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RESEARCH ARTICLE

Analysis of the Problems Posed by Pre-Service Primary School Teachers with the Context of Environment

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Abstract

The current study is an inter-disciplinary study in which the problems posed by pre-service primary school teachers were analyzed within the context of both environment and mathematical processes. A total of 75 pre-service primary school teachers participated in the current study designed according to the case study design, one of the qualitative research methods. The data were collected through the math problems posed by the pre-service teachers with the context of the environment. The environmental contexts were analyzed by using the content analysis method while the problem posing processes were analyzed through the descriptive analysis approach. The results of the analyses have revealed that the pre-service teachers generally preferred to include more than one environmental context in the problems they posed and from among these contexts, the waste, garbage, forestation and air pollution contexts came to the fore. It was found that the problems posed were solvable to a great extent and were mostly real life problems in accordance with the structure of the context. However, it was observed that more than 30% of pre-service teachers could not correctly express the grade level of primary school in terms of both mathematical processes and the environmental context.

Keywords: Environment, real life, context, problem posing.

Introduction

The main criticism levelled against traditional education (programs) is that students cannot transfer information outside of the learning environments and cannot know exactly why they have learned the subject or concept (Gilbert, 2006). The fact that learning environments are generally constituted by teacher-centred and monotonous classroom environments has a negative effect on the students' ability to transfer the acquired knowledge to real life (Bransford, Brown & Cocking, 1999). However, in the past century, many educators, especially John Dewey, have emphasized the positive effect of interdisciplinary approaches on connecting the knowledge and skills presented to students in formal learning environments with daily life practices (Beane, 1996). At this point, the presentation of the problems on the basis of a context and execution of educational activities based on interdisciplinary and real world practices such as STEM are seen as very important in terms of making learning meaningful (Karahan & Bozkurt, 2018). Context-based learning can be defined as presenting scientific concepts to students through the selected cases from daily life (Ülger & Güler, 2019). Context-based learning particularly comes to the fore in science and mathematics education. Instead of mentioning the concepts and then giving examples about them, presenting the concepts directly in real life examples makes the core courses such as science and mathematics more interesting (Choi & Johnson, 2005). Parallel to this, it is emphasized that meaningful learning will be achieved as a result of teaching concepts related to science and mathematics in contexts in which they are used in the real world and in relation to

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each other (Gilbert, Bulte & Pilot, 2011). In this sense, teaching with real-world problems is one of the sub-topics of context-based learning (Karahan & Bozkurt, 2018).

Problems including a context are particularly seen as an important way of transferring and using mathematical concepts and skills in real life situations. Such problems are considered important for students to gain experience about the problems related to real life situations, to understand the importance of mathematical concepts and to acquire creative and critical problem solving skills (Chapman, 2006; Verschaffel, Greer & De Corte, 2000). Students contribute to the development of their mathematical thinking skills by developing contextual strategies while working on contextual problems (Van Den Heuvel-Panhuizen, 2005). In this way, students can establish strong links between the mathematics they encounter in school and the mathematics they encounter in real life (Singletary, 2012; as cited in Özgeldi & Osmanoğlu, 2017). In addition to positive effects of the context-based approach on cognitive processes, Stylianides and Stylianides (2008) emphasize that real life contexts are motivational for students in an affective sense and that students' interest in mathematics increases with these contexts. Le Roux (2008) states that contextual problems, which do not require much higher order thinking than abstract problems, are useful in such associations especially for students who are not successful in mathematics. Even though the connection of mathematics with daily life is realized more intensively through problem solving processes, problem posing is also accepted as an important component of mathematics and it is stated that it is at the centre of mathematics education (Crespo, 2003; MoNE, 2018; NCTM, 2000). Problem posing is also the process of creating meaningful mathematical problems by reflecting students' own personal and mathematical experiences on concrete situations (Stoyanova & Ellerton, 1996). Abu-Elwan (2002) states that, as is the case with problem solving processes, problem posing is an effective way to ensure the relationship between students' daily life situations and mathematical situations, and thus, students' mathematical thinking can develop. Stoyanova & Ellerton (1996) stated that problem posing processes can be performed under three different categories: free, semi-structured and structured. In free problem posing activities, students produce problems without being subjected to any limitation. Semi-structured problem posing situations refer to situations in which visual representations such as pictures, graphics or tables are presented to students or situations in which verbal open-ended stories are used (English, 1998; Silver & Cai, 2005). Finally, structured problem posing refers to processes in which students create similar problems by rearranging the already solved problems or changing the conditions or questions of the given problems.

Research has shown that determining the appropriate contexts for students is the most important part of context-based teaching practices. If appropriate contexts are used, students' existing potentials and ideas about the target concept can be more easily revealed (Çelik, Akın & İlhan, 2018; De Jong, 2008; Didiş-Kabar & İnan, 2018). In the current study, the context of environment was chosen in order for the pre-service teachers to be engaged in the act of relating to daily life through problem solving processes. Free problem posing activities are thought to provide individuals with the opportunity to demonstrate their creativity at the highest level. Therefore, the current study is thought to be important in terms of revealing the pre-service teachers' skills of problem posing and relating to daily life and approaches to the concept of environment as a context. In addition to this, although the concepts of problem posing and environment are important concepts, it is thought that they are not attached the necessary importance at the elementary school level. Therefore, the current study conducted with pre-service teachers who will present these two important concepts to elementary school students is thought to contribute to the literature. In this connection, the current study aimed to analyze the mathematics problems posed by the pre-service teachers with the context of environment. To this end, answers to the following questions were sought:

a) Which environment-centred contexts did the pre-service primary school teachers prefer in the problems they posed?
b) What is the suitability of the problems posed for the indicated grade level and their state of solvability?
c) What types of problems did the pre-service teachers prefer to pose in terms of types and content standarts?

Methodology

The current study aiming to investigate the pre-service teachers' state of posing problems with the context of environment from different aspects employed the case study design, one of the qualitative research methods. The case study design is a research design in which one or more cases are intensively investigated by the researcher in a detailed manner (Christensen, Johnson & Turner, 2013).

Working Group

The study group of the current research is comprised of a total of 75 senior pre-service teachers attending the Department of Primary School Teacher Education in a state university in Turkey. No criteria other than being a senior student were used in the selection process of the participants. After the pre-service teachers were informed about the purpose and content of the study, the study was conducted on 75 pre-service teachers who wanted to participate in the study on a volunteer basis.

Analyzing Data

In the analysis of the collected data, the content and descriptive analysis techniques were used. In this regard, the content analysis approach was used in the process of determining environment-centred contexts, while the descriptive analysis approach was employed in examining the posed problems under the headings of type, solvability, the content standarts addressed and class level. In order to ensure the reliability in the data analysis process, assistance was obtained from field experts. For example, in the determination of the themes under which the codes in the problems posed by the pre-service teachers in the context of environment would be gathered, two faculty members who are experts in the field of environmental education were consulted. In the analysis of the problem posing processes, the inter-rater reliability was calculated by asking an academician specialized in the field of math education to analyze the data after the researcher completed the process of coding. To this end, the inter-rater reliability was calculated with the formula proposed by Miles and Huberman (1994) [Reliability = Agreement / (Agreement + Disagreement)] and it was found to be 91% for all the analysis categories. The raters discussed the categories on which they could not reach an agreement and thus reached a common decision.

Findings

In the current study, in which the pre-service teachers' problems posed with the context of environment were analyzed, first the numerical frequency of the environmental concepts mentioned was calculated and then which environment-centred contexts were used was investigated. In this connection, the findings related to the frequency of the inclusion of the concepts of environment in each problem statement are given in Table 1 while the environment-centred contexts are given in Table 2.

Table 1.

Frequency of inclusion of the contexts of environment in each problem statement

Frequency of environmental contexts	*f*	*%*
Focusing on only a single environmental context	29	38.7
Inclusion of more than one environmental context	46	61.3

As can be seen in Table 1, the pre-service teachers included the environmental contexts in the problems they posed in varying frequencies. For example, while 38.7% of the pre-service teachers constructed their problems on a single environmental context, 61.3% preferred to pose their problems by using more than one environmental concept together.

Table 2.

Environmental contexts used in the problems posed

Themes	*Environmental contexts*	*f*	*%*
Elements of Pollution			
	Waste	32	23.7
	Garbage	20	14.8
	Air pollution	10	7.4
	Environmental pollution	4	3
	Noise pollution	1	0.7
	Light pollution	1	0.7
	Water pollution	1	0.7
Natural Events			
	Global warming and drought	3	2.2
	Landslide	2	1.5
	Forest fire	1	0.7
Artificial Environment			
	Forestation	22	16.3
	Picnic area-garden	4	3
	Gap-pond	2	1.5
	Industry	1	0.7
Biotic Environment			
	Living things	7	5.2
	Forest	7	5.2
Abiotic Environment			
	Sea	4	3
	Nature	3	2.2
	Soil	3	2.2
	Atmosphere	2	1.5
Recycling			
	Recycling	5	3.7

As can be seen in Table 2, the pre-service teachers used the contexts of pollution, natural events, artificial environment, biotic-abiotic environment and recycling in the problems they posed with the context of environment. The pre-service teachers used the context of pollution the most frequently (51%), followed by the context of artificial environment (21.5%). In the problems with the context of pollution, while the concepts of waste (23.7%), garbage (14.8%) and air pollution (7.4%) were relatively more frequently emphasized by the pre-service teachers in their problems, in the problems with the context of artificial environment, the concept of forestation (16.3%) was preferred the most. Natural events, biotic-abiotic environment and recycling were the

contexts less frequently preferred by the pre-service teachers. One problem posed by one of the pre-service teachers is given in Figure 1 to show which concepts of environment are included at which frequency.

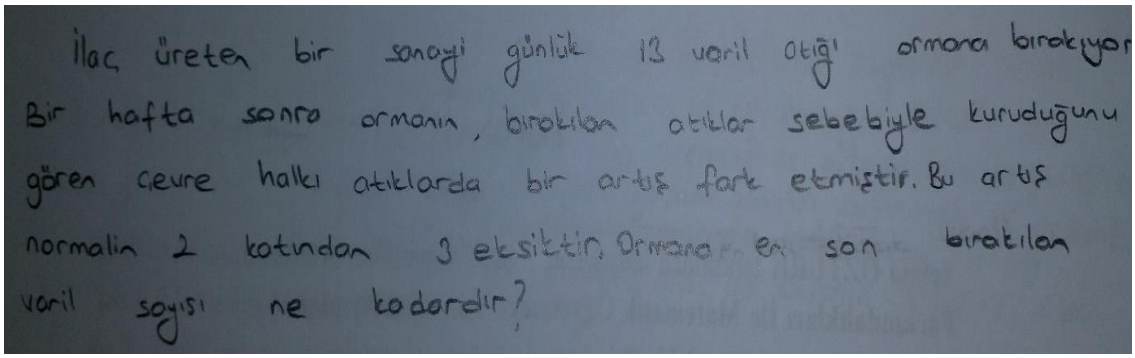

Figure 1. A sample problem including more than one environmental context

As can be seen in Figure 1, the pre-service teacher constructed the problem by using different environmental contexts together. The pre-service teacher posed a math problem by combining the context of waste under the elements of pollution and the context of forestation under the biotic environment.

In the next stage of the study, the suitability of the problems posed for the grade level indicated by the pre-service teachers and their state of solvability were examined. The findings obtained in this regard are presented in Table 3.

Table 3.

Solvability of the problems posed and their suitability for the grade level indicated

Solvability of the problems	*Suitability for the grade level*	*f*	*%*
A solvable problem		**68**	**90.7**
	Suitable for the indicated grade level	44	58.7
	Not suitable for the indicated grade level	24	32
Not a solvable problem		**7**	**9.3**

As can be seen in Table 3, nearly 91% of the pre-service teachers posed a solvable problem while nearly 9% of them could not pose a solvable problem. While 59% of the pre-service teachers correctly indicated the grade level for which the problems they posed were suitable, 32% of them could not correctly indicate the grade level for which the problems they posed were suitable. In Figure 2, a sample problem posed suitably for the grade level indicated is given.

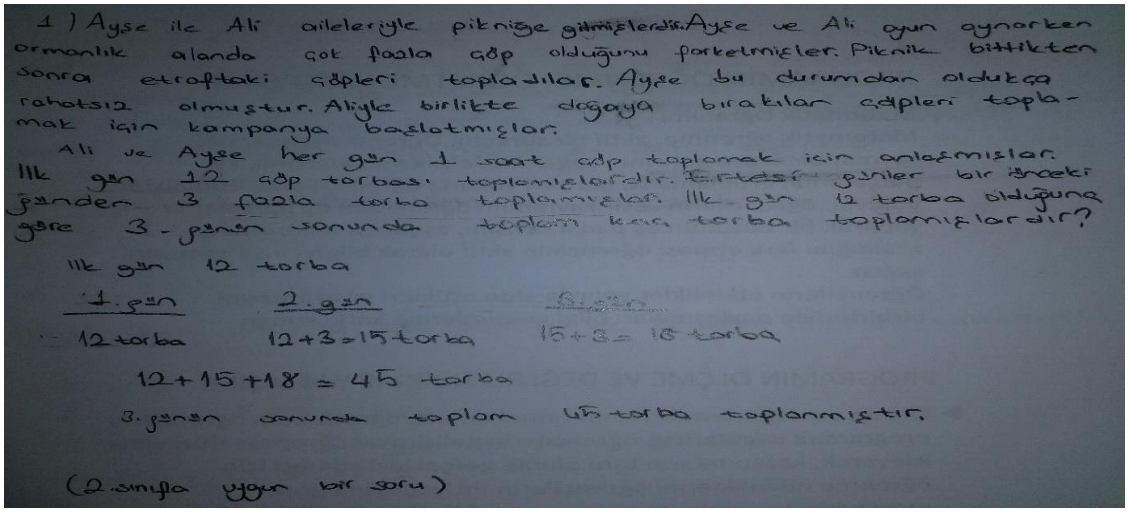

Figure 2. A sample solvable problem posed suitably for the grade level indicated

As can be seen in Figure 2, the pre-service teacher posed a math problem with the context of environment. In addition, the grade level for which the problem was suitable was indicated to be 2nd grade level. When the concepts used in the problem and arithmetic operation skills needed to solve the problem are considered, it is seen that the pre-service teacher correctly indicated the suitable grade level.

In the final stage of the current study, the types of the problems and the content standarts preferred for the problems posed by the pre-service teachers were analyzed. The results obtained in this regard are presented in Table 4.

Table 4.

The types of the problems posed and the content standarts preferred for them

Problem Types	*Content Standarts*	*f*	*%*
Real life problem		**46**	**61.3**
	Number & operations	33	44
	Measurement	13	17.3
Routine problem		**22**	**29.3**
	Number & operations	19	25.3
	Measurement	3	4
Not a solvable problem		**7**	**9.3**

As can be seen in Table 4, 61.3% of the pre-service teachers posed problems suitable for real life while 29% of them preferred to pose simple routine (verbal) problems. In addition, while 70% of the pre-service teachers are seen to have put the number & operations math content standart in the centre of the problems they posed with the context of environment, 21% of them preferred to pose problems directed to the measurement content standart. In Figure 3, a sample problem considered in the real life problem category is given and in Figure 4, a sample problem considered in the routine problem category is given.

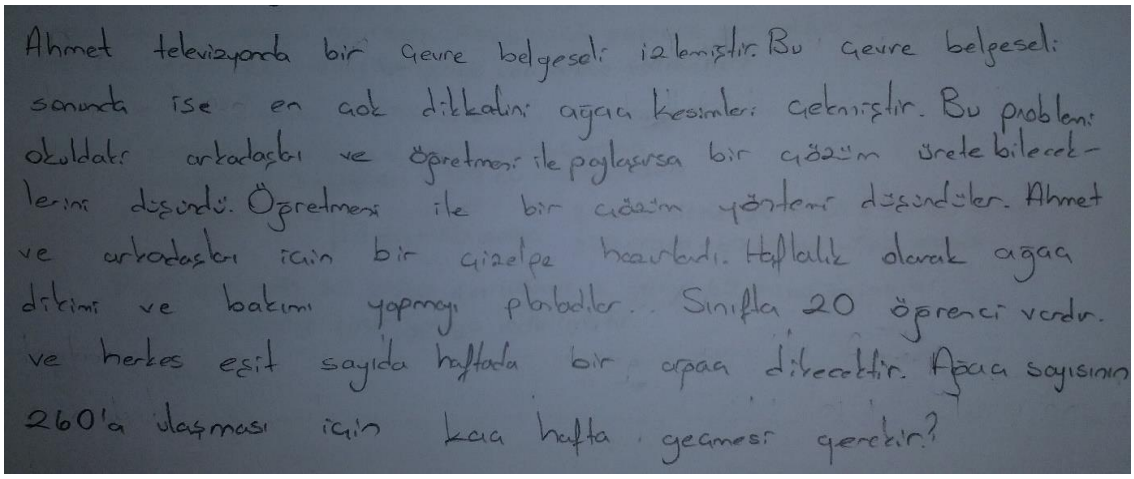

Figure 3. A sample problem considered in the real life problem category

As can be seen in Figure 3, the pre-service teacher posed a problem with the context of environment and at the same time he/she presented the problem like a scenario that has been experienced or can be experienced in real life. Thus, this problem can be considered in the real life problem category.

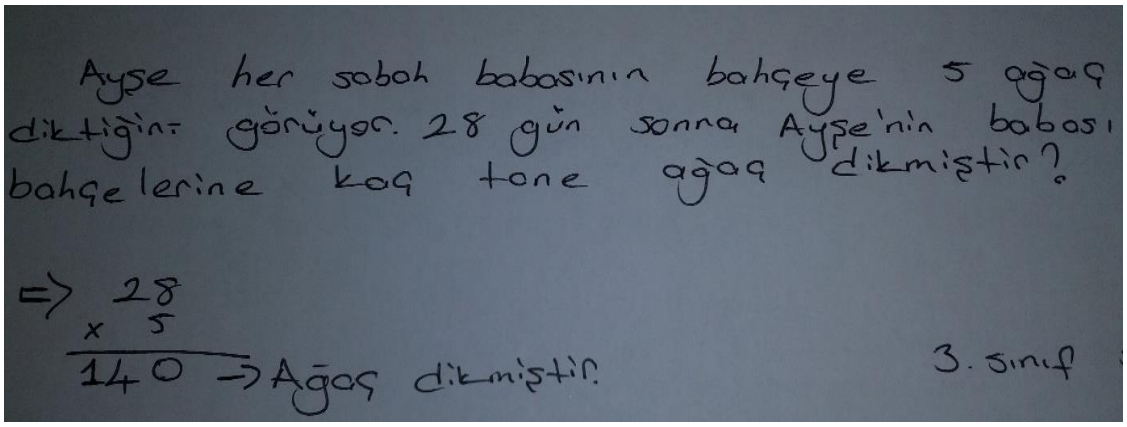

Figure 4. A sample problem considered in the routine problem category

As can be seen in Figure 4, the pre-service teacher posed a routine problem without using any real life situation in the form of an exercise. In such problems, students can reach the solution just by applying the required arithmetic operation skills in the correct sequence without needing to use their skills of relating to real life. In fact, it is seen that the context of environment selected for relating this problem to real life remains highly faint in the background.

Results and Discussion

In the current study, in which the problems posed by the pre-service primary school teachers with the context of environment were examined, first which environment-centred contexts were used in these problems was investigated. In this regard, first how

these contexts were used was examined and it was found that most of the pre-service teachers used more than one environmental context in connection with each other in their problems. Thus, these pre-service teachers' skill of relating environmental contexts with to other can be said to be at the desired level. On the other hand, the relating skill of the pre-service teachers who used only one single environmental context in their problems needs to be developed. Today, together with the increasing environmental problems, training conscious and sensitive individuals about the environment is seen as an effective way to prevent and combat the problems (Uzun & Sağlam, 2006). In the next analysis of the current study on the concept of environment, which environmental contexts were used in the problems posed by the pre-service teachers was investigated. It was seen that the pre-service teachers used the contexts of waste, garbage and forestation in their problems relatively more frequently. In this regard, it can be said that as the pre-service teacher encounter these three contexts in their daily lives more frequently, they preferred these three contexts more than the other contexts. Yücel and Özkan (2014) found that in the responses given to the key term of environment by the pre-service teachers that both the kinds of responses and their total frequencies are more than the types of responses and their frequencies related to the artificial environment. In the current study, as the environmental contexts were asked to be presented within a problem statement and as the pre-service teachers did not have enough information about other contexts, it can be argued that they could not design a suitable problem statement; therefore, they preferred simpler contexts for themselves. Within the second sub-problem of the current study, the suitability of the problems posed by the pre-service teachers for the grade level indicated and their state of solvability were examined. Almost all of the pre-service teachers were found to have posed a solvable problem. The problem posing skills of these pre-service teachers can be said to be at two different levels. On the other hand, very few pre-service teachers failed in the problem posing processes. In another study examining the problem posing skills of pre-service primary school teachers, it was concluded that approximately 20% of the pre-service teachers could not pose problems suitable for the stated objectives (Tekin-Sitrava & Işık, 2018). The reason for this failure may be the lack of problem posing skills, but this alone may not be sufficient because the pre-service teachers may have failed in the problem posing processes as they could not correctly associate the suitable environment context with mathematical processes. Under this sub-problem, the pre-service teachers were asked to indicate the grade level of the elementary school for which the problem they posed is suitable, regardless of the environmental context. In this connection, more than half of the pre-service teachers correctly stated for which grade level the problem they posed is suitable. It can be said that these pre-service teachers' levels of curriculum knowledge that can be considered within the scope of content knowledge are sufficient. Within the context of the third sub-problem of the current study, it was examined which kinds of problems pre-service teachers preferred to pose in terms of types and content standarts. As stated at the beginning of the current study, the organization of educational activities around a context in science and mathematics education enables the accomplishment of meaningful learning by increasing the relevance of these two main areas to real life. In the current study, the concept of environment was used as a context to ensure the real-life suitability of the problems posed by the pre-service teachers. As expected the results showed that most of the pre-service teachers posed mathematical problems suitable for real life. It can also be said that these pre-service teachers' mathematical problem posing skills as well as their interdisciplinary and real-life relating skills are good. According to Christou, Mousoulides, Pittalis, Pitta-Pantazi & Sriraman (2005), problem posing is an important component of both pure and applied mathematics and is also an integral part of modelling cycles in which mathematics is related to real life. However, 30% of the pre-service teachers posed routine problems having a very limited relevance to real life

although they were given a context that could facilitate association with real life. Although no problem in the problem posing skills of the pre-service teachers who posed routine problems was found in terms of the process, it can be said that their real-life skills are insufficient. Serin (2019) conducted a study to analyze the pre-service primary school teachers' semi-structured problem posing processes and concluded that the pre-service teachers tended to form more routine types of problems. Another reason to explain why the real life connection could not be established sufficiently might be that the pre-service teachers' level of knowledge about the selected environmental context is not adequate enough to establish such a connection. Within the context of this sub-problem, it was also observed that the problems posed by the pre-service primary school teachers with the context of environment were mostly directed towards the numbers and operations content standart in the field of mathematics. It was found that the pre-service teachers preferred the measurement content standart less in the problems they posed. In the current study, only which environmental contexts were involved in the problems and their frequency of inclusion in the problems were examined. Future studies can focus on the elicitation of pre-service teachers' opinions to understand which contexts are preferred and why. Interviews with pre-service teachers on the nature of the problems they have posed can be conducted. In this way, why they have preferred routine types of problems rather than real life problems can be investigated in depth.

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RESEARCH ARTICLE

Sınıf Öğretmeni Adaylarının Çevre Bağlamlı Kurdukları Problemlerin Analizi

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Özet

Bu çalışma, sınıf öğretmeni adaylarının çevre bağlamlı kurdukları matematiksel problemlerin hem çevre hem de matematiksel süreçler kapsamında analiz edildiği disiplinler arası bir çalışmadır. Nitel araştırma yöntemi kapsamında yer alan durum çalışması desenine göre tasarlanan bu araştırmada 75 sınıf öğretmeni adayı katılımcı olarak yer almıştır. Veriler, öğretmen adaylarının çevre bağlamlı olacak şekilde serbest tarzda kurdukları matematiksel problemler aracılığıyla toplanmıştır. Çalışmada çevresel bağlamlar içerik analizi, problem kurma süreçleri ise betimsel analiz yaklaşımına göre analiz edilmiştir. Araştırma sonuçlarına göre öğretmen adayları kurdukları problemlerde çoğunlukla birden fazla çevresel bağlama yer vermeyi tercih etmiş; bunlar içerisinde de ön plana atık, çöp, ağaçlandırma ve hava kirliliği bağlamları çıkmıştır. Kurulan problemlerde değinilen bağlamlar kirlilik unsurları, doğa olayları, yapay çevre, biyotik çevre, abiyotik çevre ve geri dönüşüm temaları altında toplanmıştır. Kurulan problemler matematiksel süreçler kapsamında incelendiğinde ise oldukça yüksek oranda çözülebilir problemler kurulduğu görülmüştür. Öğretmen adaylarının yine çoğunlukla çevre bağlamının yapısına uygun şekilde gerçek hayat temelli problemler kurdukları tespit edilmiştir. Bununla birlikte öğretmen adaylarının %30' undan fazlasının kurdukları problemlerin hem matematiksel süreçler hem de tercih ettikleri çevre bağlamı bakımından ilkokulun hangi sınıf seviyesi için uygun olduğunu doğru şekilde ifade edemedikleri görülmüştür.

Anahtar Kelimeler: Çevre, gerçek hayat, bağlam, problem kurma.

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