was also mentioned. For the sample in advanced level, it was observed that the pre-service teacher used a problem involving a real life context.

21.73% of the pre-service teachers suggested proper activities for each level, yet some were evaluated as inappropriate for the mentioned levels. The dialogue with one of these pre-service teachers was as follows:

Researcher: *Previously did you have any knowledge of algebra readiness indicators?*

T2: *I didn't have knowledge.*

Researcher: *Do you think that the work you did contributed to your mathematical content knowledge for learning domain of algebra and your pedagogical knowledge about mathematics teaching?*

T2: *Surely it did. I think that it gave us experience and has shed light on how our viewpoint should be when teaching. Classification into proficiency levels is very useful to show the student in which level their learning is. .*

Researcher: *What inspired you in the problems you set and activities you designed?*

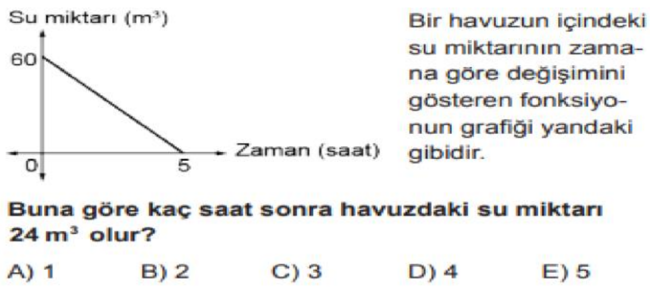
T2: *Sample problems led us. Sure, in the sense to apply to the questions of our subject, we rather had difficulty in doing comparisons but as I explained previously, after separating the levels that too was solved.*

Researcher: *Did you yourself design the problems set?*

T2: *We used a source to classify them with respect to their levels.*

Researcher: *What were the points you had trouble in the process of preparing activities and problems?*

T2: *It happened that we had difficulty in finding appropriate questions for levels through question selection.*

<table>
<tr><td rowspan="2">
</td><td>Basic Level</td></tr>
<tr><td>The time graph of a function expressing the change of volume of the water in a pool is as shown.

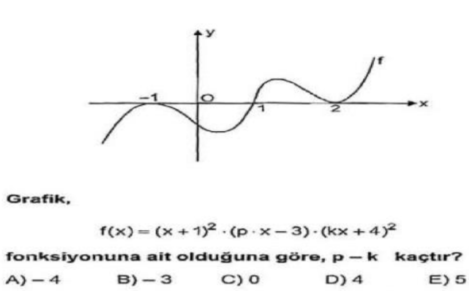
After how many hours the volume of the water in the pool reaches 24 m^3?</td></tr>
<tr><td rowspan="2">
</td><td>Proficient Level</td></tr>
<tr><td>If the graph denotes the function f(x), then what is the value for p-k?</td></tr>
</table>

Figure 2. Sample Problems of T2

According to the interview, similar responses were received from theT2. T2 stated to have difficulty in problem selection and classification into levels. While the sample for basic level in Figure 2 was evaluated as proficient level by the researchers, the proficient one was evaluated to be advanced level.

39.13% of the pre-service teachers were observed to not suggest activities for expressed levels, or that the suggested activities were not appropriate for the levels. 8.69% of the pre-service teachers didn't suggest any activity, yet they were able to present appropriate problems for the levels. 30.43% of the participants had difficulty in presenting activities and problems appropriate for the levels. The interview with one of the participants who didn't produce activities but set suggested problems was as follows:

Researcher: *Previously did you have any knowledge of algebra readiness indicators?*

T3: *I have not seen the terms about proficiency levels in textbooks and curriculums. This was my first time to encounter with the terms.*

Researcher: *Do you think that the work you did contributed to your mathematical content knowledge for learning domain of algebra and your pedagogical knowledge about mathematics teaching?*

T3: *It contributed to strength my content knowledge about the subject by reviewing it and it also helped me to develop a program for teaching activities in a better way for students.*

Researcher: *Do you think the algebra readiness indicators that you were taught will be of use in your professional life?*

T3: *Yes, I do. Since I think, for the students to grasp the subject well, a treatise appropriate for their levels would be more convenient, the algebra readiness indicators would be of use in my professional life.*

Researcher: *What inspired you in the problems you set and activities you designed?*

T3: *I overly utilized problem styles I found during research. I developed them starting from these problems.*

Researcher: *Did you yourself design the problems set?*

T3: *I did a source scan but no matter how much, since we were interested in a part of the acquisition, I was unable to find problems much appropriate. I produced problems making a few alterations on the ones I had found.*

Researcher: *What were the points you had trouble in the process of preparing activities and problems?*

T3: *The difference of the acquisition with the prior and the next, for there is a need to consider the foreknowledge, I had at this point difficulty, although a little one.*

Researcher: *In your work, there is no designed activities. What might be the reason?*

T3: *I considered the solutions of the problems I suggested appropriately for the levels as activities.*

The interview with one of the pre-service teachers who had difficulty in suggesting activities and problems appropriate for the levels was as follows:

Researcher: *Previously did you have any knowledge of algebra readiness indicators?*

T4: *No, I didn't.*

Researcher: *Do you think that the work you did contributed to your mathematical content knowledge for learning domain of algebra and your pedagogical knowledge about mathematics teaching?*

T4: *I think it did, especially preparing activities were experience for us to apply it on our own class in the future. It was both that we have learned how to prepare questions for advanced, average and, basic levels, and also it was useful to prepare those by using information technologies.*

Researcher: *Do you think the algebra readiness indicators that you were taught will be of use in your professional life?*

T4: *As well as seeing my content knowledge on algebra as being sufficient, I think that my pedagogical knowledge of mathematics teaching improved a bit more.*

Researcher: *Did you yourself design the problems set?*

T4: *While taking some of those from textbooks, we included some into the study with alterations. For example, so as to alter a test question by adapting it as a classical question…*

Researcher: *What were the points you had trouble in the process of preparing activities and problems?*

T4: *While I don't recall the assignment process fully, we had troubles about deciding which level some problems were.*

Upon examining the data from the qualitative dimension of the study, in summary, that the pre-service teachers had no knowledge of algebra readiness indicators previously and they used a source to present problems for students. This study was found useful for their professional development because they had difficulties classifying the questions into their levels, and they had shortcomings designing activities. Upon examining the suggested problems, it was found that the participants did not use real-life context in their suggested problems, and the suggested questions were rather based on operational ability.

4. Results, Discussions and Suggestions

In mathematics education, one of the important outcomes is to enhance individuals who have problem solving and communication skills, and can thin critically and analytically to meet the requirements of our time. The teachers play a key role to achieve these general and specific purposes expressed in the curriculum (Swan, 2007). In this research, the suggested activities and exercises/problems by pre-service mathematics teachers regarding algebra readiness indicators were studied. Upon investigation of the activities suggested, it was found out that 65.22% of the pre-service teachers had suggested activities at basic and proficient levels. Based on this result, it can be interpreted that most of the participants are able to design in their classes sample activities at basic and proficient levels. On the other hand, 56.53% of the pre-service teachers have suggested activities at advanced level. It is seen that the pre-service teachers had trouble about suggesting advanced level activities, compared to basic and proficient levels. the reason of this can be that they were affected by their learning life. Aydoğdu İskenderoğlu and Güneş (2016) and Işık, Işık and Kar (2011) similarly pointed out this reason. Advanced level activities consist of applications, which require treating the features of the subject with all aspects, studying with complex associations, generalization, and usage the knowledge in different contexts (Bottoms, 2003). It can be said that to establish advanced activities, it is required to consider many assumptions such as employing advanced thinking abilities and making use of many different viewpoints. In this sense, the need to improve activity designing skills of pre-service teachers is revealed. The results obtained may be said to be consistent with the literature (Toprak, Uğurel, Tuncer & Yiğit Koyunkaya, 2017; Toprak, Uğurel & Tuncer, 2014; Bozkurt, 2012; Erarslan, 2011; Metin & Özmen, 2009).

The basic level samples suggested by the pre-service teachers are similar to the ones in textbooks. Exercises are used to improve the operational ability of the students and to support learning. These types of samples are considered in the routine problems category (Yenilmez & Ev-Çimen, 2014). Similarly, Akay, Soybaş and Argün, (2006) stated that pre-service teachers produced sample exercises about a specific domain are similar to the questions in the textbooks. According to the results, almost all of the pre-service teachers were able to produce samples for the objective they chose. This case is in line with the results in the studies by Akay, Soybaş and Argün (2006), Yenilmez and Ev Çimen (2014), Aydoğdu İskenderoğlu and Güneş (2016), Işık, Işık and Kar (2011), Silver and Cai, (1996), Crespo and Sinclair (2008).

Based on the examining the suggested samples at proficient and advanced levels, we see that most of the pre-service teachers produced samples. However, it was found that in most of these samples were not related with the real life contexts. It was observed that they were rather focused on mathematical relations and operations which require complex calculations. It was stated that many pre-service teachers perceived mathematical problems as applications of algorithms without confirmation when they were students at secondary and high schools (Cortes & Paff, 2000). If we consider the pre-service teachers' learning like that, it can be an expected result suggested problems focus on operational abilities may emerge. . Thus, based on the data gathered from the interviews, pre-service teachers stated that they used different problem styles and made minor alterations on them. The influence of their past learning experiences on the suggested samples by the pre-service teachers was highlighted also by the researchers (Korkmaz & Gür, 2006; Aydoğdu İskenderoğlu & Güneş, 2016; Işık, Işık & Kar 2011; Van Dooren, Verschaffel & Onghena, 2002; Stickles, 2011). It may be said that the responses from the pre-service teachers such as "*The samples we worked and the properties we were taught during the course were inspired us."* reveal this case. In this respect, the results obtained may be said to be in line with the results from these studies.

When we consider that the pre-service teachers had more difficulty suggesting activities and exercises/problems from basic to advanced, it can be said that it is needed to concentrate on studies of activity design and problem posing in the mathematics education departments of faculties of education. Pre-service teachers generally stated that this study will contribute to their professional development. In this respect, it can be suggested that in teacher training institutions, applied courses and different activities in the courses should be increased. Further, in the annual seminars conducted at the beginning and the end of the academic years for in-service teachers, workshops might be organized in university-school cooperation.

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