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Analysis of Mathematics Teacher Candidates' Metacognitive Regulation Skills in the Context of Problem-posing Activity[#]

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Research Article

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ABSTRACT

This study aimed to examine the metacognitive regulation skills of elementary mathematics teacher (EMT) candidates during the problem-posing process. The case study method, a qualitative data approach, was used in the study. The participants were five EMT candidates studying in the 2nd year of a state university's Elementary Mathematics Teaching program. The study data were collected using a semi-structured problem-posing activity called "House Problem" created by Getzels and Jackson (1962) and organized by Leung in 1993. The problems posed by teacher candidates were completed, semi-structured interviews were conducted with the participants. The data obtained were analyzed according to the researchers' theoretical framework for metacognitive regulation skills (prediction, planning, monitoring, and evaluation). Regarding the metacognitive regulation skills exhibited by EMT candidates in problem-posing situations, the study concluded that their prediction and monitoring skills were higher than their planning and evaluation skills. Many studies in the literature examined metacognitive skills in the problem-solving process, but the studies focusing on metacognitive skills in the problem-posing process are rare. For this reason, it is thought that the studies focusing on the metacognitive skills of students and teachers in the problem-posing process will contribute to the field.

Keywords: *M*etacognitive regulation skills, problem posing, prediction, planning, monitoring, evaluation

Matematik Öğretmeni Adaylarının Üstbiliş Düzenleme Becerilerinin Problem Kurma Etkinliği Bağlamında İncelenmesi

Bilgi
#Bu çalışma TÜRKBİLMAT-4'te sunulan sözlü bildirinin genişletilmiş halidir.
**Sorumlu yazar*

Süreç
Geliş: 06/02/2023
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Bu çalışma ön inceleme sürecinde ve yayımlanmadan önce iThenticate yazılımı ile taranmıştır.

ÖZ

Bu çalışmada ilköğretim matematik öğretmen adaylarının problem kurma sürecinde sergiledikleri üstbiliş düzenleme becerilerinin incelenmesi amaçlanmıştır. Araştırmada nitel bir veri yaklaşımı olan durum çalışması deseni kullanılmıştır. Araştırmanın katılımcılarını bir devlet üniversitesinin İlköğretim Matematik Öğretmenliği programı 2. sınıfında öğrenim görmekte olan 5 ilköğretim matematik öğretmeni adayı oluşturmaktadır. Araştırmanın verileri Getzels ve Jackson (1962) tarafından oluşturulup 1993 yılında Leung tarafından düzenlenen ve "House Problem" olarak adlandırılan yarı-yapılandırılmış problem kurma etkinliği ile toplanmıştır. Öğretmen adaylarının bu etkinliğe yönelik problem kurma çalışmaları tamamlandıktan sonra katılımcılarla yarı yapılandırılmış görüşmeler gerçekleştirilmiştir. Elde edilen veriler araştırmacılar tarafından hazırlanan üstbiliş düzenleme becerilerine (tahmin, planlama, izleme ve değerlendirme) yönelik teorik çatıya göre analiz edilmiştir. İlköğretim matematik öğretmeni adaylarının problem kurma durumlarında sergiledikleri üstbiliş düzenleme becerilerinde, genel olarak öğretmen adaylarının tahmin ve izleme becerilerinin, planlama ve değerlendirme becerilerine göre daha yüksek olduğu sonucuna ulaşılmıştır. Alanyazında problem çözme sürecinde üstbiliş becerilerini inceleyen çok sayıda çalışma olmasına rağmen problem kurma sürecinde üstbiliş becerilerine odaklanan araştırmalar oldukça azdır. Bu nedenle problem kurma sürecinde öğrencilerin ve öğretmenlerin üstbiliş becerilerine odaklanan çalışmaların yapılmasının alana katkı sağlayacağı düşünülmektedir.

Anahtar Kelimeler: Üstbiliş düzenleme becerileri, problem kurma, tahmin, planlama, izleme, değerlendirme

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Introduction

One of the main goals of education is to raise individuals who can overcome the challenges they encounter in society and their own lives, that is, quickly solve their problems (Diken, 2014). Like our country, many countries continuously update their education system and transfer the responsibility of learning from the teacher to the learner. In this sense, only a student possessing metacognitive skills can organize his/her learning process where he/she is responsible for learning, like in Türkiye and the international arena (Aydurmuş, 2013). Indeed, metacognition plays an essential role in verbal communication of information, reading comprehension, writing, language learning, social cognition, attention memory, problem-solving, self-control, and many types of self-learning (Flavell, 1979). For this reason, metacognition is an essential skill that students and all individuals should possess.

The concept of metacognition first emerged with Flavell's studies on metamemory in the 1970s (Desoete et al., 2001; Diken, 2014; Magiera, 2008; Tachie, 2019). The concept of metacognition is based on various concepts, including being aware of oneself and the way of learning (awareness), conscious behavior (consciousness), self-regulation and control, self-assessment, planning, and monitoring learning (Akben, 2018). "Metacognition" is often defined as "thinking about thinking," and although mainly associated with John Flavell (1979), different researchers made different definitions. Flavell (1979) defined metacognition as one's knowledge of their own cognitive processes and being able to control the thinking processes. He modeled it as a four-fold classification, expressed as metacognitive knowledge, metacognitive experiences, goals (or tasks), and actions (or strategies). Flavell (1979) emphasizes that many cognitive enterprises occur through action and interaction between these four phenomena (cited in Papleontiou-louca, 2003, p. 13). In this model metacognitive knowledge and metacognitive experiences differ from other types in terms of content and function. Flavell's model of cognitive monitoring summarized in Figure 1.

Recently, the definition of metacognition has been expanded and defined not only as "thoughts about thoughts" but also as awareness of one's own cognitive processes, taking into account his/her cognitive and affective states, and the ability to consciously and deliberately self-regulate and manage these processes according to the learning task (Kaberman & Dori, 2009; Papleontiou-louca, 2003). In this context, most researchers differentiate the two elements of metacognition; knowledge of cognition and regulation of cognition (Aydurmuş, 2013; Brown, 1987; Schraw, 1998). Knowledge of cognition refers to what individuals know and are aware of their own cognition or about cognition in general; regulation of cognition refers to a set of activities that enable students organizing and controlling their learning (Desoete, 2009b; Jacobs & Paris, 1987; Kyriakides et al., 2020; Papleontiou-louca, 2003; Schraw, 1998). In summary, metacognition consists of two main components: metacognitive knowledge, which is generally used to control one's cognition, and metacognitive regulation, which means monitoring one's cognition (Brown, 1987; Duman, 2013; Livingston, 1997; Schraw, 1998). Metacognitive knowledge, which can be defined as what we know about our own cognitive processes, refers to the knowledge gained about cognitive processes and can be used to control cognitive processes (Livingston, 1997) and can be summarized in three components: declarative knowledge, procedural knowledge and conditional knowledge (Kyriakides et al., 2020). On the other hand, metacognitive regulation refers to the activities used to regulate and supervise learning (Papleontiou-louca, 2003) and includes planning, monitoring and evaluation skills (Duman, 2013; Jacobs & Paris, 1987; Kyriakides et al., 2020; Özsoy, 2008; Schraw, 1998). In addition to these skills, the prediction skill should also be considered within the scope of these skills that form metacognitive skills, and this idea was largely accepted (Desoete al., 2001). In this context, the concept of metacognition can be modeled as in Figure 2.

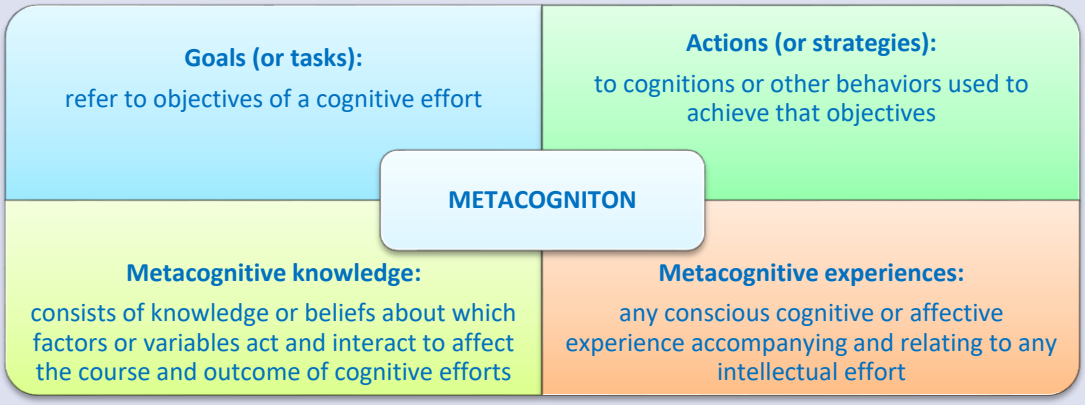


Figure 1. Flavell's model of cognitive monitoring

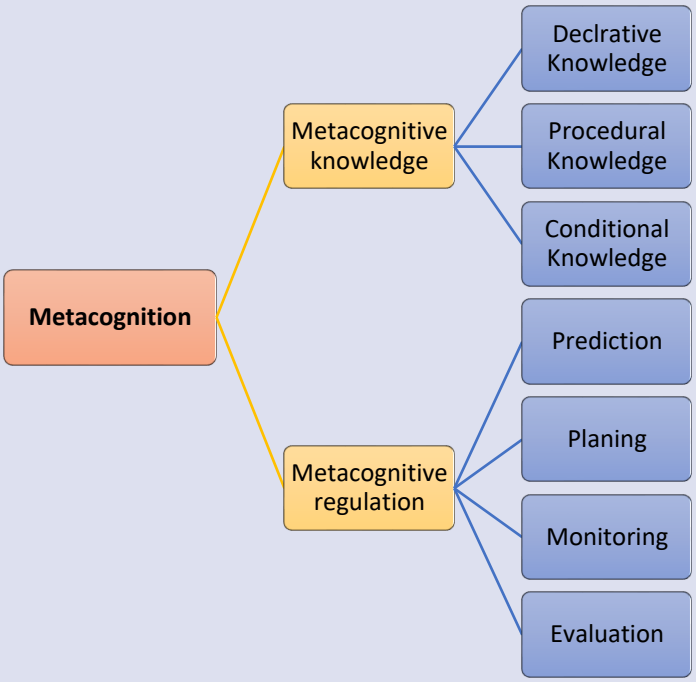


Figure 2. Flavell's model of cognitive monitoring

Metacognitive knowledge, which is the first component of metacognition, can be "stable, stable but fallible, or late developing", while metacognitive regulation, which is the second component, is 'relatively unstable, rarely stable, and age independent' (Kyriakides et al., 2020; Papleontiou-louca, 2003). In other words, metacognitive regulation can be thought of as actual activities that we engage in to facilitate learning and memory, unlike metacognitive knowledge (Schraw & Moshman, 1995). Metacognitive regulation includes planning activities, monitoring or awareness of comprehension and task performance, and evaluating the effectiveness of this processes and strategies, and the experiences gained in this process is essential for the development and refining of metacognitive knowledge (Lai, 2011). Therefore, metacognitive regulation not only allows students to control their own learning (Atay, 2014), but also allows them to adapt to successes and failures as well as changing task demands (Jacobs & Paris, 1987). In this context, this study focused on metacognitive regulation skills. These skills are explained below.

Prediction can be defined as a skill that enables children to think about learning goals, the process's learning characteristics, and the time required for the process (Aydurmuş, 2013; Desoete, 2008). In mathematics, prediction refers to activities that aim to differentiate challenging exercises from easy ones, concentrate more and be more insistent on tasks requiring high effort (Desoete et al., 2001). In this stage, the student makes preparation for the goal before starting the task he/she aims for. This skill enables the student to predict the challenges that may be encountered in reaching the goals he/she has determined by directing the student to think about how much time the task will take, how to reach the resources, and the results that may be achieved through these resources (Azak, 2015). Prediction skills enable children to predict the difficulties of tasks metacognitively, allowing them to work steadily on challenging tasks and faster on easier tasks (Desoete, 2009b).

Planning refers to choosing the best strategy for achieving the learning goal (Akben, 2018) and includes selection of appropriate strategies and allocation of resources that affect performance (Schraw, 1998). Planning skill allows students to think in advance about how, when, and why to act through a series of sub-goals to reach the goal after reading the main problem (Desoete, 2008). Planning includes analyzing exercises (e.g., it is a division exercise in number problem format), retrieving relevant domain-specific knowledge and skills (e.g., how to do divide), and sequencing problem-solving strategies (e.g., division of hundreds, tenth) (Desoete et al., 2001; Desoete, 2008). Examples include making predictions before reading, sequencing strategies, and selectively dedicating time or attention before starting a task (Schraw, 1998).

Monitoring means implementing the plans and then monitoring the process followed to achieve the learning goal (Akben, 2018). This skill can be defined as the self-regulation control of cognitive skills used to identify problems and change plans during the actual performance (Desoete, 2008). The ability to periodically self-test while learning is an excellent example for monitoring, which expresses one's awareness of comprehension and task performance (Schraw, 1998). Monitoring in the classroom context is related to the questions such as "Am I following my plan?", "Does this plan work?", "'Should I use paper and pen to solve the division?" (Desoete et al., 2001).

Evaluation refers to determining the strategy's effectiveness in reaching the learning goal (Akben, 2018) and evaluating the products and efficiency of one's learning (Schraw, 1998). In this stage, the student can evaluate his/her experiences from other stages and use this evaluation in the subsequent learning (Azak, 2015). Evaluation includes the reevaluation of the goals, answers, and the process of reaching these answers (Desoete et al. 2001; Schraw, 1998). In other words, children look at what they do and check what this leads to the desired result (Desoete, 2008). Evaluation skills enable children to evaluate their own performance, compare their task performance with others, and discover the errors in problem-solving process (Desoete, 2009b).

As can be understood from the explanations above, these skills allow controlling learning, planning, choosing appropriate strategies, monitoring progress, identifying, and eliminating mistakes, evaluating the appropriateness of the strategy, evaluating the learning process, and evaluating the outputs (Aydurmuş, 2013). Based on all the literature, it can be inferred that metacognition is "Experiencing one's cognitive processes through planning, monitoring, regulating, controlling, managing, evaluating and reflecting, and being aware of how one thinks and learns" (Akben, 2018).

There are many studies in the literature on metacognition. These studies can be classified under metacognitive behaviors (Azak, 2015; Fauzi et al., 2020; Magiera, 2008; Yıldız et al., 2011), metacognitive skills (Aydurmuş, 2013; Desoete, 2008; Tachie, 2019; Tuncer & Kaysi, 2013), metacognitive awareness (Atay, 2014; Bağceci et al., 2011; Deniz et al., 2014; Karakelle, 2012; Schraw, 1998; Yıldız, 2014); metacognitive strategies (Azak, 2015; Diken, 2014; Kaya & Kılıç, 2015; Okur & Azizoğlu, 2016; Tachie, 2019), the relationship between metacognition and problem solving (Desoete et al., 2001) and improving metacognition (Fisher, 1998; Hancock & Karakok, 2021; Kyriakides et al., 2020). In addition to them, there are many theoretical studies (Brown et al., 1982; Flavell, 1979; Jacobs & Paris, 1987; Livingston, 1997; Özsoy, 2008; Papleontiou-louca, 2003). The review of the studies shows that they primarily focus on metacognitive awareness and strategies, and metacognition is mainly associated with problem-solving. Nevertheless, there are limited studies on problem-posing and metacognition (Akben, 2018; Ghasempour et al., 2013; Kaberman & Dori, 2009; Karnain et al., 2014; Yüksel, 2019). Based on this deficiency in the literature, in this study, metacognitive regulation skills are discussed in the context of problem-posing activities.

Problem-posing and Metacognition

Problem-posing can be defined as the generation of new problems and mathematical questions, or the reformulation of problems when one restores or recreates a given problem to make a problem more accessible for solution (Nicolaou & Philippou, 2007). According to this definition, there are two different actions in problem-posing. The first is to generation of new problems, and the second is converting a given problem into a different representation, as Leung (1997) states. Therefore, problem-posing can occur during or after the solution of a problem (Silver, 1994). In addition, Baumanns and Rott (2022) described problem-posing as an activity involving regulation of cognition as metacognitive behaviour in problem-posing. Ghasempour et al. (2013) emphasizes that because, the habit of asking questions to oneself (such as “What … is changed?”, “What happens if …?” and “What if …not?”) is important for success in problem-posing attempts, metacognition has an important role in problem-posing activities; and because metacognitive skills play a critical role in successful problem-posing activities, it is important to examine metacognitive situations and strategies. However, there is limited study on metacognition related directly to problem-posing settings (Karnain et al., 2014).

Theoretical approaches to problem-posing state that problem-posing implicitly includes some aspects of metacognition and metacognitive regulation in particular (Baumanns & Rott, 2022). So that, problem-posing is seen as a function of complex and simultaneous growth in metacognition (English, 1998). Problem-posing activities can activate metacognitive skills, also called valuable control skills, to successfully implement problem-solving strategies; metacognitive skills play a critical role in successful problem-posing activities (Akben, 2018; Ghasempour et al., 2013). In addition, revealing students' metacognition during problem-posing activities is seen as a necessary step to move from theory to reality (Karnain et al., 2014). Related studies present that metacognitive skills are forefront in the implementation of metacognitive strategies and that problem posing activities can provides students developing their problem solving skills (Akben, 2018). However, the assessment of activities such as problem-posing, problem finding etc. is pending (Baumanns & Rott, 2022). For this reason, it is essential to examine students' metacognitive skills in problem-posing situations. On the other hand, regarding the studies on problem-posing and metacognition, three of them (Akben, 2018; Ghasempour et al., 2013; Kaberman & Dori, 2009; Yüksel, 2019) were related to the field of science. Among the related studies, only Yüksel (2019) examined the metacognitive strategies of secondary school students with high academic achievement in different types of problem-posing tasks, individually and in groups. Therefore, as Baumanns and Rott (2022) stated, future studies on problem-posing may inductively enrich the criteria of metacognitive behaviour within problem-posing. Teachers are the ones who will encourage students to think metacognitively by creating a communication environment in the classroom, encouraging students to validate, question, criticize and evaluate others' arguments, attempting to build knowledge through various processes, and encouraging students to produce new knowledge through self-discovery (Ghasempour et al., 2013). For this reason, the metacognitive skills that teacher candidates, who are future teachers, have and how they use these skills in

problem-posing situations are vital as they will affect their future teaching practices. However, whether teacher candidates have these skills and how they use them is still unknown. In this context, it is thought that this study will contribute to the literature in that it provides a theoretical framework for how metacognitive regulation skills emerge in mathematical problem-posing situations and that there is no study examining pre-service teachers' metacognitive regulation skills in mathematical problem-posing situations. This study aims to examine the metacognitive regulation skills of elementary mathematics teacher (EMT) candidates in problem-posing situations. Hence, the main problem of the research can be stated as "How do elementary mathematics teacher candidates display their metacognitive regulation skills (prediction, planning, monitoring, evaluation) in problem-posing situations?".

Method

Since the study aimed to examine the metacognitive regulation skills of the EMT candidates in detail in the problem-posing process the case study method, which is one of the qualitative research design and allows one aspect of the research problem to be studied in depth and in a short time (Creswell, 2007), was used in the study.

Sample

The participants were five EMT candidates studying in the 2nd year of a state university's Elementary Mathematics Teaching program in spring semester of the 2018-2019 academic year. The purposive sampling method was used to determine the participants, considering that it allows detailed research of the situations that are thought to be rich in information (Patton, 1997). Teacher candidates who participated in the study were chosen from among those who took the "mathematics and life" course, assuming that they know the role and importance of mathematics subjects in daily life thanks to the activities developing problem-solving and problem-posing skills in the lesson. Having experience with problem posing may be important in determining their metacognitive skills because more and more different problems can arise, and skills can come to the fore in this process. Attention was paid to the academic success of the five selected EMT candidates and their willingness to participate in the study. In addition, to obtain more in-depth data, the academic success of the teacher candidates selected for the study was medium and high. The literature indicates that metacognitive skills and academic achievement are related (Alkan & Açıkyıldız, 2018). It consists of pre-service teachers with an academic achievement score of 2.70 and a base. The participants were coded as S1, S2, S3, S4, S5. Demographic characteristics of the participants are shown in Table 1.

Table 1.Demographic information of the participants

Participants	Gender	Grade Point Average (GPA)
S1	M	3.37
S2	F	3.07
S3	F	2.90
S4	F	2.95
S5	M	2.79

Data Collection Tool and Application

The study data were collected using a semi-structured problem-posing activity called "House Problem". The House problem was designed for Leung's (1993) study to examine the effect of creative thinking on mathematical problem posing, based on a measure of creativity developed by Getzels and Jackson (1962). Several studies suggest that creative thinking is closely related to metacognition (Beghetto et al., 2011; Erbaş & Baş, 2015; Hargrove, 2013; Preiss et al., 2016) and stress the importance of metacognitive knowledge in helping individuals select, evaluate, and correct cognitive strategies for creative thinking (Armbruster, 1989; Davidson & Sternberg, 1998; Hayes, 1989). In this regard, the semi-structured problem-posing activity that was designed to reveal creative thinking was chosen as it would provide detailed data on metacognitive regulation skills. The researchers adapted the problem-posing activity to Turkish. The activity was examined by three experts, one of whom was a language expert and the other two were experts in mathematics education, who previously worked on problem posing and metacognitive skills. Necessary revisions were made in line with the experts' opinions, and the activity was finalized (in Appendix 1).

The activity, adapted into Turkish, was administered to teacher candidates by one of the researchers. During the application, EMT candidates were asked to think aloud and pose as many problems as possible, and if they wished, different types without any time limit. During the problem-posing process, teacher candidates were not intervened, and the process was audio-recorded, taking into account their voluntariness. After teacher candidates' problem-posing was finished, semi-structured interview questions prepared by the researchers were asked. This interview consisted of questions measuring teacher candidates' metacognitive regulation skills, allowing both to verify the data obtained during the problem-posing process and measure all their skills (Prediction, Planning, Monitoring, Evaluation). The relevant literature (Azak, 2015, Aydurmuş, 2013, Desoete, 2008, Schraw, 1998) pointed out that certain questions are important in determining metacognitive skills. Some of them stated that questions such as "reaching the goal while solving the problem, being successful or not, deciding how the solution will be, creating goals and sub-goals" are important. It has been seen that most of these studies in the literature are related to the problem solving process. Researchers thought that these questions might be important in the problem posing process of metacognitive skills, and they revised these questions again. The questions were finalized in line with

the opinions of experts working in the field of metacognition and problem posing skills (Table 2).

Data Analysis

In the study aiming to determine the metacognitive regulation skills of EMT candidates in the problem-posing process, the data were analyzed using the descriptive analysis technique. In this study, teacher candidates were asked to pose different problems in the semi-structured problem-posing activity. The audio recordings taken during teacher candidates' problem-posing activity and the data obtained from the interview made by the researcher at the end of the activity were analyzed by three researchers, who are experts in the field of mathematics education and have previously worked on problem posing and metacognitive skills, prepared based on the literature (Aydurmuş, 2013; Azak, 2015; Desoete et al., 2001; Desoete, 2008; Schraw, 1998). In this context, eight sub-codes were identified for the prediction skill, six for planning, nine for monitoring, and eight for evaluation skill, which are thought to constitute metacognition regulation skill. These codes were submitted to the opinion of two mathematics education experts. According to expert opinions, some codes were removed because they expressed the same behavior; some were revised in terms of language and comprehension and got their final form. For example; In the estimation skill, the criterion in the form of "Thinking about solving the problems he has established (If I make snow, insulation...)" with expert opinions, "Thinking about the variables of the problems he has established (If I make snow, insulation, simple interest)?" and "Estimating according to the difficulty level of the problem it posed". The expression "planning about time before the problem-posing" belonging to the planning skill was similarly excluded from the sub-codes in line with the expert opinions. Because it was thought that it would be more appropriate to use this code in the problem solving process rather than the problem posing process. The development process of the theoretical framework is summarized in Figure 3.

The final version of the theoretical framework is presented in Table 3.

In this framework, the prediction skill was analyzed under six codes, planning under six, monitoring under eight, and evaluation skill under seven codes. The frequencies of the obtained data were taken according to these codes.

Table 2.Questions asked during the problem-posing process for measuring metacognitive regulation skills

Metacognitive Regulation Skills	Questions asked in the problem-posing process
Prediction	What are the points you might have difficulties with while posing a problem?
Planning	What is your objective in your problem? In what order should things be done when posing the problem? What is the preliminary information that can help in posing the problem?
Monitoring	Did you need to go back in the process of posing the problem? Did you regularly check the problem that you posed? How did you proceed while posing the problem? Does your problem fit the plan? If not, how should planning be changed? Is there anything you want to change in the problem you have posed?
Evaluation	Did you achieve the problem you planned? Did you check if the problem you posed is logical and solvable? Did you check the problem you posed to detect errors (reviewing the adequacy of the problems posed in terms of language and expression) ? What would you do differently if you were to pose a problem again?

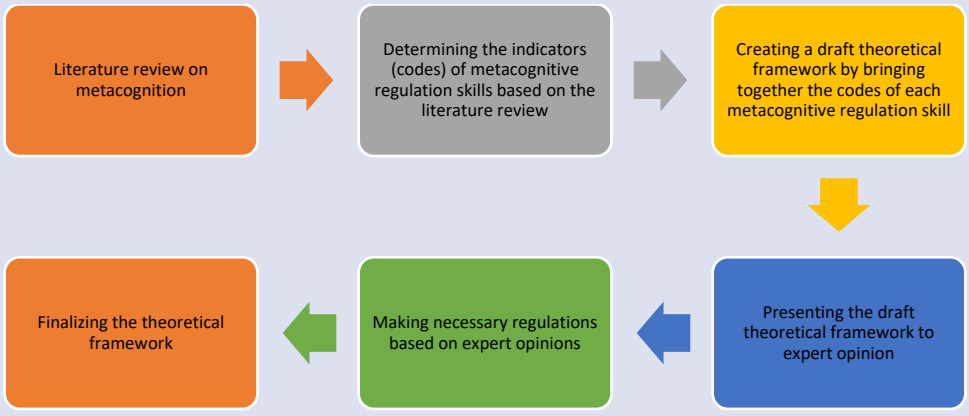


Figure 3. The process of developing the theoretical framework

Table 3.Codes for measuring metacognitive regulation skills

Regulation skills	Codes
Prediction	Predicting the number of problems he/she would pose Thinking about the variables of the problems he/she would pose (Shall I pose a problem involving profit, insulation, simple interest?) Predicting the difficulty level of the problem he/she posed Predicting the information to be used and how to use them (home loan, for heating) Anticipating difficulties and expressing expectations according to this prediction Reading the semi-structured problem, checking the numbers given in the problem, underlining critical words, taking notes on the paper, or circling them.
Planning	Determining the goal and sub-goals related to the problem to be posed Expressing in advance what can be asked for the determined purpose Being able to make Strategic Planning (plans or designs made to reach the goal) Reviewing the information required for the problem to be posed (for example, for thermal insulation, choosing the terms about thermal insulation from the text) Organizing the preliminary information that may help pose the problem (the data to be used for thermal insulation, checking the adequacy for the problem) Determining the order of the actions that will be carried out in the problem to be posed (take a loan first for thermal insulation and rental costs?)
Monitoring	Reviewing his/her prior knowledge belonging to the problems while posing the problems. Checking whether he/she progressed correctly while posing the problem (Did I proceed correctly?) Thinking about making changes while posing a problem (Should I make a change? Is it understandable as it is?...). Checking whether he/she has already asked the problem he/she has posed (Have I asked this before?). Checking whether he/she has used the information related to the problem elsewhere Thinking about how to proceed while posing problems (How should I proceed?) Needing to go back to the problem while posing a problem Checking the posed problem regularly
Evaluation	Checking whether the problem posed is suitable for his/her goal Expressing why he/she could not reach the problems he/she aimed Expressing his/her thoughts on what to do differently if he/she would pose the problem again Checking whether the problem posed is logical and solvable Checking the comprehensibility of the problem posed (reviewing the adequacy of the problems posed in terms of language and expression) Evaluating the problem posed according to the degree of difficulty. Reading the problem posed

According to Table 3, these skills can be explained as follows:

Prediction skill: The prediction skills include teacher candidates' reading the semi-structured problem before posing the problem, checking the numbers given in the problem. Similarly, teacher candidates' comments on what to ask and how in their problems (for example, should I make a profit, add the cost of heat?...), their thoughts on the problems' difficulty level, comments on the information and how they can use them, anticipating the difficulties they may encounter while posing problems and arranging the problems according to their predictions were also considered within the prediction skills.

Planning skill: The planning skill involves teacher candidates setting goals and sub-goals related to the problems they will pose and reviewing the given information in this direction, deciding how to use the information and in what order, and making the necessary calculations for the problems they will pose.

Monitoring skill: The monitoring skill includes teacher candidates sticking to their plans and reviewing their information about the problems according to this plan, reading what they have written and making the necessary changes in this direction, checking how the problem progresses, being aware of where they have used the knowledge about the problem before, and confirming or making changes on the problem considering the solutions of the problems they have posed.

Evaluation skill: The planning skill involves teacher candidates re-reading the problems they have posed and reviewing them according to their goals, examining the problems they have created according to their difficulty levels, whether it is solvable and reasonable and checking whether the problems are understandable in terms of language and expression.

In this direction, the behaviors and thoughts (pause, deletion, etc.) of the EMT candidates during the problem-posing process was noted in the transcription of the audio recordings. Their frequencies were taken according to the criteria displayed in Table 3.

Validity and Reliability of the Study

In qualitative research, four criteria (credibility, transferability, consistency, confirmability) put forward by Lincoln and Guba (1985) were used instead of the concepts of validity and reliability. Teacher candidates were asked to think aloud while posing the problem. In addition, the behaviors of the EMT candidates in this

process (reading the problem, deleting the problem, posing the problem, underlining the problem) were noted by the researcher, along with their thoughts aloud to increase the consistency of the study. After completing the problem-posing process, the researcher interviewed the EMT candidates to increase the credibility of the data obtained. The data obtained during the research process were presented to the reader after being organized under themes and categories without adding any comments, adhering to the nature of the data. In this way, it has been aimed that the readers reach the results related to the researched subject more clearly. The data was also coded by researchers separately and then with together. Different codes were discussed, a consensus was reached about the relevant code, and finalized. Thus, the confirmability of the study was established.

Findings

Regarding EMT candidates, S1, S2, and S4 posed five problems; S3 posed six, and S5 posed two problems. However, the first problem posed by the teacher candidate S3 was not a mathematical problem but only a statement reflecting a situation, and it was omitted from the analysis. Teacher candidates' metacognitive regulation skills in their posed problems were examined according to the sub-skills (Prediction, Planning, Monitoring, and Evaluation skills).

Findings on S1's metacognitive regulation skills in the problem-posing process

S1 posed five problems. S1 was observed to start to pose problems by reading the semi-structured problem aloud and checking the given numbers before posing the problems. In this direction, S1 started to pose a problem by performing the operations in Figure 4 with the following explanations:

"Now Onur will buy a house worthing 600 thousand liras, let's write this down. He pays 200,000 liras down payment when buying the house. Then he says that he has planned to pay the remaining money by dividing it into … monthly installments. Regarding monthly payments, there is 8% interest on the principal (he thinks) by paying 200,000 lira; he got rid of the high interest brought by the 200,000 lira of the principal. Well, the interest rates include an insurance amount of 5,180 lira every year. Onur talks to the former owner of the house and learns that the monthly average heating fee of the house is 800 lira, and upon this, he will build an insulation system, which guarantees to reduce the heating fee of the house by 15%. So here we are again aiming for profit. He spent 16,000 lira on this insulation system. Hm-mm (he thinks) let's see."

It was seen that S1 read the data in the semi-structured problem one by one and tried to understand the scenario by underlining the parts he deemed critical. S1's behaviors of reading the semi-structured problem, checking the numbers given in the problem, underlining critical words, taking notes on paper, or circling them, belong to the prediction skills.

"For this, I will first add all the expenses I have made up to now. I bought the house for 600,000 lira, but it is not all. Here, it says 8% over 400 …..5180… (he thinks). (Reread the question), (Making operation on the calculator) 600000+32000+5180+800x12. If we continue without installing the heating, we will spend 646,780 TL for one year. However, let's see how much the cost will decrease if we have insulation. (Making operation on the calculator) 600000+32000+5180+16000+620x12. Here, something like this came up, 660620. Now, something like this, ok, another problem came to my mind. Now we have made insulation for the cost of heating…..I say as an extra that is… Ok. I am writing the first problem. If we make the insulation and consider that it is rented for X TL per month, how can we do … So if we add the insulation costs to the rent within a year, how much will the monthly rental amount increase? It may be our first problem. (Planning-Monitoring-Evaluation)

S1 reviewed and worked on the preliminary information while posing a problem. In addition, he has set goals related to the problem to be posed. The explanation made by S1 has been considered as the Planning skill. In addition, re-reading and thinking about the problem while posing was evaluated as a Monitoring skill. On the other hand, S1 did not reread the problem after posing and did not explain the number he expressed with x% (see Figure 5). Therefore, S1 was observed to fail to evaluate the problem with this behavior.

"What did I say about the problem at first… It is monthly… There are two problems here. If we install the heating system, umm… and offer it for sale or rent, the tenant must pay us a certain amount. Now how can we develop a mathematical model from there? We can say this. Maybe I have to write it. (He writes the problem on the paper) By not installing heat insulation…" (Monitoring-Prediction)

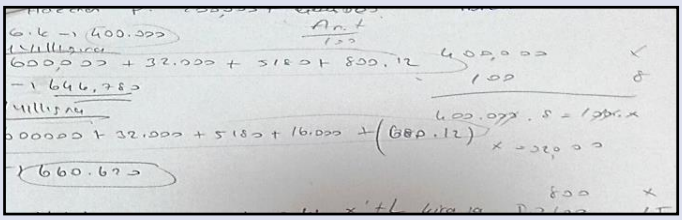


Figure 4. Problem posing activity of S1

S1 turned back to the first problem with his statement, "what did I say at the beginning..." and reviewed his preliminary information about the problems he had posed. This behavior of S1 has been identified as a Monitoring skill. It was seen that he did not make a plan about the problem he would pose with the phrase "I may remember if I write it." Its explanation, "If we offer it for sale, if we offer it for rent, then the tenant has to pay us a certain amount," has been identified as a prediction skill.

"I tried to make it a little hard. Now I want to make it harder here, but... Maybe I can make the insulation at the owner's expense this time? I can do it. Now, in the first question, we had made the insulation, we made the thing, tenant paid the extra heating and insurance fees. Now, what if we pay for the heating and insurance here, and a friend does the insulation? I can write that too. Nevertheless, I think something more original could come." (Evaluation-Monitoring)

Regarding the above explanation, S1 was observed to go back and check the problems he posed sometimes. He examined the problems about what he asked, looked back at what was asked in the problem posed, and thought about the solution of the problems he posed. The teacher candidate thought about what kind of question would be difficult and made comments based on the existing information.

The frequencies of the metacognitive regulation skills of the teacher candidate S1 in the problem-posing process are shown in Figure 6.

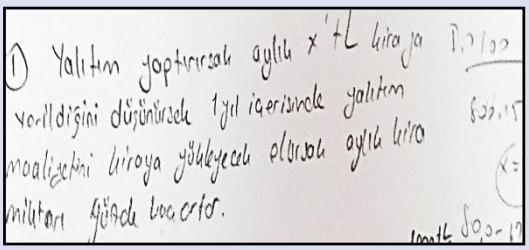
Regarding Figure 6, the monitoring and prediction skills of S1 are more prominent than his planning and evaluation skills.

Findings on S2's metacognitive regulation skills in the problem-posing process

S2 posed five problems within the semi-structured problem-posing activity. S2 first read the semi-structured problem-posing scenario and reviewed provided information. In addition, S2 has decided on the sequence of the problems posed in advance. She occasionally returned to the original problem scenario during the problem-posing process and checked whether she misunderstood any part of it. This behavior of S2 has been identified as a behavior for the Monitoring skill. Afterward, the teacher candidate thought about the problem's solution and interpreted what information to use and how.

"I would set a few steps. I would ask how much he paid in the first year, calculating the full money he paid to the bank. I would ask the amount of interest he withdrew from the bank with simple interest. I would ask how much he paid." (planning)

This explanation of S2 shows that she set goals and sub-goals related to the problems she would pose. This explanation showed that S2 planned the posed problems. Similarly, S2's "*To avoid confusion, I can ask him to withdraw 1,600 TL from the bank with interest*" statement shows that she thinks in a solution-oriented way. Expressing her thoughts on the solution to the problem that she would pose was also considered as a Planning skill.



English Description: "If we make the insulation, assuming to rent it for X lira/month, if we add the insulation cost to the rent for one year, how much the monthly rent will increase?"

Figure 5. A problem posed by S1

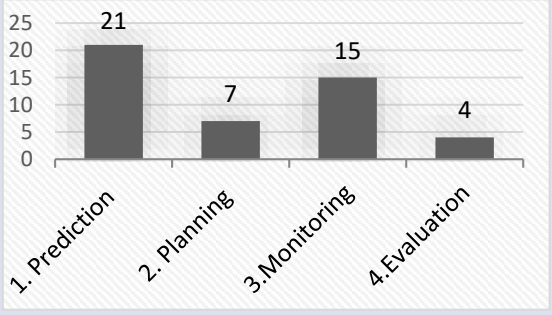


Figure 6. Frequencies of S1's metacognitive regulation skills

After the problem-posing process was completed, the researcher asked the teacher candidate, "*Is there a question you would like to change*?" She answered, "*Yes, maybe I can change a few of my questions.*" She expressed the reason for this situation as "*I would change the questions according to the student group I will ask, for example, this question, I don't want to scare my students*." It was observed that S2 actually evaluated himself with these statements. She was aware of the difficulty levels of the problems that she has posed and made predictions for this.

The frequencies of the metacognitive regulation skills of the teacher candidate S2 in the problem-posing process are shown in Figure 7.

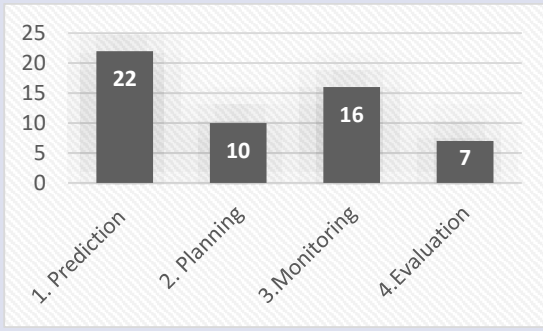


Figure 7. Frequencies of S2's metacognitive regulation skills

Regarding Figure 7, the monitoring and prediction skills of S2 in the problem-posing process are more prominent than planning and evaluation skills.

Findings on S3's metacognitive regulation skills in the problem-posing process

S3 started the problem-posing process by reading the semi-structured problem-posing activity. In order to understand the problem-posing activity, S3 underlined the critical parts of the problem and tried to make mathematical operations in the activity. S3 made predictions about the information used and how to use it. S3 has posed six problems. However, the first of these problems was not a problem, but only a statement containing a situation. The first problem of S3 is as follows:

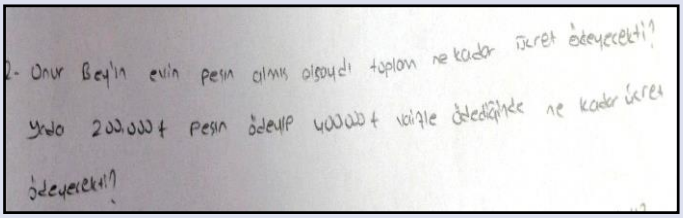
"How to improve the quality of the insulation system?" After the problem-posing process of S3 was completed, the researcher asked her, "*Are there any problems you would like to change if you start the problem-posing process again?*" She looked at the problems she wrote and said, "*Actually, I would like to change my first problem because here I asked logical inferences; I could have asked an operational question instead. Here, I increased the money to be spent on the insulation system so that the insulation would be of better quality, and the heating fee would be reduced*." This statement of S3 shows that she reads and re-evaluates the problems after posing them. Besides, there is a solution-oriented idea in her statement, indicating that she made a plan while posing the problem.

"*Then let's say Onur had bought the house for cash, ummm, how much would he have paid, for example. I mean, he would pay 200 for cash and hmmm... 400 with interest, and how much would he pay in total? I couldn't fully conclude. If he had bought it for cash, how much would he have paid in total, or when he paid 200,000 (writes the problem) with interest?* With this explanation, the problem written by S3 is presented in Figure 8.

This explanation shows that S3 did not set a goal while posing a problem and did not evaluate the problem she wrote in terms of language and expression.

S3 has been observed to review the preliminary information about the problems she posed, sometimes checking whether it is progressing correctly or not, and sometimes thinking about making changes in her problem. In addition, she did not feel the need to go back to her problem during the problem-posing process. She expressed her thoughts about how to proceed while posing a problem. The frequencies of the metacognitive regulation skills of the teacher candidate S3 in the problem-posing process are shown in Figure 9.

The monitoring and prediction skills of S3 are more prominent than planning and evaluation skills.



English Description: *"If Onur had bought the house in cash, how much would he pay? Or how much would he pay by paying 200,000 in cash and 400,000 with interest?*

Figure 8. A problem posed by S3

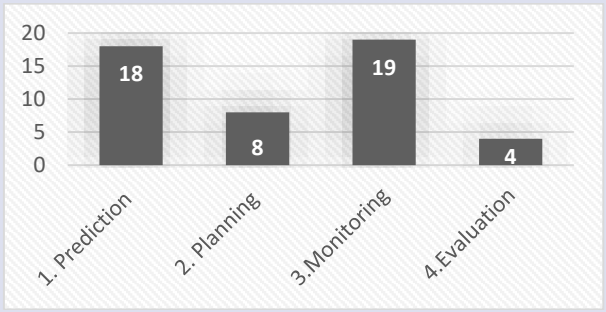


Figure 9. Frequencies of S3's metacognitive regulation skills

Findings on S4's metacognitive regulation skills in the problem-posing process

S4 posed six problems. S4 read the semi-structured problem aloud, checked the numbers given in the problem, and underlined critical words. These behaviors of the teacher candidate are metacognitive and evaluated as behaviors related to the prediction skill. Before starting the problem-posing process, the researcher asked the teacher candidate, "*What are the points you may encounter difficulty in problem-posing*?". The teacher candidate answered the researcher's question as follows: "*Maybe calculating 8% interest on the principal… In calculating and changing the data*". This answer of the teacher candidate was evaluated as a prediction skill from metacognitive regulation skills. S4 made a prediction about the problem she will pose using the given information by reading the words she underlined and expressing her thought as "*there is a home loan, there is a heating fee, there is insurance… how can I ask with this information, that is, should I ask one of them.*"

S4 said, "*Let Onur buys the house without giving any money in advance and let him pay a certain amount of money every month, and then I can pose a problem so that an interest is charged to the money*." The teacher candidate has set a goal related to the problem she will pose with this statement. Therefore, this behavior of the teacher candidate was evaluated as a planning skill. S4 was observed to start writing the problem after this statement. She continued to express her thoughts aloud while posing the problem. S4 said about the problem she has posed in this process: "*However, he does not pay in advance for this. (She returns to the main text again and looks carefully) How much money should he pay in advance… it's ok if he pays 10 thousand every month, 10 thousand for 3 months. I guess later…*" Here, S4 attempted to make a strategic plan for the problem she wanted to pose. Teacher candidates returning to the main text and examining the text in more detail for the problem that she wanted to pose was evaluated as a Monitoring skill. In addition, the statement of the teacher candidate for the solution of the problem, that is, to pay 10 thousand Turkish Liras every month for 3 months, was identified as a metacognitive skill for the prediction skill of the candidate. Teacher candidate S4 made calculations for the house price with the amount paid later, and she expressed this process as follows: "*How much did he pay now? (makes calculations by looking at what she wrote) 30 thousand, ok. The house is worth 600,000 TL… Then, how much is left when 30,000 TL was paid? 570000TL. We will go from easy to difficult, let him pay it within 57 months. How many years are 57 months? Since he has paid 4 years and 9 months, how much will he pay each month?*" It was observed that the teacher candidate read what she wrote starting with "How much did he pay now?" and calculated accordingly. This behavior of the teacher candidate was identified as a Monitoring skill. At the same time, it was seen that she continued to write the problem with the calculations in her hoose-related fiction. The teacher candidate made predictions about the difficulty level of the problem she posed when she said, "*We will go from easy to difficult*." This thought of the candidate is a skill that belongs to the prediction. Her statement "*Let him pay within 57 months*" and writing this statement as month and year are also evaluated as a behavior belonging to the Planning skill. The teacher candidate did not read the problem after posing the problem and did not evaluate whether the problem was understandable or not. The researcher asked the following question to the teacher candidate regarding this situation at the end of the study:

R: Have you read the problems you have posed?

Q4: I haven't read them, but I don't think it will be a problem.

It has been determined that the teacher candidate did not evaluate this question with her answer. At the same time, the review of the problems posed by S4 showed that they should be revised in terms of language and expression, as in Figure 10, which points that S4 has not evaluated the problems she has posed.

It has been concluded that S4's other problems need to be re-evaluated in language and expression, as in Figure 10.

The frequencies of the metacognitive regulation skills of the teacher candidate S4 in the problem-posing process are shown in Figure 11.

Regarding metacognitive regulation skills, monitoring and prediction skills of S4 are more prominent than planning and evaluation skills.

Findings on S5's metacognitive regulation skills in the problem-posing process

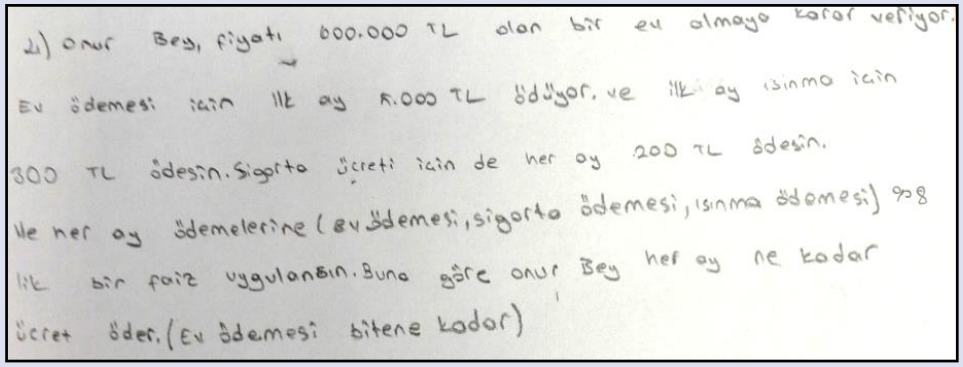
S5 started the problem-posing process by reading the problem. S5 was observed to underline the necessary parts while reading the problem and noted down the numerical values given on the paper. S5 posed three basic problems and created sub-problems for each problem. S5 made various calculations for the solution of the problem he was going to pose, and he planned what he wanted to ask in this problem. The calculations made by S5 are shown in Figure 12.

S5 made the following statement to the researcher regarding the problem he posed: "*I asked two questions in one question. To answer one, he/she has to find the other's solution (re-read the question and tried to reveal something)*". With this explanation, S5 created a goal for the problem he posed and planned another sub-goal in line with this goal. In addition, re-reading the problem posed was evaluated as a Monitoring skill.

"But what am I going to teach the children here is a mystery… You know, they'll gain a few computation skills, that's all…" This statement by S5 shows that he is evaluating whether the problem he posed is suitable for his purpose. In addition to this, the expression "...*what am I going to teach here is a mystery*..." shows that he has not set a goal and made a plan for the problem he will pose.

He made a prediction about the problem he will pose by saying, *"Let's omit isolation from the question; it might be unreasonable."* Similarly, his explanation, "*The answer will be half-integral in this question, they should get used to it in the answers*," shows that he did planning for the solution of the problem he posed.

His statement, *"It was an inverted sentence (he read what he wrote and deleted it, retyped it, and reviewed what he was doing). Let them not misunderstand."* shows that he evaluated the problem he posed in terms of language and expression; in addition, reading and reviewing the problem show that he monitors what he does.



English Description: *"Onur decides to buy a house worthing 600,000 TL. He pays 5,000 TL for the house and 300 TL for heating in the first month. He pays 200 TL for insurance every month. An interest of 8% is applied to his monthly payments (house, insurance, heating). Accordingly, how much should Onur pay every month (until the payment of the house is over)?"*

Figure 10. A problem posed by S4

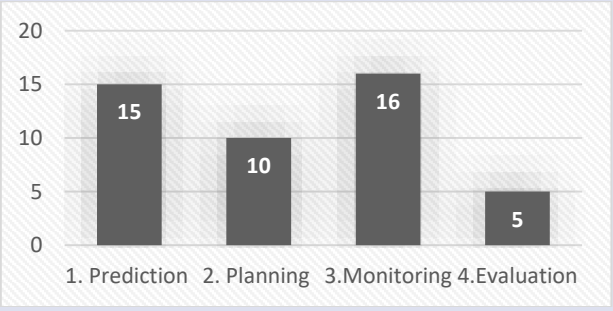
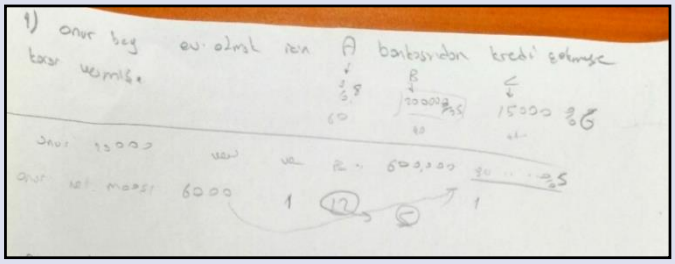


Figure 11. Frequencies of S4's metacognitive regulation skills



English Description: “Onur decided to take credit from Bank A to buy a house.
Onur 20,000 …..
Onur's net salary 6,000”

Figure 12. A problem posed by S5

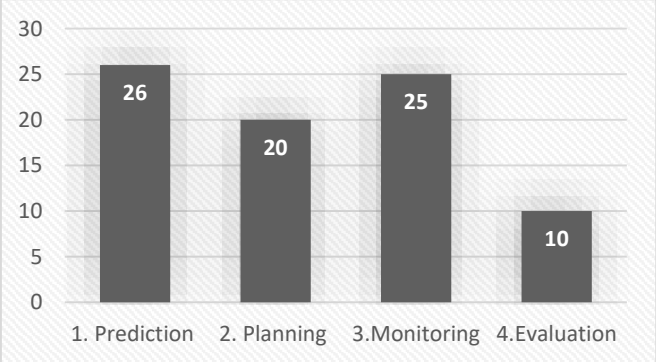


Figure 13. Frequencies of S5's metacognitive regulation skills

Table 4. Frequencies of metacognitive regulation skills of EMT candidates observed in problem-posing activity.

Teacher Candidates	Skills			
	Prediction	Planning	Monitoring	Evaluation
S1	21	7	15	4
S2	22	10	16	7
S3	18	8	19	4
S4	15	10	16	5
S5	26	20	25	10
Total				

This explanation shows that S5 did not evaluate the problems he posed. However, during the problem-posing process, it was determined that S5 evaluated some of the problems that he posed. For example, the following statements of S5, "*But what am I going to teach the children here is a mystery … they'll gain a few computation skills, that's all …" or "…so this question might be for a primary school kid,"* show that he evaluated the problem he posed in terms of difficulty level and the suitability to the goal. S5 answered the question, "*In addition, is there any part you would like to change?*" as *"I have inverted sentences, I want to change them."* This showed that S5 reviewed the problems he posed in terms of language and expression. The frequencies of the metacognitive regulation skills of EMT candidate S5 in the problem-posing process are shown in Figure 13.

Figure 13 shows that S5's prediction and monitoring skills are high. Besides, his planning skill is higher than his evaluation skill.

Accordingly, the information about the metacognitive skills used by the teacher candidates participating in the study while posing problems are presented in Table 4.

As seen from Table 4, EMT candidates' prediction and monitoring skills are higher than their planning and evaluation skills in the problem-posing process. In fact, S5 is the teacher candidate who uses these skills the most regarding Table 4. A more detailed examination of the table shows that the prediction skills of S1, S2, and S5 are higher than their monitoring skills. Similarly, the

behaviors of these teacher candidates towards planning and evaluation skills are better than other teacher candidates.

Discussion, Conclusion and Suggestions

This study, which examined the metacognitive regulation skills of elementary mathematics teacher candidates in problem-posing situations, concluded that the prediction and monitoring skills of the teacher candidates are higher than their planning and evaluation skills.

One of the metacognitive regulation skills EMT candidates exhibited most during the problem-posing process was the prediction. Teacher candidates' sub-skills such as making predictions about which information they would use the most, reading the problem, checking the information given in the problem, underlining essential words, taking notes on the paper, and thinking about the variables of the problems were prominent. Predicting the difficulty level of the problems posed was the least emerging sub-skill. As a metacognitive skill, the prediction skill directs the student to think about the most likely goal to be reached, the time that the process will take, and the appropriateness of the results (Serin & Korkmaz, 2018). Aydurmuş (2013) states that the sub-skills of the prediction are used at the beginning of the problem-solving process, and therefore they are independent of the students' planning and implementation steps. According to this statement, it can be said that in a successful problem-solving process, the strategies of the prediction skill are used as much as the Planning and Monitoring skills. In this study, teacher candidates showed more sub-skills of the prediction skill but could not sufficiently exhibit the sub-skills of planning. This situation resulted from EMT candidates failing to create goals and sub-goals when starting to pose problems.

The study concluded that teacher candidates' planning skills in the problem-posing process were lower than their prediction and monitoring skills. During the problem-posing process of EMT candidates, the most common planning sub-skills were reviewing the information required for the problem and organizing the preliminary information that may help pose the problem. On the other hand, after reviewing the data for the planning skill, EMT candidates only decided what to ask in the process. They did not determine the order in which the actions within the problems should take place, did not make strategic planning, and did not create goals and sub-goals for their problems. EMT candidates' failure to demonstrate their metacognitive regulation skills for planning caused them to constantly go back and check and review what they did during the problem-posing process. It is thought that teacher candidates' monitoring skills are higher because they do not take enough action for Planning before they pose their problems. This result of the study differs from the results of Karnain et al. (2014). In the study conducted by Karnain et al. (2014) with 21 students to examine the metacognitive skills of secondary school students during mathematical problem-posing activities, it was concluded that the students equally use planning and monitoring skills in the problem-posing process. This situation resulted from the fact that secondary school students exhibited many planning skills at the beginning of the process for the non-routine problem-posing activity used in the study, such as identifying the goals and sub-goals, making sense of the problem, sorting out the given information, and researching any examples used in the past. Regarding the studies involving metacognitive skills in the problem-solving process (Aydurmuş, 2013; Kavlak, 2019), planning skill is one of the skills with the least data in terms of using metacognitive strategies. In his study, examining the metacognitive skills of 7^{th} grade students in solving and posing mathematical problems, Kavlak (2019) showed that some of the students skipped the planning step because they wrote the first problem that came to their mind and started working on it. It is necessary to conduct studies to improve teacher candidates' planning skills. In Özsoy's (2007) study, in which he implemented an instruction to help fifth-grade students acquire metacognitive strategies, it was concluded that the students' planning skills developed the most. Based on this, it is recommended to conduct studies on teaching metacognitive strategies to improve teacher candidates' metacognitive skills in the problem-posing process.

Another metacognitive regulation skill EMT candidates exhibit most during the problem-posing process is monitoring. This situation resulted from the fact that pre-service teachers often felt the need to go back while posing a problem, as they exhibited a few sub-skills for planning the problem they would pose. Hence, the sub-skills that EMT candidates use most while posing problems are checking whether they were progressing correctly, thinking about how to proceed, and checking whether they asked the posed problem before. Nevertheless, EMT candidates who failed to identify the preliminary information about the problems to be posed at the beginning had to review it for each problem they posed. In this context, teacher candidates' failure to take enough action for planning has affected the high level of monitoring skills. Similarly, regarding studies examining metacognitive skills in problem-solving, some of them reported that students' monitoring skills are high (Aydurmuş, 2013; Sevgi & Çağlıköse, 2020).

The study concluded that teacher candidates' evaluation skills in the problem-posing process were lower than the other skills. It has been determined that EMT candidates did not read the problems they pose, did not review them in terms of language and expression, and therefore did not evaluate their problems. Among teacher candidates, only S1 and S5 evaluated their problems regarding whether they could be solved or not, whereas other teacher candidates evaluated them after the questions the researcher asked at the end of the process. In addition, it was observed that teacher

candidates did not check whether the problems they posed were suitable for their goals. Parallel to this result, studies examining metacognitive skills in the problem-solving process (Aydurmuş, 2013; Sevgi & Çağlıköse, 2020; Yıldız, 2013) have found that students do not use their skills to evaluate the problem-solving process. As Aydurmuş (2013) states, this may be because students encounter multiple-choice problems more often in their school life, and they end the problem-solving process and move to other problems when they reach one of the alternatives in multiple-choice problems.

The findings highlighted that teacher candidates did not do strategic planning while posing problems, and they did not set any goals for the problems they would ask. During the study, teacher candidates did not evaluate the problems they posed, especially at this stage. It was concluded that teacher candidates' evaluation and planning skills in problem-posing activity are weak. The results of many studies examining the problem posing skills of teacher candidates also state that teacher candidates have difficulties in posing problems and their problem posing skills are not at a sufficient level (Güveli, 2015; Işık & Kar, 2012; Leavy & Hourigan, 2020; Van Harpen & Sriraman, 2013). In addition, in the problem posing studies conducted with teacher candidates, it is among the results that the participants did not evaluate the problems they posed (Bayazit & Kırnap-Dönmez, 2017) and had difficulty in changing the problems they posed (Breda et al., 2017; Mallart et al., 2018). Therefore, the fact that teacher candidates did not adequately display metacognitive behaviors towards the evaluation step in problem posing situations may also be related to the results mentioned. In this context, it is recommended to carry out studies to improve teacher candidates' behaviors towards the evaluation step in the problem posing process.

Metacognitive skills significantly affect problem-solving strategies, and problem-posing exercises increase success in problem-solving. For this reason, students' problem-posing exercises should include activities that question their thinking processes. In the study of Yıldız and Güven (2016), examining mathematics teachers' behavior that activates their students' metacognition in problem-solving environments, the study determined that no teacher attempted to activate their students' metacognition in the problem-posing step. In order for teacher candidates to develop their students' metacognitive skills in the problem-posing process in the future, they must first have these skills (Alkan & Açıkyıldız, 2020; Yıldız & Güven, 2016). Md. Nor and Ilfi (2012) state that metacognition stages may occur in problem-posing activities and lead students to produce solvable problems. They also state that guiding students through metacognitive clues at these stages will form the basic structure of problem-posing activities. For this reason, it is recommended to increase studies on metacognitive strategies and their teaching in the elementary mathematics teaching undergraduate curriculum to raise students who are successful in problem posing. Among the results of the study, it is stated that the teacher candidates did not use the metacognitive skills for the evaluation step sufficiently. In this context, it is suggested that in problem posing practices, encouraging studies should be carried out in order to check whether the problems posed by the teacher candidates are suitable for the objectives, whether the posed problem is logical and solvable, and the clarity of the posed problem, and also to express what differences they can make if they pose a problem again. For this reason, presenting and discussing the products that emerge at the end of each problem-posing practice in the classroom can help teacher candidates engage in more metacognitive behaviors in the evaluation process. In addition, carrying out problem posing practices with group work can also contribute to the development of evaluation process skills. Besides, even though the textbooks published in recent years contain more illustrative examples emphasizing metacognitive actions performed in problem-solving (Aşık, 2015), it is suggested to emphasize problem-posing activities and metacognitive actions in the course materials. Thus, the awareness of teachers and students about the importance of metacognition will increase, and they will use these actions in their lessons and transfer them to their students more frequently.

The results obtained from this study are limited to the studies of 5 EMT candidates on a semi-structured problem posing situation. In future studies, the results obtained can be tested by working with different types of problem posing activities with more participants. In addition, in future studies, learning environments that will activate teacher candidates' metacognitive skills in problem posing practices can be designed and its effect on the development of metacognitive skills can be examined.

Genişletilmiş Özet

Giriş

Flavell'in 1970'li yıllarda üst bellek (metamemory) ile ilgili yaptığı çalışmalar sonucunda ilk defa ortaya çıkan üstbiliş kavramı, bireyin bilişsel süreç deneyimlerinden edindiği bilgileri kapsamaktadır (Baltacı, Yıldız & Güven, 2011). Üstbiliş hakkında alanyazında çeşitli tanımlar bulunmakla birlikte, Flavell (1979) tarafından ifade edilen; bireyin kendi bilişsel süreçlerinin farkında olup bu süreçleri kontrol edebilmesi, en çok kabul gören tanım olarak karşımıza çıkmaktadır. Bilişsel süreçlere yönelik farkındalık öğrencinin ne bildiğine ve nasıl öğrendiğine yönelik bilgisini ifade etmekte; tahmin, planlama, izleme ve değerlendirme becerileri ise bu bilişsel süreçlerin kontrolünü içermektedir (Aydurmuş, 2013). Üstbilişsel beceriler olarak ifade edilen bu becerilerden tahmin aşamasında birey göreve başlamadan önce hedefine yönelik plan yapma hazırlığı içerisinde bulunmaktadır. Tahmin becerisi öğrenciyi, belirlediği hedeflere ulaşmada karşılaşabileceği zorlukları öngörmeye; çalışmalarının ne

kadar süreceğini, kaynaklara nasıl ulaşacağını ve bu kaynaklar aracılığıyla ulaştığı sonuçlar hakkında düşünmeye yönlendirir (Azak, 2015). Planlama becerisi, ana problemi okuyan öğrencilerin hedefe ulaşmak amacıyla çeşitli alt hedefler oluşturarak nasıl, ne zaman ve niçin hareket edeceklerini önceden düşünmelerini sağlar. İzleme becerisi, problemleri belirleme ve planları değiştirmek için gerçek performans sırasında kullanılan bilişsel becerilerin öz-düzenleme kontrolü olarak tanımlanabilir (Desoete, 2008). Değerlendirme aşamasında ise öğrenci önceki basamaklarda yaşadığı deneyimlere yönelik değerlendirmeler yapar ve bunu bir sonraki öğrenmelerde etkili bir şekilde kullanabilir (Azak, 2015). Bu beceriler öğrenmenin kontrol edilmesini, planlama yapmayı, uygun stratejilerin belirlenmesini, ilerlemenin izlenmesini, hataların belirlenmesi ve giderilmesini, seçilen stratejinin uygunluğunun değerlendirilmesini, öğrenme sürecinin ve çıktıların değerlendirilmesini sağlamaktadır (Aydurmuş, 2013). Başka bir ifadeyle üstbiliş, bireyin öğrenmeyi öğrenmesini kapsayan bir kavram olarak karşımıza çıkmakta (Atay, 2014) ve bireylerin sadece düşünmek ve bilmek için değil, aynı zamanda kendi düşünme ve bilmeleri hakkında düşünmeleri için gerekli olan eşsiz öz-yansıma kapasitesine sahip olmalarına işaret etmektedir (Fisher, 1998).

Üstbiliş üzerine alanyazında yer alan çalışmaları; üstbilişsel davranışların incelenmesi (Azak, 2015; Yıldız, Baltacı ve Güven, 2011), üstbilişsel beceriler (Aydurmuş, 2013; Tuncer ve Kaysi, 2013); üstbilişsel farkındalık (Atay, 2014; Bağceci, Döş ve Sarıca, 2011; Deniz vd., 2014; Karakelle, 2012; Yıldız, 2014); üst bilişsel stratejiler (Diken, 2014; Azak, 2015; Kaya ve Kılıç, 2015; Okur ve Azizoğlu, 2016) ve üstbiliş ile problem çözme arasındaki ilişkinin incelenmesi (Desoete, Roeyers & Buysse, 2001) şeklinde sınıflandırmak mümkündür. Alanyazında yer alan çalışmalarda çoğunlukla üstbilişsel farkındalık ve stratejiler üzerine odaklanıldığı, bununla birlikte çalışmalarda üstbilişin daha çok problem çözme ile ilişkilendirildiği dikkat çekmektedir. Problem kurma konusunda üstbilişsel beceriler ve stratejiler ise henüz yeterince bilinmemektedir (Ghasempour, Bakar & Jahanshahloo, 2013). Oysaki problem kurma, üstbilişte karmaşık ve eş zamanlı büyümenin bir fonksiyonu olarak görülmektedir (English, 1998). Bununla birlikte problem kurma çalışmaları, problem çözme stratejilerini başarıyla uygulamak için yararlı kontrol becerileri olarak adlandırılan üstbiliş becerilerini harekete geçirebildiği gibi üstbiliş becerileri de başarılı problem kurma etkinliklerinde kritik bir rol oynamaktadır (Ghasempour, Bakar & Jahanshahloo, 2013). Dolayısıyla, öğrencilerin problem kurma sürecinde sergiledikleri üstbiliş becerilerin incelenmesi önemli görülmektedir. Sınıf ortamında öğrencilerin üstbilişsel düşünmelerini teşvik edecek olan kişiler ise öğretmenlerdir (Ghasempour, Bakar & Jahanshahloo, 2013). Öğretmenler, iletişim kurma ortamı oluşturarak, başkalarının tartışmalarını doğrulama, sorgulama, eleştirme ve değerlendirmeye teşvik ederek, çeşitli süreçler aracılığıyla bilgi oluşturmaya çalışarak ve kendi kendini keşfetme yoluyla yeni bilgiler üretme konusunda öğrencileri teşvik ederek üstbilişsel düşünmenin gelişmesine yardımcı olabilir. Bu bağlamda geleceğin öğretmenleri olan öğretmen adaylarının problem kurma durumlarında bu becerilere sahip olup olmadıkları ve bu becerileri nasıl kullandıkları merak konusudur. Bu nedenle öğretmen adaylarının problem kurma durumlarında hangi üstbiliş becerilere sahip oldukları ve bu becerileri nasıl kullandıkları onların ilerideki öğretmenlik uygulamalarını etkileyeceğinden çalışmanın bu yönüyle önemli olduğu düşünülmektedir. Bu bağlamda bu çalışmada ilköğretim matematik öğretmeni adaylarının problem kurma durumlarında sergiledikleri üstbiliş becerilerinin incelenmesi amaçlanmıştır.

Yöntem

Araştırmada nitel araştırma desenlerinden olan durum çalışması yöntemi kullanılmıştır. Araştırmanın katılımcıları bir devlet üniversitesinin İlköğretim Matematik Öğretmenliği programı 2. sınıfında öğrenim görmekte olan 5 öğretmen adayından oluşmaktadır. Katılımcılar belirlenirken amaçlı örnekleme yönteminden yararlanılmıştır. Araştırma 2018-2019 akademik yılı bahar döneminde uygulanmıştır. Araştırmanın verileri "House Problem" isimli yarı-yapılandırılmış problem kurma etkinliği aracılığıyla toplanmıştır. Öğretmen adaylarının bu etkinliğe yönelik problem kurma çalışmaları tamamlandıktan sonra katılımcılarla yarı yapılandırılmış görüşmeler gerçekleştirilmiştir. Yarı yapılandırılmış görüşme soruları, öğretmen adaylarının üstbilişsel düzenleme becerilerini ölçmeye yönelik, problem kurma sürecinde elde edilecek verileri hem doğrulamak hem de tüm becerilerinin ölçülmesine olanak sağlayan sorulardan oluşmaktadır. İMÖ adaylarının problem kurma sürecindeki üstbiliş düzenleme becerilerini belirlemeyi amaçlayan bu çalışmada veriler betimsel analiz tekniğinden yararlanılarak analiz edilmiştir.

Bulgular

Araştırmadan elde edilen bulgulara göre tüm katılımcıların tahmin ve izleme becerilerinin planlama ve değerlendirme becerilerine göre daha ön planda olduğu belirlenmiştir. Ö2 katılımcısının kurduğu problemlerde tahmin becerisi ve izleme becerisinin planlama becerisinden daha iyi olduğu, değerlendirme becerisinin ise diğer becerilere göre daha düşük olduğu belirlenmiştir. Ö5 katılımcısının diğer öğretmen adayları ile benzer şekilde izleme ve tahmin becerilerinin diğer becerilere göre daha fazla olduğu, hatta bu becerileri en fazla kullanan öğretmen adayının da Ö5 olduğu tespit edilmiştir. Bununla birlikte Ö1, Ö2 ve Ö5 katılımcılarının tahmin becerilerinin izleme becerilerine göre de ön planda olduğu belirlenmiştir.

Tartışma ve Sonuçlar

İlköğretim matematik öğretmeni adaylarının problem kurma durumlarında sergiledikleri üstbiliş

düzenleme becerilerinin incelendiği bu çalışmada genel olarak öğretmen adaylarının tahmin ve izleme becerilerinin, planlama ve değerlendirme becerilerine kıyasla daha yüksek olduğu sonucuna ulaşılmıştır. Araştırmanın sonucunda öğretmen adaylarının problem kurarken genellikle stratejik bir plan yapmadıkları, kuracakları problemlere yönelik herhangi bir hedef belirlemedikleri görülmüştür. Problem kurma sürecinde öğretmen adaylarının kurdukları problemleri değerlendirmedikleri tespit edilmiştir. Özellikle katılımcıların problemleri kurduktan sonra tekrar okumadıkları ve kurulan problemlerin akıcılık, anlaşılabilirlik veya sadelik bakımından değerlendirilmediği belirlenmiştir. Problem kurma sürecinde öğretmen adaylarının planlama ve değerlendirme becerilerinin diğer becerilere göre daha düşük olduğu sonucuna varılmıştır. Öğretmen adaylarının tahmin ve izleme becerilerinin daha yüksek çıkmasının nedeninin problemleri kurmadan önce planlamaya yönelik yeterince eylemde bulunmamasından kaynaklandığı düşünülmektedir.

Öneriler

Bu çalışmanın verileri öğretmen adaylarının bir yarı yapılandırılmış problem kurma etkinliğine yönelik yapmış olduğu çalışmalardan elde edilmiş olup ileride yapılacak olan çalışmalar farklı türde problem kurma etkinlikleri ile gerçekleştirilebilir. Gelecekte yapılacak çalışmalarda daha geniş bir örneklem grubuyla benzer bir çalışma yürütülerek elde edilen sonuçlar karşılaştırılabilir. Alanyazında problem çözme sürecinde üstbiliş becerilerini inceleyen çok sayıda çalışma olmasına rağmen problem kurma sürecinde üstbiliş becerilerine odaklanan araştırmalar oldukça azdır. Bu nedenle problem kurma sürecinde öğrencilerin ve öğretmenlerin üstbiliş becerilerine odaklanan çalışmaların yapılmasının alana katkı sağlayacağı düşünülmektedir.

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Appendix 1. “House Problem” problem posing activity

PROBLEM POSING ACTIVITY

Onur decided to buy a house priced at 600000 ₺. He paid 200000 ₺ in advance at the time of purchase and planned to pay the rest in monthly instalments. Monthly payment includes annual interest rate of 8 % on the capital as well as insurance fee of 5180 ₺ per year. Onur talks to the former owner of the house and learns that monthly average heating expense of the house is 800 ₺ and in response, he had an insulation system done with the guarantee of reducing the heating expense by 15 %. He spent 16000 ₺ for the construction of the insulation system.

Duration: 20 min.

Instructions: Considering the potential relations among the information given, pose mathematical problems including operations related to the house and purchase of the house. Do not ask questions such as “Where is the house?” since it is not a mathematical problem.

- Try to pose as many problems as possible.
- Try to pose problems of different levels of difficulty.
- Do not solve the problems you pose.
- Pose different types of problems rather than problems of the same type.
- Try to pose extraordinary problems that your peers cannot pose.

NOTE: You can change the information given in the problem and/or add extra information. If you make any change in the problem, please write down the changes applied.