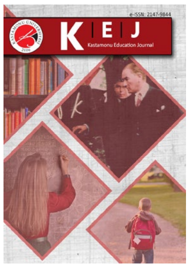
Kastamonu Education Journal, 2022, Vol. 30, No:1, 141-160
doi: 10.24106/kefdergi. 801083



| Research Article / Araştırma Makalesi |

Examination of Preservice Teachers' Skills in Classifying Learning Objectives and Problem Posing Involving Fractions

Öğretmen Adaylarının Kesirler Konusuna Yönelik Kazanım Sınıflandırma ve Problem Kurma Becerilerinin İncelenmesi[1]

Okan Kuzu[2], Osman Çil[3]

Keywords
1. Fraction
2. Problem posing
3. Knowledge
4. Cognitive process
5. Classification

Anahtar Kelimeler
1. Kesir
2. Problem kurma
3. Bilgi
4. Bilişsel süreç
5. Sınıflandırma

Received/Başvuru Tarihi
28.09.2020

Accepted / Kabul Tarihi
05.02.2021

Abstract

Purpose: This study investigated how primary school preservice mathematics teachers and preservice classroom teachers classified the learning objectives and problems about fractions in terms of knowledge and cognitive processes. In addition, the study examined how preservice teachers posed problems about the learning objectives regarding fractions and what kind of errors they made in this process.

Design/Methodology/Approach: Designed with the mixed research model, the study was carried out during the 2019-2020 academic year with the participation of 55 preservice middle school mathematics teachers and 101 preservice classroom teachers. It was determined nine objectives about "Fractions" and "Operations with Fractions" from the 2018 Mathematics Curriculum, and the preservice teachers were asked to classify these objectives in terms of knowledge and cognitive process dimensions of the revised Bloom's taxonomy and to pose suitable problems for each of these objectives.

Findings: Analyses conducted in the framework of the study showed that while classifying the learning objectives at the level of understanding and applying, both primary school preservice mathematics teachers and preservice classroom teachers confused the steps of recognizing fractions and using fractions and obtained a low rate in regards to accurate classification. Regarding the knowledge dimension, it was observed that the preservice teachers did not confuse the learning objectives with each other at the conceptual and procedural knowledge level and performed a moderately accurate classification. On the other hand, it was concluded that both preservice middle school mathematics teachers and preservice classroom teachers were able to pose accurate problems in line with the knowledge process and cognitive process dimensions relevant to the learning objectives, but they did not have the same performance in classifying the problems prepared for these objectives. The errors made by preservice teachers in the process of problem posing were collected under three categories as "problems not relevant to the learning objective ", "limitations regarding subject matter knowledge" and "limitations in problem posing skills".

Highlights: it is concluded that it is very important for preservice teachers in the learning and teaching process to problem posing in line with the behavior to be measured in terms of knowledge and cognition by paying attention to the purpose of the learning objective.

Öz

Çalışmanın amacı: Bu çalışmada, kesirler konusuna ait kazanımların ve problerin ilköğretim matematik ve sınıf öğretmeni adayları tarafından bilgi ve bilişsel süreç açısından nasıl sınıflandırıldıkları incelenmiştir. Ayrıca, öğretmen adaylarının kesirler konusuna ait kazanımlara yönelik nasıl problem kurdukları ve problem kurma sürecinde ne tür hatalar yaptıkları belirlenmiştir.

Materyal ve Yöntem: Karma araştırma modeli ile tasarlanan bu çalışma 2019-2020 eğitim öğretim yılında, 55 ilköğretim matematik ve 101 sınıf öğretmeni adayının katılımıyla gerçekleştirilmiştir. 2018 matematik dersi öğretim programında yer alan "Kesirler" ve "Kesirlerle İşlemler" konularına ait dokuz kazanım belirlenmiş ve adaylardan bu kazanımları revize edilmiş Bloom taksonomisinin bilgi ve bilişsel bilişsel süreç boyutları açısından sınıflandırmaları ve bu kazanımlara uygun bir problem kurmaları istenmiştir.

Bulgular: Yapılan analizler sonucunda, bilişsel süreç boyutu açısından hem ilköğretim matematik hem de sınıf öğretmeni adaylarının anlamak ve uygulamak basamağındaki kazanımları sınıflandırırken birbiri ile karıştırdıkları ve düşük oranda doğru bir sınıflandırma yaptıkları görülmüştür. Bilgi boyutu açısından ise adayların kavramsal ve işlemsel bilgi basamağındaki kazanımları sınıflandırırken birbiri ile karıştırmadıkları ve orta oranda doğru bir sınıflandırma yaptıkları görülmüştür. Diğer taraftan, bu çalışmada, hem ilköğretim matematik hem de sınıf öğretmeni adaylarının kazanımın bilgi ve bilişsel süreç boyutuna uygun problem kurabildikleri görülürken, kazanımları ve bu kazanımlara yönelik hazırlanan problemleri sınıflandırmada ise aynı performansı sergileyemedikleri dikkatleri çekmiştir. Adayların problem kurma sürecinde yaptıkları hatalar incelendiğinde ise hataların "kazanım dışı sorular", "alan bilgisine yönelik sınırlılıklar", "problem kurma becerisine yönelik sınırlılıklar" şeklinde üç kategori altında toplandığı görülmüştür.

Önemli Vurgular: Adayların problem kurma sürecinde kazanımın eğitsel amacına ve ifadesine dikkat ederek, bilgi ve bilişsel süreç açısından ölçülmek istenilen davranışa uygun problem kurulmasının öğrenme ve öğretme sürecinde oldukça önemli olduğu düşünülmektedir.

[1] A part of this study was presented as an oral presentation at the International Online Conference on Mathematics Education in between May 26-29, 2021.
[2] **Corresponding Author,** Kirsehir Ahi Evran University, Faculty of Education, Department of Mathematics and Science Education, Kirsehir, Turkey, okan.kuzu@ahievran.edu.tr, https://orcid.org/0000-0003-2466-4701
[3] Kirsehir Ahi Evran University, Faculty of Education, Department of Primary Education, Kirsehir, Turkey, ocil@ahievran.edu.tr, https://orcid.org/0000-0001-5903-9864

Citation/Alıntı: Kuzu, O., & Çil, O. (2022). Examination of preservice teachers' skills in classifying learning objectives and problem posing involving fractions, *Kastamonu Education Journal, 30*(1), 141-160. doi: 10.24106/kefdergi.801083

INTRODUCTION

Mathematics, whose importance is increasing day by day, forms the basis of many studies from past to present and it is the common language and thought of people. People learn mathematics based on intuition just as they learn their mother tongue before they learn how to read and write and many mathematical concepts and techniques are listed while thinking, a chain of thinking is formed and creative solutions emerge just as words are ordered in line with certain rules and structures while speaking (Umay, 1996). After this thinking process takes place in the mind, new ideas and ways can be generated thanks to performance-based activities and by using this creativity, alternative solutions can be offered for the problems that are encountered.

Measurement and evaluation approach, which is one of the most important components of the curriculum in recent years, has been adapting itself to improve students' creativity and contribute to their problem-solving skills. Measurement and evaluation is used to evaluate to the extent of achievement regarding the program objectives, whether the course content has been understood or not, the achieved skills and the level of these skills. Measurement is required to ensure that the evaluation is accurate, and a correct measurement tool is needed for the measurement to be done in the correct manner (Akpınar, 2003). Since mathematics includes more cognitive acquisitions (MoNE, 2018a), oral, written (short-answer, long-answer) and objective (multiple-choice, true-false, matching, completion) tests, which are cognitive behavioral measurement tools, may be more appropriate to use.

Oral tests are a type of non-written assessment in which questions and answers are provided orally. Written tests are a type of non-objective test in which questions and answers are presented in writing. Objective tests, on the other hand, are a type of assessment that requires more expertise and knowledge in the preparation stage than oral and written tests and has an objective evaluation. In the objective test type, students' difficulty and discrimination levels can be determined with more ease, and psychometric properties such as validity and reliability can be examined more easily (Umay, 1996). However, it has been argued that objective tests limit students to the given options and hinder the assessment of high-level cognitive skills such as judgment, interpretation, analysis, evaluation and creation (Üstüner & Şengül, 2004), and it is emphasized that the use of oral and written tests is more appropriate to measure these skills (Umay, 1993). In addition, it is stated within the framework of the 2023 Education Vision that measurement tools that support high-level cognitive skills are important for students to achieve high performance in international exams and to associate the problems presented in the learning process with daily life (MoNE, 2018b). For example, international large-scale exams like PISA, do not aim to measure how much the students learn, but how much they reflect the knowledge to the society (OECD, 2007), and this situation is reflected more with open-ended problems (Öksüz & Güven, 2019). Open-ended problems are reported to contribute to students' perception, thinking and implementation skills (Badger & Thomas, 1992; Cooney, Sanchez, Leatham, & Mewborn, 2004), to be more appropriate for measuring higher-order thinking skills than other problem types (Bahar, Nartgün, Durmuş, & Bıçak, 2012) and to allow students to make interpretations and think creatively in the process of solving daily life problems (Akay, Soybaş, & Argün, 2006; Öçal, İpek, Özdemir, & Kar, 2018). The suitability of open-ended problems prepared to measure high-level cognitive skills for students in mathematics is closely related to the creativity levels of educators who prepare these problems (Umay, 1996).

Teachers undertake the responsibility to prepare and implement the problems and to interpret the results correctly to determine students' performance (Küçükahmet, 2006). While teachers prepare their problems, they sometimes change only the figures on the existing, readymade problems and this may prevent the students from thinking creatively and producing new ideas. However, the correct preparation and effective use of problems makes it easier to determine students' understanding levels, to increase their participation and motivation more easily, and to raise their knowledge and cognitive skills to higher levels (Ralph, 1999). For example, problems that have only one correct answer that can be easily figured out cause students and teachers not to use their thinking skills sufficiently, while high-level problems are very useful in developing students' skill to access information, testing their own knowledge, recognizing problems and producing solutions for them (Koray, Altunçekiç, & Yaman, 2005; Feldhusen, 1985). Hence, it would be more appropriate to prepare the problems to fit the purpose and objectives, rather than random selection of items, so that students can develop all the required cognitive skills. Learning objectives have an important place in the regulation, implementation and evaluation of these goals and objectives (MoNE, 2018a). Since primary school mathematics course learning objectives are predominantly cognitive, it would be a more appropriate approach to use a cognitive taxonomy in classifying the problems to be prepared for these outcomes.

Bloom's taxonomy, which has a cognitive structure, is widely accepted by educators in interpreting the standards in mathematics and classifying upper and lower thinking skills (Arı, 2013; Näsström, 2009). Bloom's taxonomy, which has a hierarchical structure from low cognitive skills to high cognitive skills, previously consisted of six steps from simple to complex information, comprehension, application, analysis, synthesis and evaluation (Bloom et al., 1956). Based on the results of the studies carried out over time, it was reported that the one-dimensional classification was insufficient for in-depth analyses and therefore the taxonomy was revised to support a two-dimensional structure (Anderson et al., 2001). It was argued that the synthesis step includes more complex mental processes compared to the evaluation step; the incompatibility between them has been eliminated by changing their places in the taxonomy. In addition, the steps in the cognitive process dimension were named by using verbs (emphasizing the actions) rather than using nouns and rearranged as remembering, understanding, applying, analyzing, evaluating and creating (Anderson et al., 2001). Here, remembering, understanding and applying steps are considered as low-level cognitive processes while analyzing, evaluating and creating steps are accepted as high-level cognitive processes

(Crowe, Dirks & Wenderoth, 2008). In addition, a knowledge dimension consisting of factual, conceptual, procedural and metacognitive knowledge steps has been added to the revised Bloom's taxonomy in order to express cognitive terminology more clearly. Each step in the dimension of knowledge in the vertical column and the dimension of cognitive process in the horizontal column also includes the other steps under it, and abstraction, complexity and scope increase as one moves up to the higher order levels (Krathwohl, 2002).

Table 1. The structure of knowledge and cognitive process dimensions of the revised Bloom's taxonomy (Krathwohl, 2002)

Cognitive Process Dimension					
Remember	Understand	Apply	Analyze	Evaluate	Create
Retrieving relevant knowledge from long-term memory	Determining the meaning of instructional messages, including oral, written, and graphic communication	Carrying out or using a procedure in a given situation	Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose	Making judgments based on criteria and standards	Putting elements together to form a novel, coherent whole or make an original product
Recognizing *Recalling*	*Interpreting* *Exemplifying* *Classifying* *Summarizing* *Inferring* *Comparing* *Explaining*	*Executing* *Implementing*	*Differentiating* *Organizing* *Attributing*	*Checking* *Critiquing*	*Generating* *Planning* *Producing*

Knowledge Dimension			
	Factual knowledge	The basic elements a student must know to be acquainted with a discipline or solve problems in it.	*Terminology* *Specific details and elements*
	Conceptual knowledge	Interrelationship among basic elements in a larger structure that allows them to function together	*Classifications and categories* *Principles and generalizations* *Theories, models and structures*
	Procedural knowledge	How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods	*Subject-specific skills/processes* *Subject-specific techniques/methods* *Criteria for determining when to apply suitable procedures.*
	Metacognitive knowledge	Knowledge of cognition in general, awareness and knowledge of one's own cognition	*Strategic knowledge* *Cognitive tasks, appropriate contextual and conditional knowledge* *Self-knowledge*

The level of problems used to measure higher-order thinking skills is very important (Aslan, 2011). For example, a problem at the level of factual knowledge leads students to remember and memorize, while a problem at the level of metacognitive knowledge leads students to use their existing knowledge and to think effectively with this knowledge (Paul, 1995; Doğanay & Ünal, 2006). The problems used both in textbooks and in the classroom settings from the first years of primary education should be prepared in a manner to improve students' thinking skills (Elder & Paul, 2003; Goatly, 2000). The quality and relevance of these problems contribute to the increase in student motivation for the courses, encourage them and significantly affect their future achievement (Belcastro, 2017; Carr, 1998; Jones, 2008). For this reason, preparing relevant problems for the learning objectives in line with the aims and objectives of the program is believed to be important in developing students' thinking skills and evaluating them accurately. It is also reported that the problems prepared in accordance with the learning objectives classification prevent accumulation in certain steps and help the teacher in determining students' cognitive levels (Büyükalan, 2007; Özden, 1998).

The relevant literature points out that the studies in the field mostly investigated the level of problems prepared to measure the students (Alexander et al., 1994; Aydemir & Çiftçi, 2008; Baysen, 2006; Çalışkan, 2011; Dursun & Aydın-Parim, 2014; Jesus & Moreira, 2009; Koray & Yaman, 2002; Köğce & Baki, 2009; Özcan & Akcan, 2010; Geçit & Yazar, 2010; Gökler, Arı, & Aypay, 2012; Gündüz, 2009; Ülger, 2003). It was observed in these studies that the problems were mostly prepared at the lower levels, and higher level problems that required higher-order thinking skills were not encountered very often. The studies in literature focusing on teachers' skill to prepare problems (Çakıcı, Ürek, & Dinçer, 2012; Erdoğan, 2017; Marbach-Ad & Sokolove, 2000; Yeşilyurt, 2012; Yılmaz & Keray, 2012) were mostly conducted in the fields of Turkish and Science and generally included the classification of prepared problems. The studies examining students' and teachers' problem posing skills also focused on the fields of Turkish and Science, and the studies examining the problem posing skills for the learning objectives in mathematics were rather limited.

Regarding the fact that mathematics is used as a tool in solving problems encountered in daily life, it may be easily comprehended seen that natural numbers, which are frequently used in daily life, are not enough for some mathematical calculations. For example, if 3 apples are to be shared equally among 2 children, the operation (the number of apples per child) cannot be executed with natural numbers (Baykul, 2014). Also, the set of natural numbers, which are closed under addition and multiplication, is not closed under subtraction and division. The set of natural numbers, which is insufficient in terms of subtraction and division operations, has been expanded and the set of integers has been obtained with an expansion so that subtraction can be done, and the set of rational numbers has been expanded so that division can be done (Baykul, 2005). The set of rational numbers and fractions are presented to students in relation to each other, and at this stage, the part-whole relationship becomes important (MoNE, 2018a). Therefore, fractions are defined as each or a few of the equal parts of a whole (Baykul, 2014). The fact that fractions have their own abstract meanings and are not used much in daily life forms the basis of why it is one of the difficult subjects to learn and teach (Albayrak, 2000; İpek, Işık, & Albayrak, 2005). Similarly, the studies in the literature (Aksu, 1997; Alacaci, 2012; Behr, Lesh, Post & Silver, 1983; Biber, Tuna, & Aktaş, 2013; de Castro, 2008; Işık & Kar, 2012; Işık, Öçal, & Kar, 2013; Kar & Işık, 2015; Kocaoğlu & Yenilmez, 2010; Moss, & Case, 1999; Okur, Çakmak-Gurel, 2016; Olkun & Toluk-Uçar, 2012; Pesen, 2008; Soylu & Soylu, 2005; Soylu, 2008; Stafylidou & Vosniadou, 2004; Tirosh, 2000; Ünlü & Ertekin, 2012; Wu, 1999) demonstrate that students have learning difficulties regarding the concept of fractions as well as the operations related to fractions. In that case, preparing appropriate problems for the subject of operations with fractions can help improve the cognitive levels of students and create a more effective and permanent learning environment since this subject includes an important conceptual expression such as the part-whole relationship and which can be used frequently in daily life problems but is one of the difficult subjects to learn.

This study examined how the learning objectives and problems on the subject of fractions were classified in terms of knowledge and cognitive process dimensions of the revised Bloom's taxonomy by primary school preservice mathematics and preservice classroom teachers. In addition, the study set out to determine how the preservice teachers posed problems about the learning objectives related to fractions and what kind of errors they made during the problem posing process.

METHOD/MATERIALS

Research Model

Quantitative and qualitative data, which had equal importance for the purpose of the research, were collected at the same time in this study which utilized the simultaneous transformational design of the mixed research model. Case study model was used as the quantitative research model while the survey model was selected as the qualitative research model. According to Cresswell (2009), using qualitative and quantitative approaches together enables us to better understand research problems

Participants

The research participants consisted of 55 preservice mathematics teachers and 101 preservice classroom teachers studying at the education faculty of a state university in Turkey during the 2019-2020 academic year. Convenience sampling method was used in the selection of the relevant university while the criterion sampling method, one of the purposive sampling methods, was used in the selection of primary school preservice mathematics and classroom teachers studying at this university. Criterion sampling is the selection of people, objects or situations that are predetermined with certain conditions (Patton, 2002). In this study, the criterion for the selection of the primary school preservice mathematics and classroom teachers was designated as attending a course on teaching mathematics during the undergraduate education process.

Data Collection and Analysis

A test consisting of two items was prepared by the researchers in this study to examine the classification of learning objectives and problem posing skills regarding fractions (see Appendix 1). The first test item included nine objectives about "Fractions" and "Operations with Fractions" from the 2018 Mathematics Curriculum, and the preservice teachers were asked to classify these objectives in terms of knowledge and cognitive process dimensions of the revised Bloom's taxonomy and to pose suitable problems for each of these objectives. The second item included 14 problems on "Fractions" and "Operations with Fractions" and the candidates were asked to classify these problems in terms of knowledge and cognitive process dimensions of Bloom's taxonomy.

Firstly, the 2018 mathematics curriculum was examined while the test was being developed and it was observed that the subject of "Fractions" was taught in grades 1-5 and the subject of "Operations with Fractions" was taught in grades 4-6 under the "Numbers and Operations" learning area. Since including all the learning objectives in the program may cause boredom and result in a loss of interest, attention and motivation for the participants during the implementation, the test focused on a limited number of learning objectives. In this context, all the learning objectives on the subject of fractions and operations with fractions were examined for grades 1-6 and attention was paid to include the learning objectives that serve different purposes or competencies in order to avoid being redundant.

In addition, the more complex learning objective was included in the test when one learning objective was the natural progression of others within the same class level. For example, the learning objective at 6th Grade "*A.6.1.5.6. Performs the division of two fractions and makes sense of them*" is more complex than the following learning objective, since the learning objective presented above is a natural progression of the similar objectives preceding it: "*A.6.1.5.5. Divides a natural number by a fraction and a fraction by a natural number*, and *makes sense of this operation*". For this reason, the learning objective *A.6.1.5.6* was included in the test. In addition, similar learning objectives that serve the same learning purpose and competence in the program are taught at different grade levels. Since this study focused on primary school preservice mathematics and classroom teachers, test problems were created for the similar learning objectives by paying attention to the learning objective presented in the highest grade level. For example, "*A.1.1.4.1. Shows the concept of whole and half with appropriate models and explains the relationship between the whole and the half*" learning objective at the first grade level is expressed as follows in the second grade "A*.2.1.6.1. Shows the concept of whole, half and quarter with suitable models; explains the relationship between the whole, half, and quarter*". For this reason, the second grade learning objective was taken into account due to being more complex and comprehensive among the similar learning objectives relevant to the subject.

Nine learning objectives presented in the first item of the test and 14 problems related to learning objectives in the second item were coded independently by the researchers, taking into account Krathwohl's (2002) table, which includes knowledge and cognitive process dimensions, and the inter-coder reliability was calculated as .818 using Cohen's kappa statistics (Fleiss & Cohen, 2008). 1973). Kappa statistic takes a value between -1 and +1 and it is recommended to be at least .60. Values between 60 and 80 indicate good agreement between encoders, and values above .80 indicate a very good agreement between encoders (Fleiss & Cohen, 1973; Landis & Koch, 1977; Wood, 2007). In this context, the obtained inter-coder agreement was found to be at a very good level. In addition, the disagreements that occurred after the coding were re-evaluated by the researchers and a consensus was reached for all disagreements.

The test was applied to 55 preservice mathematics teachers and 101 preservice classroom teachers, and the content analysis method was used to analyze the qualitative data regarding the problem posing in the first problem. The two-dimensional table created by Krathwohl (2002) consisting of information/cognitive process dimensions was used as the coding key in the content analysis, and preservice teachers' knowledge and thought processes were investigated. Both the classification and content analysis of the problems posed by the candidates in accordance with the learning objectives were conducted independently by researchers who are experts in primary school mathematics and classroom education, and the agreement between the classifications was found to be .961 with Cohen's kappa statistics (Fleiss & Cohen, 1973). Three categories emerged as a result of the content analysis: problems not relevant to the learning objective", "limitations regarding subject matter knowledge" and "limitations in problem posing skills". Whether the problems represented these categories were calculated with the *consensus/(consensus + disagreement)* formula as .953 (Miles & Huberman, 1994). This value was regarded to be rather good as well in the study.

On the other hand, participants' accurate classification of the objective/problem in the first and second items of the test and their problems in accordance with the objective in the first item were examined and the data was coded as 1 for correct answers and 0 for incorrect or blank answers. The data obtained this way was transferred to SPSS 23 (Statistical Package for the Social Sciences 23) program and the reliability of the test was calculated as .747. In addition, using these quantitative data, the percentages of correct classification of the objectives and problems regarding fractions were examined as well as the percentages of posing the correct problems suitable for the objectives. The findings for this study are as follows: $0 \leq \text{percentage} \leq 20$: Very low, $20 < \text{percentage} \leq 40$: Low, $40 < \text{percentage} \leq 60$: Moderate, $60 < \text{percentage} \leq 80$: High, $80 < \text{percentage} \leq 100$. The results were found to be very high

FINDINGS

This section presents the findings about how primary school preservice mathematics and classroom teachers classified the learning objectives and the problems prepared for the subject of fractions, how they posed problems in line with the learning objectives, and what errors were found in the problems they posed.

Quantitative Findings of the Study

This section examined how the candidates classified the learning objectives and the problems on fractions in terms of knowledge and cognitive process dimensions of the revised Bloom's taxonomy and how they posed problems suitable for the learning objectives. The findings are presented below in tables.

Table 2. Percentage distribution of the classification of the learning objectives prepared in the steps of understanding and applying in terms of the cognitive process dimension

Learning objectives Classification	Primary Mathematics Education						Classroom Education					
	R	U	A	An	E	C	R	U	A	An	E	C
Understand	5.90	26.81	25.45	25.90	10.90	2.72	3.21	33.41	39.35	14.85	1.98	-
Apply	4.36	26.54	29.09	17.81	8.00	10.18	6.73	26.33	39.00	13.26	2.17	4.55

R: Remember, U: Understand, A: Apply, An: Analyze, E: Evaluate, C: Create

Table 2 shows that the learning objectives prepared at the level of understanding for the subject of fractions were classified as understanding by 26.81% of the primary school preservice mathematics teachers. Although the majority of the preservice mathematics teachers concentrated on understanding and made the accurate classification, it was observed that 25.45% of the preservice teachers were inaccurate with a percentage close to each other (applying by 25.45% and analyzing by 25.90%). It was seen that the learning objectives prepared at the level of understanding were misclassified as applying by 39.35% of the primary school preservice classroom teachers, and correctly classified by 33.41% of the primary school preservice classroom teachers. On the other hand, it was found that the learning objectives prepared at the level of applying were classified correctly by 29.09% of the primary school preservice mathematics teachers. However, 26.54% of primary school preservice mathematics teachers classified these as understanding and misclassified them with a percentage close to the level of applying. It was observed that 39.00% of primary school preservice classroom teachers classified the learning objectives prepared at the level of applying correctly, while 26.33% of the primary school preservice classroom teachers classified them incorrectly as understanding. In this context, it was observed that both primary school preservice mathematics and classroom teachers confused the learning objectives at the level of understanding and applying with each other and had a low rate of correct classification.

Table 3. Percentage distribution of the classification of the learning objectives prepared in conceptual and procedural steps in terms of the knowledge dimension

Learning objectives Classification	Primary Mathematics Education				Classroom Education			
	F	C	P	M	F	C	P	M
Conceptual	13.63	44.54	27.27	7.72	9.40	57.42	26.23	.49
Procedural	11.27	17.81	50.90	13.81	20.19	15.44	49.90	4.55

F: Factual, C: Conceptual, P: Procedural, M: Metacognitive

Table 3 demonstrates that the learning objectives prepared at the conceptual knowledge level for the subject of fractions were mostly identified to be in the conceptual knowledge level by both primary school preservice mathematics teachers (44.54%) and primary school preservice classroom teachers (57.42%), and were classified correctly. Similarly, the preservice teachers stated that the learning objectives prepared in the procedural knowledge level were mostly in the procedural knowledge level and again the learning objectives were classified correctly. In this context, it was seen that both primary school preservice mathematics and classroom teachers made a moderately correct classification when classifying the learning objectives in the conceptual and procedural knowledge level.

Table 4. Percentage distribution of the steps for which the problems were posed for the learning objectives prepared in the steps of understanding and applying in terms of cognitive process dimension

Learning objectives Classification	Primary Mathematics Education						Classroom Education					
	R	U	A	An	E	C	R	U	A	An	E	C
Understand	.90	78.18	12.27	.45	-	-	-	68.06	8.16	-	-	-
Apply	-	6.54	85.45	-	.72	1.09	-	2.77	66.53	-	-	-

R: Remember, U: Understand, A: Apply, An: Analyze, E: Evaluate, C: Create

Table 4 shows that both primary school preservice mathematics teachers (78.18%) and primary school preservice classroom teachers (68.06%) focused on *understanding* the most and posed correct problems in accordance with the cognitive process step. Similarly, it was determined that the participants mostly focused on *applying* in posing problems suitable for the learning objectives prepared at the level of *applying*, and they posed problems suitable for the cognitive process step. In this context, it was observed that both primary school preservice mathematics and classroom teachers posed a high percentage of correct problems in accordance with the learning objectives prepared at the level of *understanding*. It was determined that primary school preservice mathematics teachers posed correct problems at a very high rate and primary school preservice classroom teachers posed correct problems at a high rate for the learning objectives prepared at the level of *applying*.

Table 5. Percentage distribution of the steps for which the problems were posed for the learning objectives prepared in conceptual and procedural steps in terms of knowledge dimension

Learning objectives Classification	Primary Mathematics Education				Classroom Education			
	F	C	P	M	F	C	P	M
Conceptual	.90	77.72	12.72	.45	.24	67.32	8.16	-
Procedural	.36	13.81	77.81	1.81	-	10.09	58.01	1.18

F: Factual, C: Conceptual, P: Procedural, M: Metacognitive

Table 5 presents that both primary school preservice mathematics teachers (77.72%) and primary school preservice classroom teachers (67.32%) focused on the conceptual knowledge level the most and posed the right problems in accordance with the knowledge level. Similarly, it was determined that the participants mostly focused on the procedural knowledge level in posing problems suitable for the learning objectives prepared in the procedural knowledge level, and they posed problems appropriate for the knowledge level. In this context, it was found that both primary school preservice mathematics and classroom teachers posed a high percentage of correct problems in accordance with the learning objectives prepared in the conceptual knowledge level. For the learning objectives prepared in the procedural knowledge level, it was observed that the primary school preservice mathematics teachers posed problems at a high rate, while it was determined that the primary school preservice classroom teachers posed correct problems at a moderate rate.

Table 6. Percentage distribution of the level in which the problems prepared for fractions were classified in terms of cognitive dimension

Learning objectives Classification	Primary Mathematics Education						Classroom Education					
	R	U	A	An	E	C	R	U	A	An	E	C
Remember	58.18	17.27	9.09	2.72	3.63	.90	29.20	24.25	28.21	8.91	2.47	-
Understand	11.36	27.72	17.27	20.90	15.90	.45	5.69	40.84	21.78	17.07	8.41	-
Apply	3.03	13.33	38.18	17.57	16.96	4.24	2.97	17.16	51.15	18.81	3.30	.66
Analyze	.90	10.00	18.18	50.00	7.27	10.00	1.98	22.77	42.07	25.74	1.98	-
Evaluate	-	5.45	27.27	18.18	41.81	1.81	-	8.91	37.62	16.83	28.71	.99
Create	-	9.09	4.54	5.45	9.09	66.36	-	12.37	18.31	6.93	.99	55.44

R: Remember, U: Understand, A: Apply, An: Analyze, E: Evaluate, C: Create

Table 6 demonstrates that the problems prepared for the subject of fractions at the level of *remembering* were classified correctly as *remembering* the most by 58.18% of the primary school preservice mathematics teachers. Although it was observed that 29.20% of the primary school preservice classroom teachers classified them correctly as *remembering*, it was determined that 24.25% of the preservice teachers misclassified them with a percentage close to each other (*understanding* by 24.25% and *analyzing* by 28.21%). On the other hand, when the problems prepared in terms of *understanding* dimension were examined, it was seen that primary school preservice mathematics teachers (27.72%) and primary school preservice classroom teachers (40.84%) focused more on *understanding* than other steps and made accurate classifications. Similarly, the preservice teachers correctly classified the problems prepared at the level of *applying* compared to other options. While the problems prepared at the level of *analyzing* were correctly classified by 50.00% of the primary school preservice mathematics teachers, 42.07% of the primary school preservice classroom teachers had erroneous classification by focusing on *applying*. Only 25.74% of the primary school preservice classroom teachers made an accurate classification for the problems prepared at the level of *analyzing*. 22.77% of the primary school preservice classroom teachers made a wrong classification, by focusing on *understanding*, with a very close rate to the correct option. While 41.81% of primary school preservice mathematics teachers made a correct classification for the problems prepared at the level of *evaluating*, only 28.71% of the primary school preservice classroom teachers made a correct classification by qualifying the related problems as *evaluating*. However, 37.62% of the primary school preservice classroom teachers wrongly identified the problems prepared at the level of *evaluating* as *applying* and made a wrong classification. For the problems prepared at the level of *creating*, both primary school preservice mathematics teachers (66.36%) and preservice classroom teachers (55.44%) made a correct classification. In this context, the problems prepared at the level of *understanding* and *applying* were classified by primary school preservice mathematics teachers at a low rate; the problems prepared at the level of *remembering*, *analyzing* and *evaluating* were classified by primary school preservice mathematics teachers at a moderate rate and classified the problems prepared at the level of *creating* correctly at a high rate. On the other hand, primary school preservice classroom teachers correctly classified the problems prepared at the level of *remembering*, *analyzing* and *evaluating* at a low rate while they correctly classified the problems prepared at the level of *understanding*, *creating* and *applying* at a moderate rate. In addition, it was determined that the primary school preservice classroom teachers mixed up the problems prepared at the level of *remembering* with *understanding* and *applying* during classification, and they characterized the problems prepared at the level of *analyzing* and *evaluating* mostly as the level of *applying*.

Table 7. Percentage distribution of the level in which the problems prepared for fractions were classified in terms of knowledge dimension

Learning objectives Classification	Primary Mathematics Education				Classroom Education			
	F	C	P	M	F	C	P	M
Factual	51.81	26.36	11.81	3.63	54.45	17.32	19.30	.49
Conceptual	19.63	37.45	30.18	6.90	15.04	50.29	27.32	.39
Procedural	3.18	10.45	61.36	17.27	3.71	30.19	54.45	6.18
Metacognitive	7.87	15.15	29.09	40.60	2.97	23.76	38.94	26.40

F: Factual, C: Conceptual, P: Procedural, M: Metacognitive

Table 7 displays that the problems prepared at the factual knowledge level on the subject of fractions were classified correctly by 51.81% of primary school preservice mathematics teachers and 54.45% of primary school preservice classroom teachers. Although the problems prepared in the conceptual knowledge level were classified correctly by 37.45% of the primary school preservice mathematics teachers, it was determined that, with a similar percentage, 30.18% misclassified the problems to be prepared in the procedural knowledge level. On the other hand, it was seen that both primary school preservice mathematics teachers (61.36%) and primary school preservice classroom teachers (54.45%) concentrated on the procedural knowledge level the most in the classification of the problems prepared in the procedural knowledge level. While it was observed that 40.60% of the primary school preservice mathematics teachers made a correct classification for the problems prepared in the metacognitive knowledge level, it was determined that 38.94% of the primary school preservice classroom teachers opted for the procedural knowledge level and made a wrong classification. Only 26.40% of the primary school preservice classroom teachers made a correct classification for the problems prepared in the metacognitive knowledge level.

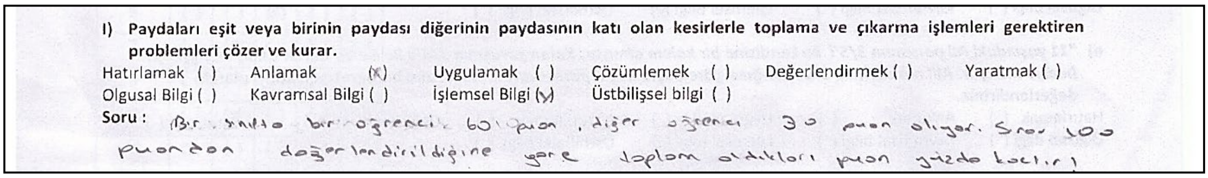
It was observed that 23.76% of the primary school preservice classroom teachers made a misclassification about the problems as conceptual knowledge, which was a rate close to the rate of teachers who had accurate classification. In this context, the problems at the conceptual knowledge level were classified accurately by preservice mathematics teachers at a low rate; the problems at the factual and metacognitive knowledge level were classified accurately at a moderate rate and the problems at the procedural knowledge level were classified accurately at a high rate. In addition, it was determined that the primary school preservice mathematics teachers confused the problems prepared at the conceptual knowledge level with the problems prepared at the procedural knowledge level during classification, while the primary school preservice classroom teachers identified the problems at the metacognitive knowledge level as procedural knowledge level.

Qualitative Findings of the Study

This section investigated the kind of mistakes made by the primary school preservice mathematics and classroom teachers regarding the problems about fractions and learning objectives, and the findings were presented as examples collected under appropriate categories.

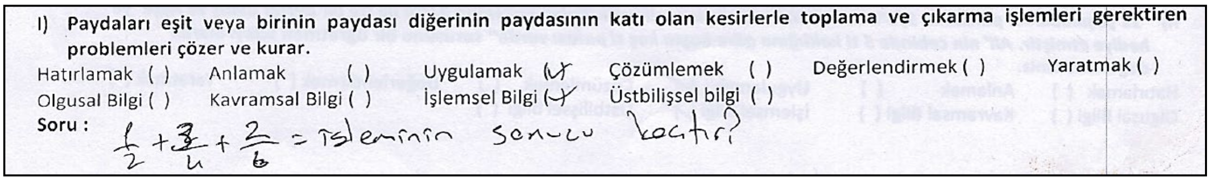
Problems which were irrelevant to the learning objective

Examination of the irrelevant problems posed by the preservice teachers pointed to two problems. The qualitative findings related to these problems are presented below as examples. The first of these problems was related to the fact that preservice teachers posed problems that measured a different learning objective other than the intended one, which was not related to the statement or the level of the learning objective in terms of knowledge and cognitive dimensions. For example, primary school preservice mathematics teacher M2 focused on integers contrary to what was desired in the learning objective, addressed the percentage problem and ignored the cognitively higher level action of posing a problem:


l) Paydaları eşit veya birinin paydası diğerinin paydasının katı olan kesirlerle toplama ve çıkarma işlemleri gerektiren problemleri çözer ve kurar.
Hatırlamak ( ) Anlamak (X) Uygulamak ( ) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi ( ) İşlemsel Bilgi (X) Üstbilişsel bilgi ( )
Soru : Bir sınıfta bir öğrenci 60 puan, diğer öğrenci 30 puan alıyor. Sınav 100 puandan değerlendirildiğine göre toplam aldıkları puan yüzde kaçtır

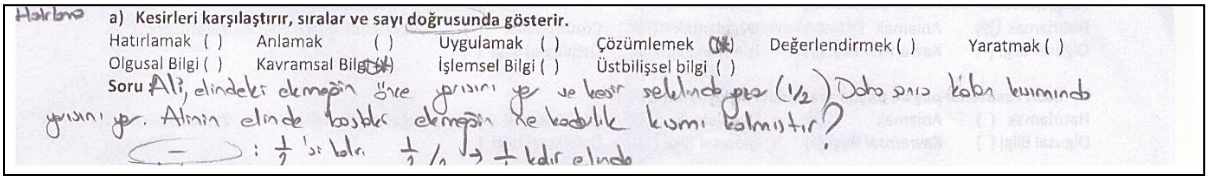
(Problem: In a class, one student gets 60 points and the other student gets 30 points. Since the exam is evaluated out of 100 points, what is the percentage of the total score they get)

It was observed that the preservice classroom teacher C8 posed a problem that could measure the skills of adding with fractions instead of posing a problem that would measure problem solving and posing skills:


l) Paydaları eşit veya birinin paydası diğerinin paydasının katı olan kesirlerle toplama ve çıkarma işlemleri gerektiren problemleri çözer ve kurar.
Hatırlamak ( ) Anlamak ( ) Uygulamak (X) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi ( ) İşlemsel Bilgi (X) Üstbilişsel bilgi ( )
Soru : $\frac{1}{2}+\frac{3}{4}+\frac{2}{6}$ = işleminin sonucu kaçtır?

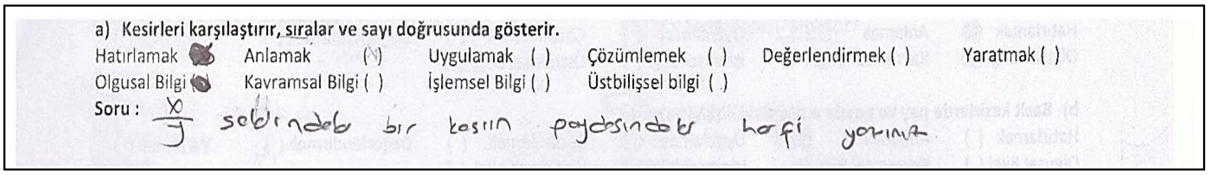
(Problem: What is the result of the operation 1/2+3/4+2/6=?)

When the problem posed by the preservice teacher M6 was examined, it was determined that the problem was not suitable for both the purpose of the given objective and the desired level in terms of knowledge and cognitive dimensions. Although the posed problem seemed to be about fractions, it was not related or suitable to the educational actions in the content or purpose of the learning objective, so it was classified as irrelevant:


a) Kesirleri karşılaştırır, sıralar ve sayı doğrusunda gösterir.
Hatırlamak ( ) Anlamak ( ) Uygulamak ( ) Çözümlemek (X) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi (X) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : Ali, elindeki ekmeğin önce yarısını yer ve kesir şeklinde yazar (1/2). Daha sonra kalan kısmının yarısını yer. Ali'nin elinde baştaki ekmeğin ne kadarlık kısmı kalmıştır?

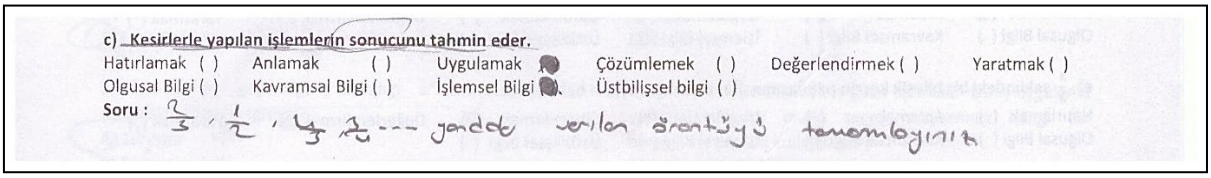
(Problem: Ali first eats half of the bread in his hand and writes it as a fraction (1/2). Then he eats half of the remaining portion. How much of the bread does Ali have now?)

The preservice teacher M26 asked for the letter in the denominator of a fraction whose numerator and denominator were unknown, and the problem was cognitively at a lower level than the expectations of the learning objective. It was noticed that M26 posed a completely unrelated problem, irrelevant to the statement and the educational purpose of the learning objective which was intended to be measured:


a) Kesirleri karşılaştırır, sıralar ve sayı doğrusunda gösterir.
Hatırlamak ( ) Anlamak ( ) Uygulamak ( ) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi ( ) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : x/y şeklindeki bir kesrin paydasındaki harfi yazınız

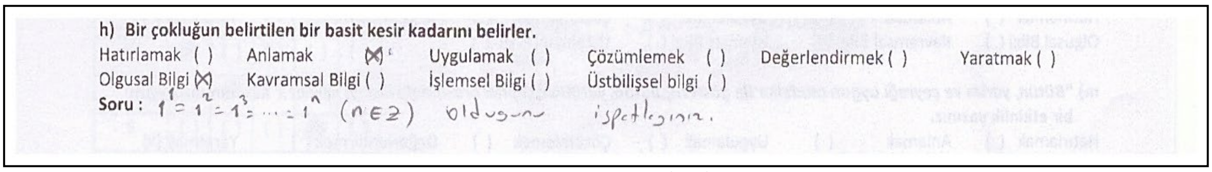
(Problem: Write the letter in the denominator of x/y fraction.)

In addition, with the problem, M26 focused on the pattern instead of four operations in the fractions presented latently in the content of the learning objective, and aimed to measure higher levels in terms of knowledge and cognitive dimensions. Although the term “four operations” was not mentioned in the content of the learning objective, M26 posed an incorrect problem on this subject, since the preservice teacher were informed that the learning objective were prepared on four operations in fractions:


c) Kesirlerle yapılan işlemlerin sonucunu tahmin eder.
Hatırlamak ( ) Anlamak ( ) Uygulamak ( ) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi ( ) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : 2/3, 1/2, 4/3, 3/4 --- yandaki verilen örüntüyü tamamlayınız

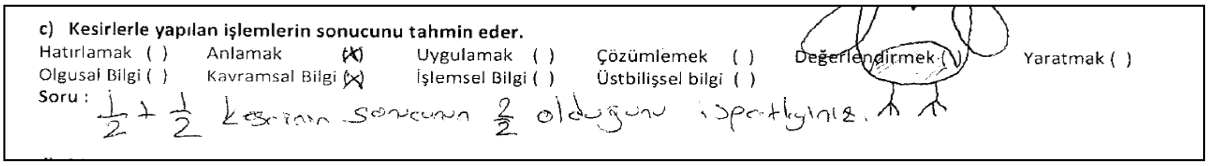
(Problem: 2/3, 1/2, 4/3, 3/4 … complete the pattern on the right.)

It was observed that the problem posed by M19 did not include fractions and/or operations with fractions, it was out of the scope of the statement and the educational purpose of the objective and was a higher level problem terms of knowledge and cognitive dimensions:


h) Bir çokluğun belirtilen bir basit kesir kadarını belirler.
Hatırlamak ( ) Anlamak (X) Uygulamak ( ) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi (X) Kavramsal Bilgi ( ) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : $1^1=1^2=1^3=\dots=1^n$ ($n\in Z$) olduğunu ispatlayınız.

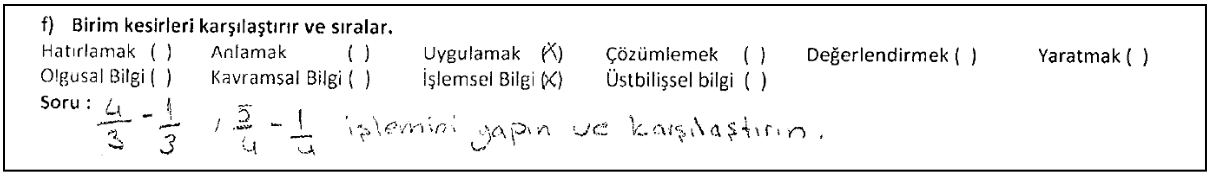
(Problem: Prove that $1^1=1^2=1^3=\ldots=1^n$ ($n \in Z$).)

Another problem encountered in the irrelevant problems posed by the preservice teachers is that they posed problems related to the learning objective statement, but the posed problems could not fully measure the educational skills intended to be measured in terms of knowledge and/or cognitive dimensions. For example, the problem posed C50 measured a different learning objective by explaining how the process was realized rather than the prediction of the result of operations with fractions, and it was determined that the problem was cognitively at a higher level:


c) Kesirlerle yapılan işlemlerin sonucunu tahmin eder.
Hatırlamak ( ) Anlamak (X) Uygulamak ( ) Çözümlemek ( ) Değerlendirmek (X) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi (X) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : 1/2 + 1/2 kesrinin sonucunun 2/2 olduğunu ispatlayınız.

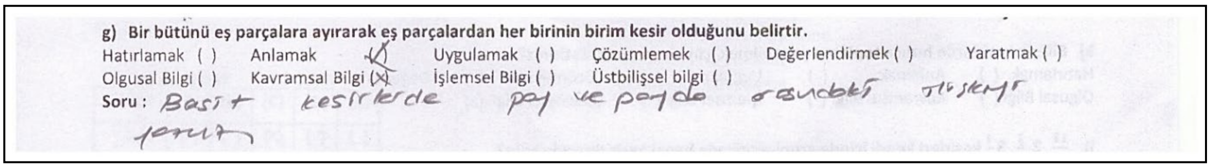
(Problem: Prove that the result of the fraction 1/2+1/2 is 2/2.)

C52 posed a problem that measured students' subtraction skills in fractions as well instead of posing a problem that measured only the skill to compare and order unit fractions:


f) Birim kesirleri karşılaştırır ve sıralar.
Hatırlamak ( ) Anlamak ( ) Uygulamak (X) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi ( ) İşlemsel Bilgi (X) Üstbilişsel bilgi ( )
Soru : 4/3 - 1/3 , 5/4 - 1/4 işlemini yapın ve karşılaştırın.

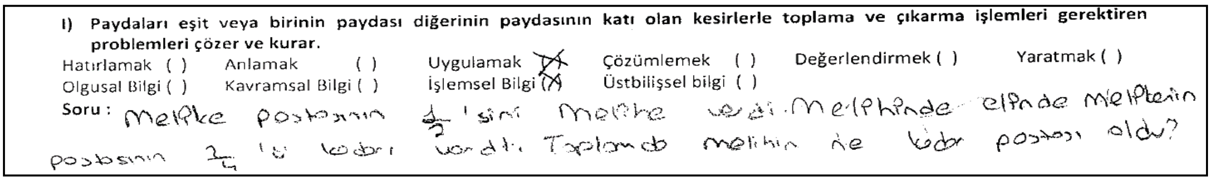
(Problem: Do the operation 4/3-1/3, 5/4-1/4 and compare.)

M40, on the other hand, focused on the simple fraction instead of the unit fraction as expressed in the objective and went beyond the purpose of the objective and asked about the relationship between the numerator and denominator of simple fractions. It was identified that the problem posed by preservice teacher was unrelated to both the objective statement and its educational purpose:


g) Bir bütünü eş parçalara ayırarak eş parçalardan her birinin birim kesir olduğunu belirtir.
Hatırlamak ( ) Anlamak (X) Uygulamak ( ) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi (X) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru: Basit kesirlerde pay ve payda arasındaki ilişkiyi yazın

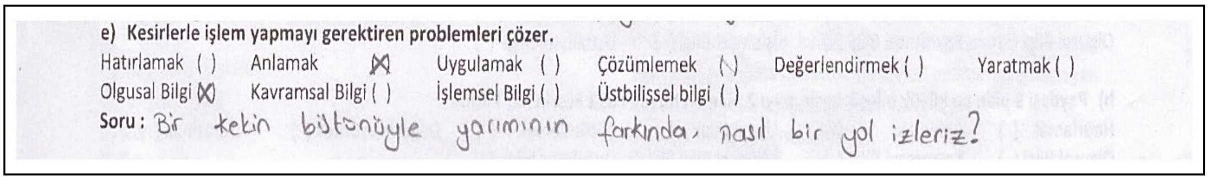
(Problem: Write the relationship between the numerator and denominator in simple fractions.)

The structure of the objectives included in the 2018 Mathematics curriculum may be an important reason why the candidates cannot pose problems in accordance with the objectives. For example, the following objective in the program "*Solves and constructs problems that require addition and subtraction with fractions whose denominators are equal or whose denominator is a multiple of the other*" aims to measure more than one educational skill. It was seen that many preservice teachers who posed problems for this objective ignored and/or overlooked the educational skill (constructing problems) of the learning objective. For example, C64 only concentrated on the educational action of problem solving while posing a problem for the aforementioned objective:


l) Paydaları eşit veya birinin paydası diğerinin paydasının katı olan kesirlerle toplama ve çıkarma işlemleri gerektiren problemleri çözer ve kurar.
Hatırlamak ( ) Anlamak ( ) Uygulamak (X) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi ( ) İşlemsel Bilgi (X) Üstbilişsel bilgi ( )
Soru: Melike pastasının 1/2'sini Melihe verdi. Melih'in elinde Melike'nin pastasının 2/4'ü kadar vardı. Toplamda Melih'in ne kadar pastası oldu?

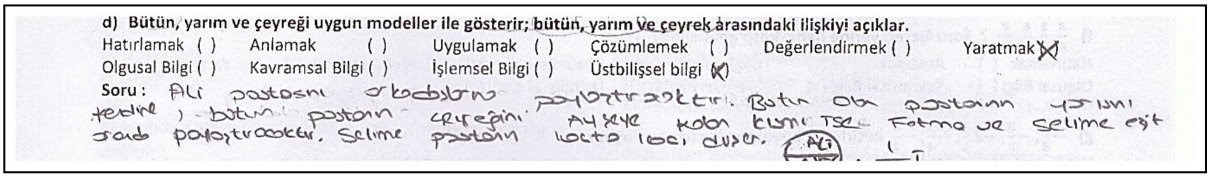
(Problem: Melike gave 1/2 of her cake to Melih. Melih had 2/4 of Melike's cake in his hand. How much cake did Melih have in total?)

M1 posed a problem below the cognitive level of the objective by asking how to solve the problem instead of posing a problem with appropriate problem-solving skills for the "Solves problems that require operations with fractions" learning objective statement:


e) Kesirlerle işlem yapmayı gerektiren problemleri çözer.
Hatırlamak ( ) Anlamak (X) Uygulamak ( ) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi (X) Kavramsal Bilgi ( ) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru: Bir kekin bütünüyle yarımının farkında, nasıl bir yol izleriz?

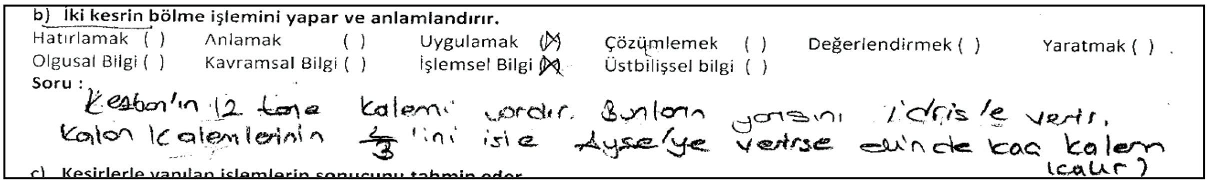
(Problem: Which way do we follow for the subtraction of a half cake from a whole cake?)

M13, on the other hand, posed an irrelevant problem by not asking students to show the relationship with appropriate models, and posing a problem at a higher knowledge and cognitive level with problem solving instead of pointing to the relationship between fractions:


d) Bütün, yarım ve çeyreği uygun modeller ile gösterir; bütün, yarım ve çeyrek arasındaki ilişkiyi açıklar.
Hatırlamak ( ) Anlamak ( ) Uygulamak ( ) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak (X)
Olgusal Bilgi ( ) Kavramsal Bilgi ( ) İşlemsel Bilgi ( ) Üstbilişsel bilgi (X)
Soru: Ali pastasını arkadaşları ile paylaştıracaktır. Bütün olan pastanın yarısını kendine, bütün pastanın çeyreğini Ayşe'ye kalan kısmı Fatma ve Selime eşit paylaştıracaktır. Selime pastanın kaçta kaçı düşer.

(Problem: Ali will share his cake with his friends. He will take half of the whole cake to himself, will give a quarter of the whole cake to Ayşe, and will give the remaining part to Fatma and Selim equally. How much of the cake will Selim get.)

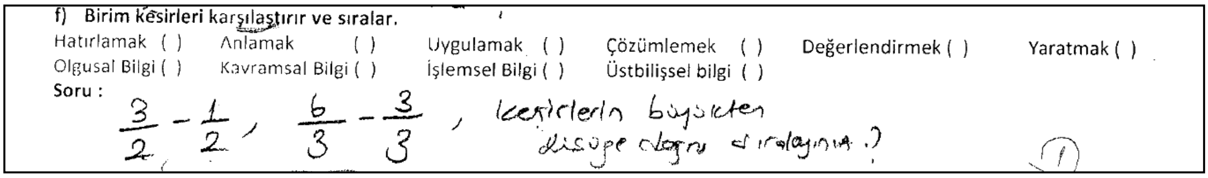
The fact that some expressions included in the objectives are not clear or observable is another reason affecting the quality of the problems posed by teachers. For example, C54, who tried to pose a problem suitable for the objective of " *Performs the division of two fractions and makes sense of them* ", ignored the educational skill of making sense included in the objective, and posed a problem only for the educational action of solving a division problem:


b) İki kesrin bölme işlemini yapar ve anlamlandırır.
Hatırlamak ( ) Anlamak ( ) Uygulamak (X) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi ( ) İşlemsel Bilgi (X) Üstbilişsel bilgi ( )
Soru: Kezban'ın 12 tane kalemi vardır. Bunların yarısını İdris'e verir. Kalan kalemlerinin 2/3'ini de Ayşe'ye verirse elinde kaç kalem kalır?
c) Kesirlerle yapılan işlemlerin sonucunu tahmin eder.

(Problem: Kezban has 12 pencils. She gave half of them to Idris. If she gives 2/3 of the remaining pencils to Ayşe, how many pencils will she have left.)

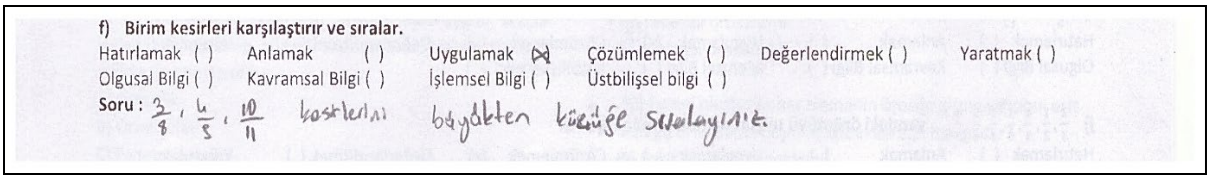
Limitations regarding subject matter knowledge

Preservice teachers' inability to fully understand the concepts in the learning objectives, their tendency to get confused by the learning objectives or having generally limited problem posing skills are other reasons for the errors encountered the problems in this study. For example, C54 not only confused the concepts of operation and fraction in regards to the subject of fractions, but also confused the concepts of unit fractions and compound fractions, and posed a problem that could not meet the learning objective:


f) Birim kesirleri karşılaştırır ve sıralar.
Hatırlamak ( ) Anlamak ( ) Uygulamak ( ) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi ( ) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : $\frac{3}{2}-\frac{1}{2}$, $\frac{6}{3}-\frac{3}{3}$, kesirlerin büyükten küçüğe doğru sıralayınız?

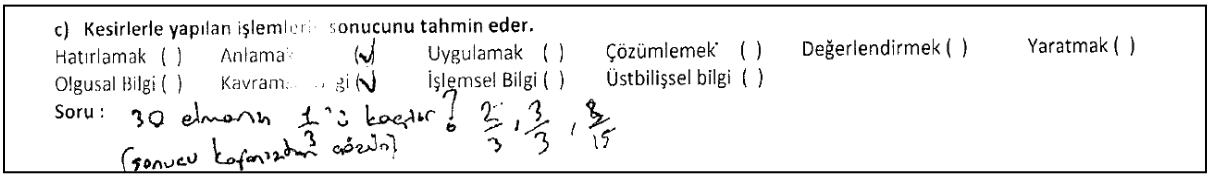
(Problem: Order the fractions 3/2-1/2, 6/3-3/3 from greatest to least?)

Similarly, M3 posed a problem that did not meet the purpose of the objective as a result of confusing the concepts of unit fraction and simple fraction:


f) Birim kesirleri karşılaştırır ve sıralar.
Hatırlamak ( ) Anlamak ( ) Uygulamak (X) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi ( ) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : $\frac{3}{8}$, $\frac{4}{5}$, $\frac{10}{11}$ kesirleri büyükten küçüğe sıralayınız.

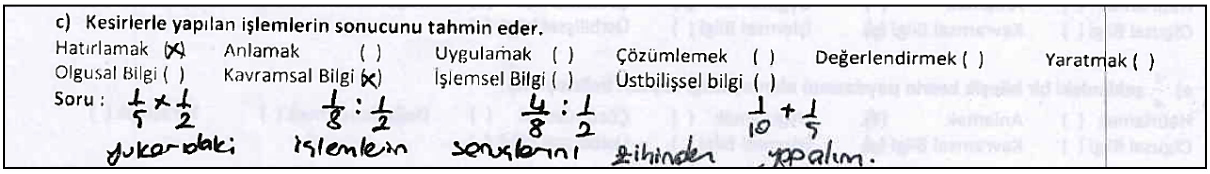
(Problem: Order the fractions 3/8, 4/9, 10/11 from greatest to least.)

The primary school preservice teachers did not only experience confusion in the subjects that include content knowledge such as fraction types, but also confused concepts such as problem sentences and operations with mathematical estimation and mental operations. For example, C67 confused mental processing with mathematical estimation skills:


c) Kesirlerle yapılan işlemlerin sonucunu tahmin eder.
Hatırlamak ( ) Anlamak (✓) Uygulamak ( ) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi (✓) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : 30 elmanın $\frac{1}{3}$'ü kaçtır? $\frac{2}{3}$, $\frac{3}{3}$, $\frac{3}{15}$ (sonucu kafanızdan çözün)

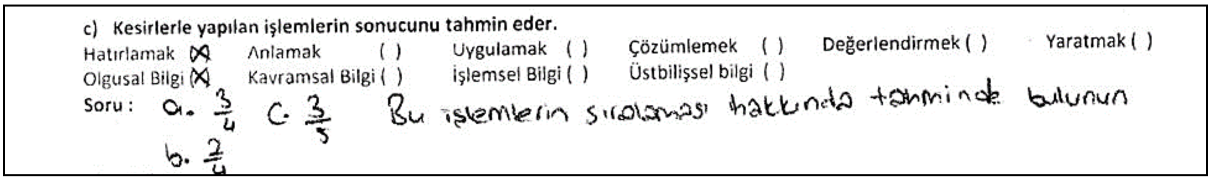
(Problem: What is 1/3 of 30 apples? 2/3, 3/3, 3/15 (calculate it with your mind))

Similarly, C92 confused the skill to estimate operation results with mental processing skills and posed the problem that did not meet the following objective:


c) Kesirlerle yapılan işlemlerin sonucunu tahmin eder.
Hatırlamak (X) Anlamak ( ) Uygulamak ( ) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi (X) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : $\frac{1}{5}\times\frac{1}{2}$ $\frac{1}{8}:\frac{1}{2}$ $\frac{4}{8}:\frac{1}{2}$ $\frac{1}{10}+\frac{1}{5}$ yukarıdaki işlemlerin sonuçlarını zihinden yapalım.

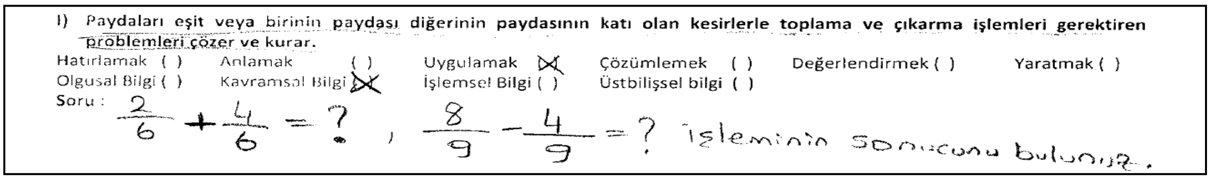
(Problem: 1/5 x 1/2 1/8 : 1/2 4/8 : 1/2 1/10 + 1/5 work out the results of the above operations with your mind.)

In another example, C31 confused the concepts of fractions and operations in fractions and instead of estimating the result of an operation related to fractions, the preservice teacher posed a problem in which fractions should be compared.


c) Kesirlerle yapılan işlemlerin sonucunu tahmin eder.
Hatırlamak (X) Anlamak ( ) Uygulamak ( ) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi (X) Kavramsal Bilgi ( ) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : a. $\frac{3}{4}$ c. $\frac{3}{5}$ Bu işlemlerin sıralaması hakkında tahminde bulunun
b. $\frac{2}{4}$

(Problem: a. 3/4 b. 2/4 c. 3/5 Guess the order of these operations)

Similarly, preservice classroom teachers often understood the educational action of problem solving as operating with fractions. For example, it was seen that C56 asked students to operate on fractions and find answers instead of creating a problem statement:


l) Paydaları eşit veya birinin paydası diğerinin paydasının katı olan kesirlerle toplama ve çıkarma işlemleri gerektiren problemleri çözer ve kurar.
Hatırlamak ( ) Anlamak ( ) Uygulamak (X) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi (X) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : $\frac{2}{6}+\frac{4}{6}=?$, $\frac{8}{9}-\frac{4}{9}=?$ işleminin sonucunu bulunuz.

(Problem: 2/6+4/6=?, 8/9-4/9=? Find the result of the operation.)

In another example, C71 posed a problem that required only one sum operation in fractions, instead of forming a problem statement, even though the preservice teacher had underlined the words in the objective such as *solves* and *constructs*:

l) Paydaları eşit veya birinin paydası diğerinin paydasının katı olan kesirlerle toplama ve çıkarma işlemleri gerektiren problemleri çözer ve kurar.
Hatırlamak ( ) Anlamak ( ) Uygulamak (✓) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi (✓) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : $\frac{2}{4} + \frac{3}{8}$ işleminin sonucunu bulunuz.

(Problem: 2/4+3/8 Find the result of the operation.)

When the problem posed by M10 was examined, it was seen that instead of using expressions such as 3/5 of a tomato, 2/7 of a lemon and 4/6 of an apple, the preservice teacher used expressions such as 3/5 tomatoes, 2/7 lemons and 4/6 apples by ignoring the fact that the concept of "piece" is used for countable or any number of objects:

e) Kesirlerle işlem yapmayı gerektiren problemleri çözer.
Hatırlamak ( ) Anlamak ( ) Uygulamak (X) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi ( ) İşlemsel Bilgi (X) Üstbilişsel bilgi ( )
Soru : Bir manavdan $\frac{3}{5}$ adet domates, $\frac{2}{7}$ adet limon ve $\frac{4}{6}$ adet elma alan Ayşe Hanım'ın elindeki posette toplam kaç adet malzeme vardır?

(Problem: Ms. Ayşe bought 3/5 piece of tomatoes, 2/7 piece of lemons and 4/6 piece of apples from a grocery store, how many ingredients are in the bag in total?)

Limitations in problem posing skills

Examination of the errors made by the preservice teachers while posing problems about fractions showed that they are limited in displaying meaningful problem posing skills in addition to confusing the concepts with each other. It was determined that some of the problems posed by the preservice teachers did not have a definite solution, and the problem statements of some of these problems were wrong. For example, the problem posed by C12 did not provide information about fractions or the operation to be done with fractions, therefore, this specific problem did not have a definite solution:

c) Kesirlerle yapılan işlemlerin sonucunu tahmin eder.
Hatırlamak ( ) Anlamak (X) Uygulamak ( ) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi (X) Kavramsal Bilgi ( ) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : İki basit kesrin sonucu nasıl bir kesirli ifade belirtir?

(Problem: What type of fractional expression does the result of two simple fractions represent?)

In the following example, the data presented by C16 in the problem and the answer requested in the problem did not match, and therefore there was no definite answer to the problem in problem:

l) Paydaları eşit veya birinin paydası diğerinin paydasının katı olan kesirlerle toplama ve çıkarma işlemleri gerektiren problemleri çözer ve kurar.
Hatırlamak ( ) Anlamak ( ) Uygulamak (X) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi ( ) İşlemsel Bilgi (X) Üstbilişsel bilgi ( )
Soru : Ali kalemlerinin $\frac{2}{5}$'ini Ayşede kalemlerinin $\frac{1}{5}$'ini Ahmet'e verecektir. Ahmed'te toplam kalemlerinin $\frac{1}{10}$'unun kardeşine verecektir kaç tane kalem vardır?

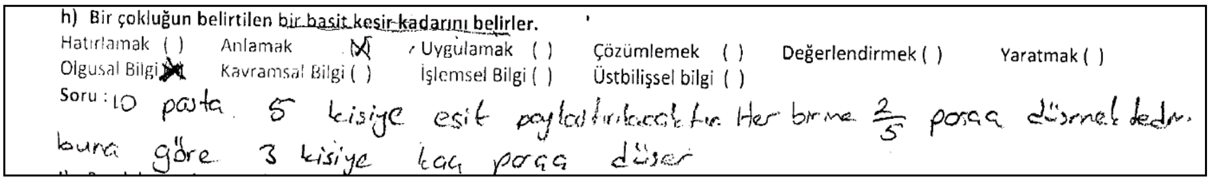
(Problem: Ali will give 2/5 of his pens to Ahmet and Ayşe will give 1/5 of her pens to Ahmet. Ahmed will give 1/10 of the total pens to his brother. How many pencils are there?)

In some cases, it was observed that the unnecessary information provided by the primary school preservice classroom teachers in the problem diverted the problem from obtaining the purpose of the learning objective. For example, in the problem of C41, providing information about the number of slices to be given to everyone made it impossible to observe the skill intended to be measured with the objective:

h) Bir çokluğun belirtilen bir basit kesir kadarını belirler.
Hatırlamak ( ) Anlamak ( ) Uygulamak (✓) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi (✓) Kavramsal Bilgi ( ) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : Bir pasta 10 parçaya ayrılmıştır. Herkese 2 dilim pasta düşecektir. 3 kişiye kaç dilim pasta düşer?

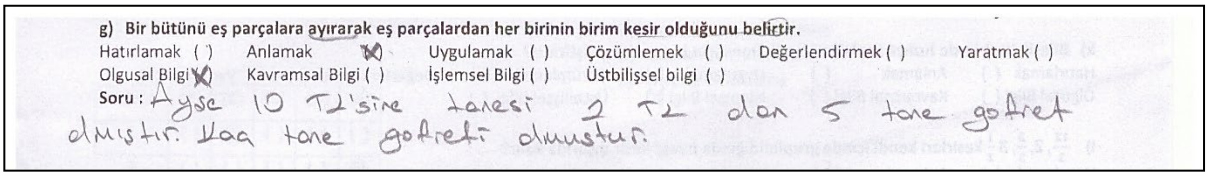
(Problem: A cake is divided into 10 pieces. Everyone will receive 2 slices of cake. How many slices of cake will there be for 3 people?)

Another problem encountered in the posed problems was related to the operation errors or logic errors. For example, the problem posed by C48 had an operation error since the share of cake slices per person could not be 2/5 even if there were 10 cakes in total or there was one cake divided into ten pieces:


h) Bir çokluğun belirtilen bir basit kesir kadarını belirler.
Hatırlamak ( ) Anlamak (X) Uygulamak ( ) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi (X) Kavramsal Bilgi ( ) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : 10 pasta 5 kişiye eşit paylaştırılacaktır. Her birine 2/5 pasta düşmektedir. buna göre 3 kişiye kaç pasta düşer

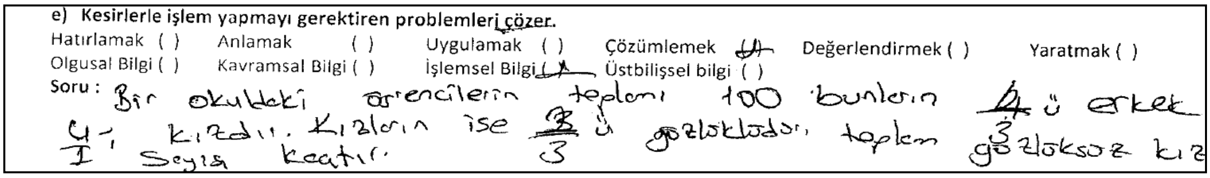
(Problem: 10 cakes will be shared equally among 5 people. There will be 2/5 slices for each. How many slices of cake will there be for 3 people)

Another problem encountered regarding the problem posing skills of the preservice teachers was related to their providing a clear and plain answer in the problem statement so that students could easily find the answer without spending any effort. For example, the problem posed by M24 asked how many wafers Ayşe bought although it was clearly stated in the problem that Ayşe bought 5 wafers:


g) Bir bütünü eş parçalara ayırarak eş parçalardan her birinin birim kesir olduğunu belirtir.
Hatırlamak ( ) Anlamak (X) Uygulamak ( ) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi (X) Kavramsal Bilgi ( ) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : Ayşe 10 TL'sine tanesi 2 TL dan 5 tane gofret almıştır. Kaç tane gofret almıştır.

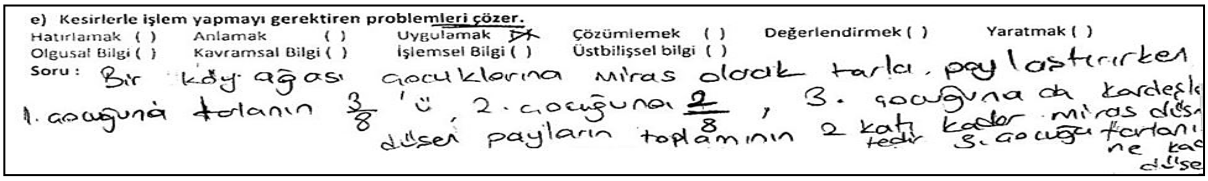
(Problem: Ayşe bought 5 wafers, each of which is 2 TL for 10 TL. How many wafers did she have.)

In the example below, C20 mixed up simple fractions with compound fractions and overlooked that most of the fraction values given in the problem were more than the total number of students provided by the teacher in the problem:


e) Kesirlerle işlem yapmayı gerektiren problemleri çözer.
Hatırlamak ( ) Anlamak ( ) Uygulamak ( ) Çözümlemek (X) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi ( ) İşlemsel Bilgi (X) Üstbilişsel bilgi ( )
Soru : Bir okuldaki öğrencilerin toplamı 100 bunların 4/3 ü erkek 4/1 kızdır. Kızların ise 2/3 ü gözlüklüdür, toplam gözlüksüz kız sayısı kaçtır.

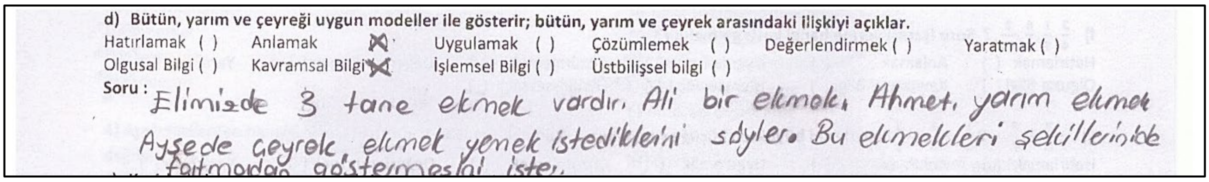
(Problem: The total number of students in a school is 100; 4/3 of them are boys and 4/1 of them are girls. 2/3 of the girls wear glasses. what is the total number of girls without glasses?)

Similarly, it is understood that C37 posed a problem statement that required dividing a field among three siblings, but according to the data presented in the problems, the piece of field that should be given to only the third sibling is more than the whole field:


e) Kesirlerle işlem yapmayı gerektiren problemleri çözer.
Hatırlamak ( ) Anlamak ( ) Uygulamak (X) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi ( ) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : Bir köy ağası çocuklarına miras olarak tarla paylaştırırken 1. çocuğuna tarlanın 3/8 'ü, 2. çocuğuna 2/8, 3. çocuğuna da kardeşlerine miras düşen payların toplamının 2 katı kadardır. 3. çocuğu tarlanın ne kadarı düşer

(Problem: When a squire distributes a field to his children as an inheritance, his 1st child inherits 3/8 of the field, his 2nd child 2/8 the field, and his 3rd child receives 2 times the sum of the shares of his siblings. How much of the field does the 3rd child get?)

When the problem posed by M12 was examined, it was seen the expressions in the problem statement were suitable for the objective, but the problem sentence was not complete and the problem was not plain, understandable and clear. It is clear that the statement in the last sentence "He asks Fatma to show the shapes of these breads" was not directed to the student who was supposed to solve the problem:


d) Bütün, yarım ve çeyreği uygun modeller ile gösterir; bütün, yarım ve çeyrek arasındaki ilişkiyi açıklar.
Hatırlamak ( ) Anlamak (X) Uygulamak ( ) Çözümlemek ( ) Değerlendirmek ( ) Yaratmak ( )
Olgusal Bilgi ( ) Kavramsal Bilgi (X) İşlemsel Bilgi ( ) Üstbilişsel bilgi ( )
Soru : Elimizde 3 tane ekmek vardır. Ali bir ekmek, Ahmet yarım ekmek Ayşe de çeyrek ekmek yemek istediklerini söyler. Bu ekmekleri şekillerinde Fatma'dan göstermesini ister.

(Problem: We have 3 loaves of bread. Ali says he wants to eat a loaf of bread, Ahmet half a loaf of bread and Ayşe a quarter. He asks Fatma to show the shapes of these breads.)

CONCLUSION, DISCUSSION AND RECOMMENDATIONS

This study examined how primary school preservice mathematics and classroom teachers classified the learning objectives on fractions and the problems prepared for these objectives. In addition, primary school preservice mathematics and classroom teachers' problem posing skills for the learning objectives were investigated and the mistakes encountered in the problem posing process were examined. In this context, primary school preservice mathematics and classroom teachers made a moderately correct classification when classifying the learning objectives in regards to conceptual and procedural knowledge. However they had a low rate of accurate classification when classifying the learning objectives at the level of *understanding* and *applying*, confusing the learning objectives at this stage with each other. This may be due to preservice teachers' perception of the expression or educational purpose in the learning objectives as the necessity to use or apply this information in a given situation while they were intended to be understood or interpreted by students instead. As a matter of fact, the study conducted by Akbulut-Taş and Karabay-Turan (2020) emphasized that preservice teachers could not fully distinguish the knowledge and cognitive process steps from one another in their classifications and that they could associate the actions in the statement of purpose with faulty cognitive processes. The study conducted by Altıntaş and Yanpar-Yelken (2016) reported that the primary school preservice mathematics teachers' skill to classify the learning objectives related to their fields was rather low.

On the other hand, regarding the classification of the problems prepared for the learning objectives in terms of cognitive process dimension, the primary school preservice mathematics teachers were found to correctly classify the problems prepared at the level of *understanding* and *applying* at a low rate; they correctly classified the problems the problems prepared at the level of *remembering*, *analyzing* and *evaluating* at a moderate rate and correctly classified the problems prepared at the level of *creating* at a high rate. The problems posed in these four steps may have been classified more easily because preservice mathematics teachers have a high level of metacognitive awareness (Deniz, Küçük, Cansız, Akgün, & İşleyen, 2014), the level of *remembering* is included in the most basic cognitive process step, and the necessary thinking skills become more advanced with *analyzing*. In addition, compared to primary school preservice classroom teachers, primary school preservice mathematics teachers did not confuse cognitive process steps in classifying problems and made a more accurate classification. This may be related to the primary school preservice classroom teachers' lower level content knowledge on fractions and especially their major shortcomings in presentations and model use (Aksu & Konyalığolu, 2015). This study concluded that primary school preservice classroom teachers correctly classified the problems prepared at the level of *remembering*, *analyzing* and *evaluating* at a low rate while they correctly classified the problems prepared at the level of *understanding*, *creating* and *applying* at a moderate rate. In addition, it was determined that the primary school preservice classroom teachers confused the problems prepared at the level of *remembering* with *understanding* and *applying* during classification, and they characterized the problems prepared at the level of *analyzing* and *evaluating* mostly as the level of *applying*.

In regards to classifying the problems prepared for the learning objectives in terms of the knowledge dimension by primary school preservice mathematics teachers and primary school preservice classroom teachers, it was found that the problems at the conceptual knowledge level were classified accurately by preservice mathematics teachers at a low rate; the problems at the factual and metacognitive knowledge level were classified accurately at a moderate rate and the problems at the procedural knowledge level were classified accurately at a high rate. The problems at the factual, conceptual and procedural knowledge level were classified accurately by primary school preservice classroom teachers at a moderate rate while the problems at the metacognitive knowledge level were classified primary school preservice classroom teachers accurately at a low rate. As a matter of fact, the study conducted by Işıksal (2006) reported that problems about operations in fractions could be symbolized and solved by preservice teachers, but they were not successful enough in interpreting and making sense of these problems. In the light of the findings obtained in this study, it was determined that the primary school preservice mathematics teachers mixed up the problems prepared at the conceptual knowledge level with the problems prepared the procedural knowledge level during classification, while the primary school preservice classroom teachers defined the problems at the metacognitive knowledge level as problems at procedural knowledge level. The previous studies showed that preservice teachers lacked knowledge about fractions and operations in fractions (Armstrong & Bezuk, 1995; Ball, 1990; Işık, et al., 2013; Işıksal, 2006; Kılcan, 2006; Ma, 1999; Rosli, et al., 2013; Zembat, 2007) and preservice teachers' operational understanding was much higher than their conceptual understanding (Rosli, et al., 2013). The inability of the preservice teachers to associate a certain type of knowledge with a specific teaching activity or to make a full distinction between the types of knowledge (Akbulut-Taş & Karabay-Turan, 2020) can be seen as a reason for the emergence of errors or confusion in the classification of problems in terms of knowledge dimension. Since designing a learning environment and teaching process that is suitable for the students' understanding is important in making sense of mathematical concepts (Kuzu, Kuzu, & Sıvacı, 2018), student understandings can also be taken into account while designing the education learning process.

Examining preservice teachers' problem posing skills for the learning objectives, this study concluded that the primary school preservice mathematics teachers posed a high percentage of correct problems in accordance with the learning objectives prepared at the level of *understanding* and posed correct problems at a high rate for the learning objectives prepared at the level of *applying.* Primary school preservice classroom teachers were also found to posed correct problems at a high rate for the learning objectives prepared at the level of *understanding* and *applying* as well. In addition, in terms of knowledge dimension, it was observed that primary school preservice mathematics teachers posed a high percentage of correct problems for the learning objectives prepared in the conceptual and operational level, while it was determined that the primary school preservice classroom teachers posed a high percentage of correct problems for conceptual knowledge level and a moderate amount of correct problems for operational knowledge level. Previous studies emphasized that the preservice teachers achieved high performance in posing problems suitable for low cognitive level learning objectives, and that they could pose more appropriate problems more comfortably (Özcan & Akcan, 2010; Yeşilyurt, 2012). On the other hand, the result of the analyzes conducted in this study showed that while the preservice teachers were able to pose problems in accordance with the knowledge and cognitive process dimension of the learning objectives, they could not exhibit the same performance in classifying the learning objectives and the problems prepared for these learning objectives. Among the reasons for this outcome may be related to the fact that many of the mathematics problems that the preservice teachers encountered during their learning process could not go beyond the application step, that the candidates were more familiar with the variety of problems at this level and thus they could pose a higher number of problems at a similar level. That is, the problems preservice teachers encountered during their learning process whether they were problems prepared by their teachers (Baysen, 2006; Dursun & Aydın-Parim, 2014; Karaman & Bindak, 2017; Köğçe & Baki, 2009a; Köğçe & Baki, 2009b), problems in different large-scale exams (Dursun & Aydın-Parim, 2014; Karaman & Bindak, 2017; Köğçe & Baki, 2009a) or problems in textbooks (Arslan & Özpınarar, 2009; Biber & Tuna, 2017; Üredi & Ulum, 2020), they mainly focused on lower cognitive levels based on *remembering*, *understanding*, and *applying*.

In addition, this study examined the mistakes made by the preservice teachers in the process of posing problems suitable for the learning objectives, and concluded that the mistakes made were grouped in three categories: "*the problems that were not relevant to the learning objective* ", "*limitations regarding subject matter knowledge*" and "*limitations in problem posing skills*". Preparing the learning objectives for a clear educational action aimed at teaching comes to the fore as the most basic and important criterion here (Kennedy, 2006; Kuzu, Çil, & Şimşek, 2019; Öçal, 2017). Preservice teachers posed problems that measured a different learning objective apart from the intended one and problems that were not related to the statement and the level of the objective in terms of knowledge and cognitive dimensions. There were also problems that were related to the statement of the intended learning objective but could not fully measure the desired educational skills in terms of knowledge and/or cognitive dimensions. Examination of the obtained results demonstrated that the preservice teachers ignored or overlooked the educational actions included in the statement of the objective that were not understood in the same way by everyone or were very difficult to observe (such as "makes sense") or made some mistakes while posing problems about these unclear objective statements. For example, the use of two different educational actions together in the learning objective of "*Solves and constructs problems that require addition and subtraction with fractions whose denominators are equal or whose denominator is a multiple of the denominator of one*" not only made the problem posing process more complicated for the preservice teachers, but also became one of the important reasons why they turned to the other educational action, *solving*. Similarly, considering how different the problem-solving skills for operations with fractions and problem posing skills and the educational activities that need to be prepared for these skills, using these educational actions together can make the education process more complex for both teachers and students. For this reason, revising the learning objectives that include more than one educational action or educational actions that are difficult to observe in the 2018 Secondary Education Mathematics Program for the next mathematics program will make these learning objectives more understandable (Kuzu et al., 2019) and it will be possible for preservice teachers to make fewer mistakes while creating problems for the objectives.

It was noted in this study that some of the preservice teachers' knowledge of mathematics was quite limited while posing problems about the learning objectives related to fractions. For example, it was observed that both primary school preservice mathematics and classroom teachers mixed up the concepts of unit fractions and simple or compound fractions, and they experience confusion about these concepts. Experiencing difficulties in understanding and interpreting the concept of fractions (Aksu, 1997; Booker, 1998; Davis, 2003; Hart, 1987; Hasemann, 1981) may cause some mistakes during the problem posing process related to lack of content knowledge. Although both preservice teacher groups were observed to make mistakes in the problem posing process related to limited content knowledge, it was determined that primary school preservice classroom teachers made more mistakes and had difficulties due to shortcomings in content knowledge and conceptual understanding compared to primary school preservice mathematics teachers. Low level of content knowledge on fractions and shortcomings regarding presentations and model representations (Aksu & Konyalığolu, 2015) can lay the groundwork for such a situation for primary school preservice classroom teachers.

On the other hand, it was observed that the preservice teachers were limited in demonstrating their problem posing skills, included unnecessary or incomplete information, made operational or logical errors, and, at times, could not prose complete problem sentences. For example, one preservice teacher posed, "Ayşe bought 5 wafers, each of which is 2 TL, for 10 TL. How many waffles has she got?" When the problem was examined, it was seen that the requested answer was given plainly and clearly in the problem, and this answer can be found easily with no effort whatsoever. It is thought that it is important for the preservice teachers to create more meaningful problems suitable for their purpose in this process, so that the learning process can be more effective.

The presentation of many mathematics subjects such as fractions and operations with fractions by enriching them with different activities in primary school mathematics and classroom teaching undergraduate programs can be seen as a solution to the problems that will be encountered in the teaching of the subject of fractions, which is present in the curriculum from the first grade of primary school. It is thought that presenting the most basic information about fractions to the preservice teachers will be effective in limiting the conceptual misconceptions specific to the field of mathematics that the candidates will experience in the future. It should be ensured that the courses such as Basic Mathematics and Mathematics Teaching are provided more efficiently throughout undergraduate education in order to maximize the future performance of the preservice teachers in teaching hard-to-learn subjects such as fractions and prevent them from making mistakes in the process of posing problems. As a matter of fact, taking the subject matter courses in the undergraduate program will increase preservice teachers' perceptions of teacher efficacy and their personal competencies in the teaching process (Çaycı, 2011). Thus, the importance of matching the knowledge, skills and concepts gained in these courses with the theoretical knowledge obtained in the Measurement and Evaluation course will be apparent. In addition, using process-based teaching approaches that involve the student in the process and ensure active participation instead of traditional methods and transferring mathematical knowledge and skills to daily life will allow more meaningful learning to occur (Çil, Kuzu, & Şimşek, 2019). For this reason, real life problems can be used in teaching fractions and real-life lesson plans, visual teaching materials and in-class/extra-class activities can be prepared to make the subject more understandable and easier to learn. On the other hand, with the integration of technology with digital games and/or stories and integrating it into the education process, a more permanent and effective learning environment will be created (Kuzu & Sıvacı, 2018), more effective and comfortable learning will be provided (Özüdoğru, 2021). Considering this stitation, the use of teaching materials with digital content can be included while preparing the programs and achievements.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, author-ship, and/or publication of this article.

Statements of publication ethics

We hereby declare that the study has not unethical issues and that research and publication ethics have been observed carefully.

Researchers' contribution rate

The study was conducted and reported with equal collaboration of the researchers.

Ethics Committee Approval Information

This study was approved for scientific research ethics in accordance with the Kirsehir Ahi Evran University Social Sciences and Humanities Publication Ethics Committee decision dated 01.07.2020 and numbered 2020/2.

REFERENCES

Akay, H., Soybaş, D., & Argün, Z. (2006). Problem kurma deneyimleri ve matematik öğretiminde açık-uçlu soruların kullanımı. *Kastamonu Eğitim Dergisi*, *14*(1), 129–146.

Akbulut-Taş, M., & Karabay-Turan, A. (2020). Öğretmen adaylarının öğretim amaçlarını yenilenen Bloom taksonomisine göre analiz etme becerilerinin incelenmesi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *35*(3), 594–612.

Akpıpar, E. (2003). Cognitive levels of the written exam questions of the secondary schools geography courses. *Erzincan Üniversitesi Eğitim Fakültesi Dergisi*, *5*(1), 13–21.

Aksu, M. (1997). Student performance in dealing with fractions. *The Journal of Education Journals*, *90*(6), 375–380.

Aksu, Z., & Konyalıoğlu, A. C. (2015). Sınıf öğretmen adaylarının kesirler konusundaki pedagojik alan bilgileri. *Kastamonu Education Journal*, *23*(2), 723–738.

Alacacı, C. (2012). Öğrencilerin kesirler konusundaki kavram yanılgıları. In E. Bingölbali & M. F. Özmantar (Eds.), *Matematiksel zorluklar ve çözüm önerileri* (pp. 63-95). Ankara: Pegem Akademi Yayıncılık.

Albayrak, M. (2000). *İlköğretimde matematik ve öğretimi*. Ankara: Aşık Matbaası.

Alexander, P. A., Jetton, T. L., Kulikowich, J. M., & Woehler, C. A. (1994). Contrasting ınstructional and structural importance: The seductive effect of teacher questions, *Journal of Reading Behaviour, 26*(1), 19–45.

Altıntaş, Y., & Yanpar-Yelken, T. (2016) İlköğretim 8. sınıf kazanımlarının yenilenmiş Bloom taksonomisine göre analiz Edilmesi. *XVIII International Congress World Association of Educational Research, Teaching and Training Today for Tomorrow*, Eskişehir, Turkey, June 01-04.

Anderson, L.W. (Ed.), Krathwohl, D.R. (Ed.), Airasian, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J., & Wittrock, M.C. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. New York: Longman.

Arı, A. (2013). Bilişsel alan sınıflamasında yenilenmiş Bloom, Solo, Fink, Dettmer taksonomileri ve uluslararası alanda tanınma durumları. *Uşak Üniversitesi Sosyal Bilimler Dergisi, 6*(2), 259–290.

Armstrong, B. E., & Bezuk, N. (1995). Multiplication and division of fractions: The search for meaning. In J. T. Sowder & B. Schappelle (Eds.), *Providing a foundation for teaching mathematics in the middle grades* (pp. 85-119). Albany, NY: SUNY Press.

Arslan, S., & Özpınar, İ. (2009). lköğretim 6. sınıf matematik ders kitaplarının öğretmen görüşleri doğrultusunda değerlendirilmesi. *Dicle Üniversitesi Ziya Gökalp Eğitim Fakültesi Dergisi*, *12*(2009), 97–113.

Aslan, C. (2011). Soru sorma becerilerini geliştirmeye dönük öğretim uygulamalarının öğretmen adaylarının soru oluşturma becerilerine etkisi. *Eğitim ve Bilim*, *36*(160), 236–249.

Aydemir, Y., & Çiftçi, Ö. (2008). Edebiyat öğretmeni adaylarının soru sorma becerileri üzerine bir araştırma. *Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi, 5*(2), 103–115.

Badger, E., & Thomas, B. (1992). Open-ended questions in reading. *Practical Assessment, Research & Evaluation*, *3*(4), 1–3.

Bahar, M., Nartgün, Z., Durmuş, S., & Bıçak, B. (2012). *Geleneksel-tamamlayıcı ölçme ve değerlendirme teknikleri: Öğretmen el kitabı*. Ankara: Pegem Akademi Yayıncılık.

Ball, D. L. (1990). Prospective elementary and secondary teachers' understanding of division. *Journal for Research in Mathematics Education, 21*(2), 132–144.

Baykul, Y. (2005). *İlköğretimde matematik öğretimi (1-5 sınıflar).* Ankara: Pegem Akademi Yayıncılık.

Baykul, Y. (2014). *Ortaokulda matematik öğretimi (5-8 sınıflar).* Ankara: Pegem Akademi Yayıncılık.

Baysen, E. (2006). Öğretmenlerin sınıfta sordukları sorular ile öğrencilerin bu sorulara verdikleri cevapların düzeyleri. *Kastamonu Eğitim Dergisi, 14*(1), 21–28.

Behr, M. J., Lesh, R., Post, T., & Silver, E. A. (1983). Rational number concepts. In R. Lesh, & M. Landau (Eds.), *Acquisitions of mathematics concepts and processes* (pp. 92–126). New York: Academic Press.

Belcastro, S. M. (2017). Ask questions to encourage questions asked. *Problems, Resources, and Issues in Mathematics Undergraduate Studies, 27*(2), 171–178.

Biber, A. Ç., Tuna, A., & Aktaş, O. (2013). Öğrencilerin kesirler konusundaki kavram yanılgıları ve bu yanılgıların kesir problemleri çözümlerine etkisi. *Trakya Üniversitesi Eğitim Fakültesi Dergisi, 3*(2), 152–162.

Biber, A. Ç. & Tuna, A., (2017). Ortaokul matematik kitaplarındaki öğrenme alanları ve Bloom taksonomisine göre karşılaştırmalı analizi. *Ondokuz Mayıs Üniversitesi Eğitim Fakültesi Dergisi*, *36*(1), 161–174.

Bloom, B.S. (Ed.), Engelhart, M.D., Furst, E.J., Hill, W.H., & Krathwohl, D.R. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive domain*. New York: David McKay.

Booker, G. (1998). Children's construction of initial fraction concepts. In A. Olivier & K. Newstead (Eds.), *Proceedings of the 22nd Conference of the International Group for the Psychology of Mathematics Education* (pp 128-135). Stellenbosch, South Africa.

Büyükalan, S. (2007). *Soru Sorma Sanatı.* Ankara: Nobel Akademi Yayıncılık.

Carr, D. (1998). The art of asking questions in the teaching of science. S*chool Science Review, 79*(289), 47–50.

Cooney, T. J., Sanchez, W. B., Leatham, K., & Mewborn, D. S. (2004). *Open-ended assessment in math: A searchable collection of 450+ questions.* Portsmouth, NH: Heinemann Educational Books.

Crowe A., Dirks C., & Wenderoth, M.P. (2008). Biology in bloom: ımplementing bloom's taxonomy to enhance student learning in biology. *CBE Life Sciences Education, 7*(4), 368–381.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: Sage publications.

Çakıcı, Y., Handan, Ü., & Dinçer, E. (2012). İlköğretim öğrencilerinin soru oluşturma becerilerinin incelenmesi. *Mersin Üniversitesi Eğitim Fakültesi Dergisi*, *8*(1), 43–68.

Çalışkan, H. (2011). Öğretmenlerin hazırladığı sosyal bilgiler dersi sınav sorularının değerlendirilmesi. *Eğitim ve Bilim*, *36*(160), 120–132.

Çaycı, B. (2011). Sınıf öğretmenliği lisans programındaki alan eğitimi derslerinin öğretmen yeterliği üzerindeki etkisinin incelenmesi. *Mersin Üniversitesi Eğitim Fakültesi Dergisi, 7*(2), 1–12.

Çil, O., Kuzu, O., & Şimşek, A.S. (2019). 2018 Ortaöğretim matematik programının revize edilmiş Bloom taksonomisine ve programın ögelerine göre incelenmesi. *YYÜ Eğitim Fakültesi Dergisi, 16*(1), 1402-1418.

Davis, E. G. (2003). Teaching and classroom experiments dealing with fractions and proportional reasoning. *Journal of Mathematical Behavior, 22*(2003), 107–111.

de Castro, B. (2008). Cognitive models: the missing link to learning fraction multiplication and division. *Asia Pacific Education Review*, *9*(2), 101–112.

Deniz, D., Küçük, B., Cansız, Ş., Akgün, L., & İşleyen, T. (2014). Ortaöğretim matematik öğretmeni adaylarının üstbiliş farkındalıklarının bazı değişkenler açısından incelenmesi. *Kastamonu Eğitim Dergisi*, *22*(1), 305–320.

Doğanay, A., & Ünal, F. (2006). Eleştirel düşünmenin öğretimi. In A. Şimşek (Ed.), *İçerik türlerine dayalı öğretim.* Ankara: Nobel Akademi Yayıncılık.

Dursun, A., & Aydın-Parim, G. (2014). YGS 2013 matematik soruları ile ortaöğretim 9. sınıf matematik sınav sorularının Bloom Taksonomisine ve öğretim programına göre karşılaştırılması. *Eğitim Bilimleri Araştırmaları Dergisi*, 4(1), 17–37.

Elder, L. & Paul, R. (2003). Critical thinking: Teaching students how to study and learn. *Journal of Developmental Education, 27*(1), 36–37.

Erdoğan, T. (2017). İlkokul dördüncü sınıf öğrencilerinin ve öğretmenlerinin Türkçe dersine ilişkin sordukları soruların yenilenmiş Bloom taksonomisi açısından görünümü. *Eğitim ve Bilim*, *42*(192), 173-191.

Feldhusen, J.F. & Treffinger, D.J. (1985). *Creative thinking and problem solving in gifted education*. Dubuque, IA: Kendall Hunt Publishing.

Fleiss, J. L., & Cohen, J. (1973). The equivalence of weighted kappa and the intraclass correlation coefficient as measure of reliability. *Educational and Psychological Measurement*, *33*, 613–619.

Geçit, Y., & Yarar, S. (2010). 9. sınıf coğrafya ders kitabındaki sorular ile çeşitli coğrafya sınav sorularının Bloom Taksonomisine göre analizi. *Marmara Coğrafya Dergisi, 0*(22), 154-167.

Goatly, A. (2000). *Critical reading and writing. An introductory coursebook.* New York: Routledge.

Gökler, Z.S., Arı, A., & Aypay, A. (2012). İlköğretim İngilizce dersi hedefleri kazanımları SBS soruları ve yazılı sınav sorularının yeni Bloom taksonomisine göre değerlendirilmesi. *Eğitimde Politika Analizi*, *1*(2), 114–133.

Gündüz, Y. (2009). İlköğretim 6, 7 ve 8. sınıf fen ve teknoloji sorularının ölçme araçlarına ve Bloom'un bilişsel alan taksonomisine göre analizi. *Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi*, *6*(2), 150–165.

Hart, K. M. (1987). Practical work and formalisation, too great a gap. In J. C. Bergeron, N. Herscovicsi & C. Kieran (Eds.), *Proceedings of the Eleventh International Conference Psychology of Mathematics Education* (pp. 408-415). Montreal: The University of Montreal.

Hasemann, K. (1981). On difficulties with fractions. *Educational Studies in Mathematics, 12*(1), 71–87.

Işık, C., & Kar, T. (2012). 7. sınıf öğrencilerinin kesirlerde toplama işlemine kurdukları problemlerin analizi. *İlköğretim Online*, *11*(4), 1021–1035.

Işık, C., Öçal, T., & Kar, T. (2013). Analysis of pre-service elementary teachers' pedagogical content knowledge in the context of problem posing. *Paper presented at the meeting of Eighth Congress of European Research in Mathematics Education (CERME 8),* Antalya, Turkey.

Isıksal, M. (2006). *İlköğretim matematik öğretmen adaylarının kesirlerde çarpma ve bölmeye ilişkin alan ve pedagojik içerik bilgileri üzerine bir çalışma*. Yayınlanmamış doktora tezi, Orta Doğu Teknik Üniversitesi, Ankara.

İpek, A. S., Işık, C., & Albayrak, M. (2005). Sınıf öğretmeni adaylarının kesir işlemleri konusundaki kavramsal performansları. *Kazım Karabekir Eğitim Fakültesi Dergisi, 2005*(1)*,* 537–547.

Jesus, H. P., & Moreira, A. C. (2009). The role of students' questions in aligning teaching, learning and assessment: A case study from undergraduate sciences. *Assessment & Evaluation in Higher Education, 34*(2), 193–208.

Jones, R. C. (2008). The "Why" of class participation: A question worth asking. *College Teaching, 56*(1), 59–63.

Kar, T., & Işık, A . (2015). Ortaokul matematik öğretmenlerinin kesirlerle çıkarma işlemine yönelik problem kurma becerilerinin incelenmesi. *Dicle Üniversitesi Ziya Gökalp Eğitim Fakültesi Dergisi*, (24), 243–276.

Karaman, M., & Bindak, R. (2017). İlköğretim matematik öğretmenlerinin sınav soruları ile TEOG matematik sorularının yenilenmiş Bloom Taksonomisi'ne göre analizi. *Curr Res Educ, 3*(2), 51-65.

Kennedy, D. (2006). *Writing and using learning outcomes: a practical guide*. University College Cork, Munster.

Kılcan, S. A. (2006). *İlköğretim matematik öğretmenlerinin kesirlerle bölmeye ilişkin kavramsal bilgi düzeyleri*. Yayınlanmamış yüksek lisans tezi, Abant İzzet Baysal Üniversitesi, Bolu.

Kocaoğlu, T., & Yenilmez, K. (2010). Beşinci sınıf öğrencilerinin kesir problemlerinde yaptıkları hatalar ve kavram yanılgıları. *Dicle Üniversitesi Ziya Gökalp Eğitim Fakültesi Dergisi, 14*(2010), 71–85.

Koray, Ö., Altunçekiç, A., & Yaman, S. (2005). Fen bilgisi öğretmen adaylarının soru sorma becerilerinin Bloom taksonomisine göre değerlendirilmesi. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, *17*(17), 33–39.

Koray, Ö., & Yaman, S. (2002). Fen bilgisi öğretmenlerinin soru sorma becerilerinin Bloom taksonomisine göre değerlendirilmesi. *Gazi Üniversitesi Kastamonu Eğitim Dergisi, 10*(2), 317–324.

Köğce, D., & Baki, A. (2009a). Matematik öğretmenlerinin yazılı sınav soruları ile ÖSS sınavlarında sorulan matematik sorularının Bloom taksonomisine göre karşılaştırılması. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, *26*(26), 70–80.

Köğce, D., & Baki, A. (2009b). Farklı türdeki liselerin matematik sınavlarında sorulan soruların Bloom taksonomisine göre karşılaştırılması. *Kastamonu Eğitim Dergisi*, *17*(2), 557–574.

Krathwohl, D.R. (2002). A revision of Bloom's taxonomy: An overview. *Theory into Practice. 41*(4), 212–218.

Kuzu, O., Çil, O., & Şimşek, A.S. (2019). 2018 Matematik dersi öğretim programı kazanımlarının revize edilmiş Bloom taksonomisine göre incelenmesi. *Erzincan Üniversitesi Eğitim Fakültesi Dergisi*, *21*(3), 129–147.

Kuzu, O., Kuzu, Y., & Sıvacı, S. Y. (2018). Preservice teachers' attitudes and metaphor perceptions towards Mathematics. *Cukurova University Faculty of Education Journal, 47*(2), 897–931.

Kuzu, O., & Sıvacı, S. Y. (2018). Dijital oyun bağımlılığı ile teknoloji okuryazarlığı arasındaki ilişki. İçinde *I. Uluslararası multidisipliner dijital bağımlılık kongresi tam metin e-kitap*, (ss. 69-78). Bursa: Kuzgun Kitap.

Küçükahmet, L. (2006). *Öğretimde planlama ve değerlendirme*. Ankara: Nobel Akademik Yayıncılık.

Landis, J., & Koch, G. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33*, 159–174

Ma, L. (1999). *Knowing and teaching elementary mathematics*. Mahwah, NJ: Lawrence Erlbaum Associates.

Marbach-Ad, G., & Sokolove, P.G. (2000). Can undergraduate biology students learn to ask higher level questions?. *Journal of Research in Science Teaching, 37*(8), 854–870.

MEB (2018a). *Matematik dersi öğretim programı*. Milli Eğitim Bakanlığı, Ankara.

MEB (2018b). *2023 Eğitim Vizyonu*. Milli Eğitim Bakanlığı, Ankara.

Miles, M.B. & Huberman, A.M. (1994). *Qualitative data analysis*. London: SAGE Publication.

Moss, J., & Case, R. (1999). Developing children's understanding of the rational numbers: a new model and experimental curriculum. *Journal for Research in Mathematics Education*, *30*(2), 122–147.

Näsström, G. (2009). Interpretation of standards with Bloom's revised taxonomy: A comparison of teachers and assessment experts. *International Journal of Research & Method in Education, 32*(1), 39–51.

Okur, M., & Çakmak-Gürel, Z. (2016). Ortaokul 6. ve 7. sınıf öğrencilerinin kesirler konusundaki kavram yanılgıları. *Erzincan Üniversitesi Eğitim Fakültesi Dergisi*, *18*(2), 922–952.

Olkun, S., & Toluk-Uçar, Z. (2012). *İlköğretimde etkinlik temelli matematik öğretimi*. Ankara: Anı Yayıncılık.

Öçal, M. F., İpek, A. S., Özdemir, E., & Kar, T. (2018). Investigation of elementary school students' problem posing abilities for arithmetic expressions in the context of order of operations. *Turkish Journal of Computer and Mathematics Education, 9*(2), 170–191.

Öçal, T. (2017). Comparing Turkish early childhood education curriculum with respect to common core state standards for mathematics. *Eğitimde Nitel Araştırmalar Dergisi, 5*(3), 155–171.

Öksüz, Y., & Güven Demir, E. (2019). *Açık uçlu ve çoktan seçmeli başarı testlerinin psikometrik özellikleri ve öğrenci performansı açısından karşılaştırılması. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 34*(1), 259–282.

Özden, Y. (1998). *Öğrenme ve öğretme.* Ankara: Pegem Akademi Yayıncılık.

Özcan, S., & Akcan, K. (2010). Fen bilgisi öğretmen adaylarının hazırladığı soruların içerik ve Bloom taksonomisi'ne uygunluk yönünden incelenmesi. *Kastamonu Eğitim Dergisi*, *18*(1), 323–330.

Özüdoğru, G. (2021). Digital storytelling in education from teachers' perspectives. *Bartın University Journal of Faculty of Education, 10*(2), 445–454.

Paul, R. (1995). Critical thinking: Basic questions and answers. In J. Wilsen & A. J. A. Binker (Eds.), *Critical Thinking: How to Prepare Students for a Rapidly Changing World* (pp. 489-500). Santa Rosa, CA: Foundation for Critical Thinking.

Patton, M. Q. (2002). *Qualitative research and evaluation methods.* Thousand Oaks, CA: Sage.

Pesen, C. (2008). Kesirlerin sayı doğrusu üzerindeki gösteriminde öğrencilerin öğrenme güçlükleri ve kavram yanılgıları. *İnönü Üniversitesi Eğitim Fakültesi Dergisi, 9*(15), 157–168.

Ralph, E.G. (1999). Oral Questioning Skills of Novice Teachers: …Any Questions?. *Journal of Instructional Psycology, 26*(4), 286-296.

Rosli, R., Han, S., Capraro, R., & Capraro, M. (2013). Exploring preservice teachers' computational and representational knowledge of content and teaching fractions. *Journal of Korean Society of Mathematics Education, 17*(4), 221–241.

OECD (2007). *Pisa 2006: Science competencies for tomorrow's World.* Paris: Organisation for Economic Cooperation and Development.

Soylu, Y., & Soylu, C. (2005). İlköğretim beşinci sınıf öğrencilerinin kesirler konusundaki öğrenme güçlükleri: kesirlerde sıralama, toplama, çıkarma, çarpma ve kesirlerle ilgili problemler. *Erzincan Eğitim Fakültesi Dergisi*, *7*(2), 101–117.

Soylu, Y. (2008). Öğrencilerin kesirler konusundaki hata ve yanlış anlamaları ve sınıf öğretmen adaylarının tahmin edebilme becerileri. *Çağdaş Eğitim Dergisi, 33*(356), 31–39.

Stafylidou, S., & Vosniadou, S. (2004). The development of students' understanding of the numerical value of fractions. *Learning and Instruction*, *14*(5), 503–518.

Tirosh, D. (2000). Enhancing prospective teachers' knowledge of children's conceptions: the case of division of fractions. *Journal for Research in Mathematics Education*, *31*(1), 5–25.

Umay, A. (1993). Matematiksel düşünmede süreci ve sonucu yoklayan testler arasında bir karşılaştırma. *Eğitim ve Bilim, 17*(90), 42–48.

Umay, A. (1996). Matematik öğretimi ve ölçülmesi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *12*(1996), 145–149.

Ünlü, M. & Ertekin, E. (2012). Why do pre-service teachers pose multiplication problems instead of division problems in fractions? *Procedia - Social and Behavioral Sciences, 46*(2012), 490–494.

Üredi, L., & Ulu, H. (2020). İlkokul matematik ders kitaplarında bulunan ünite değerlendirme sorularının yenilenmiş Bloom taksonomisine göre incelenmesi. *Mersin Üniversitesi Eğitim Fakültesi Dergisi*, *16*(2), 432–447.

Üstüner, A., & Şengül, M. (2004). Çoktan seçmeli test tekniğinin Türkçe öğretimine olumsuz etkileri. *Fırat Üniversitesi Sosyal Bilimler Dergisi, 14*(2), 197–208.

Yeşilyurt, E. (2012). Öğretmen adaylarının bilişsel alanla ilgili sınama durumu soruları yazma yeterliklerinin değerlendirilmesi. *Kastamonu Eğitim Dergisi*, *20*(2), 519–530.

Yılmaz, E., & Keray, B. (2012). Through the interwiev texts the analysis of the 8th grade students' skills of asking questions according to the revised Bloom's taxonomy. *Sakarya University Journal of Education*, *2*(2), 20–31.

Wood, J. M. (2007). Understanding and computing Cohen's kappa: A tutorial. *Web Psych Empiricist. Retrieved electronically from https://wpe.info/vault/wood07/Wood07.pdf on September, 26, 2020.*

Wu, H. (1999). Some remarks on the teaching of fractions in elementary school. *Retrieved electronically from* http://math.berkeley.edu/~wu/fractions2.pdf *on September, 26*, 2020.

Zembat, İ. Ö. (2007). Sorun aynı–kavramlar; Kitle aynı-öğretmen adayları. *İlköğretim Online, 6*(2), 305–312.

Appendix 1. Learning objective classification and problem posing test for fractions

Item 1) Below are the learning objectives on "Fractions" and "Operations with Fractions". Determine in which step these objectives are included in the revised Bloom taxonomy for the Cognitive Process and Knowledge dimensions. Prepare a question suitable for this objective and step.

a) Compares, orders and displays fractions on the number line.
Remember ( ) Understand (x) Apply ( ) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge (x) Procedural Knowledge ( ) Metacognitive Knowledge ( )
Problem :

b) Performs the division of two fractions and makes sense of them.
Remember ( ) Understand ( ) Apply (x) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge ( ) Procedural Knowledge (x) Metacognitive Knowledge ( )
Problem :

c) Predicts the result of operations with fractions.
Remember ( ) Understand (x) Apply ( ) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge (x) Procedural Knowledge ( ) Metacognitive Knowledge ( )
Problem :

d) Shows the concept of whole, half and quarter with suitable models; explains the relationship between the whole, half, and quarter
Remember ( ) Understand (x) Apply ( ) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge (x) Procedural Knowledge ( ) Metacognitive Knowledge ( )
Problem :

e) Solves problems that require operations with fractions
Remember ( ) Understand ( ) Apply (x) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge ( ) Procedural Knowledge (x) Metacognitive Knowledge ( )
Problem :

f) Compares and orders unit fractions
Remember ( ) Understand (x) Apply ( ) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge (x) Procedural Knowledge ( ) Metacognitive Knowledge ( )
Problem :

g) Divides a whole into equal parts and states that each of the equal parts is a unit fraction.
Remember ( ) Understand (x) Apply ( ) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge (x) Procedural Knowledge ( ) Metacognitive Knowledge ( )
Problem :

h) Determines a specified simple fraction of a multiplicity.
Remember ( ) Understand ( ) Apply (x) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge ( ) Procedural Knowledge (x) Metacognitive Knowledge ( )
Problem :

l) Solves and constructs problems that require addition and subtraction with fractions whose denominators are equal or whose denominator is a multiple of the other
Remember ( ) Understand ( ) Apply (x) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge ( ) Procedural Knowledge (x) Metacognitive Knowledge ( )
Problem :

Item 2) Below are sample questions on "Fractions" and "Operations with Fractions". Determine at which step these questions take place in the revised Bloom's taxonomy for the Cognitive Process and Knowledge dimensions (You do not need to write the answers to the sample questions).

a) Write the letter in the denominator of the fraction $\frac{a}{b}$
Remember (x) Understand ( ) Apply ( ) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge (x) Conceptual Knowledge ( ) Procedural Knowledge ( ) Metacognitive Knowledge ( )

b) Write the relationship between the numerator and denominator in simple fractions.
Remember ( ) Understand (x) Apply ( ) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge(x) Procedural Knowledge ( ) Metacognitive Knowledge ( )

c) Show the fraction $\frac{3}{5}$ on the number line.
Remember ( ) Understand ( ) Apply (x) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge (x) Procedural Knowledge ( ) Metacognitive Knowledge ( )

d) Write the number that the denominator of the fraction $\frac{a}{b}$ cannot take.
Remember (x) Understand ( ) Apply ( ) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge (x) Conceptual Knowledge ( ) Procedural Knowledge ( ) Metacognitive Knowledge ( )

e) Determine the numbers that the denominator of a composite fraction $\frac{3}{a}$ cannot take.
Remember ( ) Understand (x) Apply ( ) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge (x) Procedural Knowledge ( ) Metacognitive Knowledge ( )

f) $\frac{3}{4}, \frac{1}{7}, \frac{6}{8}, \frac{2}{14}$, ? Which fraction should come in place of the question mark?
Remember ( ) Understand ( ) Apply ( ) Analyze (x) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge ( ) Procedural Knowledge (x) Metacognitive Knowledge ( )

g) $-\frac{9}{8}, -\frac{3}{2}, -2\frac{1}{2}, -\frac{3}{4}, -\frac{3}{2}$ Order the fractions from greatest to least.
Remember ( ) Understand (x) Apply ( ) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge (x) Procedural Knowledge ( ) Metacognitive Knowledge ( )

h) The smallest composite fraction with a denominator of 9 is how many times the largest simple fraction with a numerator of 2?
Remember ( ) Understand ( ) Apply (x) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge ( ) Procedural Knowledge (x) Metacognitive Knowledge ( )

i) Compare the result you found by multiplying the fractions $\frac{16}{5}$ and $\frac{4}{17}$ mentally with the result of the operation.
Remember ( ) Understand ( ) Apply (x) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge ( ) Procedural Knowledge (x) Metacognitive Knowledge ( )

j) $\frac{2}{3}, \frac{1}{2}, \frac{4}{3}, \frac{3}{4}, \frac{1}{3}, \frac{5}{4}, \frac{4}{5}$, ... Complete this pattern composed of simple fractions, compound fractions, and unit fractions.
Remember ( ) Understand ( ) Apply ( ) Analyze (x) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge ( ) Procedural Knowledge (x) Metacognitive Knowledge ( )

k) Develop a method for quick addition in compound fractions.
Remember ( ) Understand ( ) Apply ( ) Analyze ( ) Evaluate ( ) Create (x)
Factual Knowledge ( ) Conceptual Knowledge ( ) Procedural Knowledge ( ) Metacognitive Knowledge (x)

l) Which fraction is left out when the fractions $\frac{12}{3}, 2, \frac{2}{3}, 3\frac{1}{2}$ are grouped together?
Remember ( ) Understand (x) Apply ( ) Analyze ( ) Evaluate ( ) Create ( )
Factual Knowledge ( ) Conceptual Knowledge (x) Procedural Knowledge ( ) Metacognitive Knowledge ( )

m) Write a suitable activity for the educational objective *"Shows the concept of whole, half and quarter with suitable models; explains the relationship between the whole, half, and quarter"*
Remember ( ) Understand ( ) Apply ( ) Analyze ( ) Evaluate ( ) Create (x)
Factual Knowledge ( ) Conceptual Knowledge ( ) Procedural Knowledge ( ) Metacognitive Knowledge (x)

n) *"Ali is 11 years old. Ali bought himself a pen with 3/5 of his money. He bought a notebook with 3/4 of his remaining money. He gave this notebook to Ayşe as a present. How much money did Ali have at first, since Ali has now 5 TL in his pocket?"* Consider the question as a teacher candidate.
Remember ( ) Understand ( ) Apply ( ) Analyze ( ) Evaluate (x) Create ( )
Factual Knowledge ( ) Conceptual Knowledge ( ) Procedural Knowledge ( ) Metacognitive Knowledge (x)