



Examining Mathematics Teachers' Metacognitive Teaching Experiences

Matematik Öğretmenlerinin Üst Bilişsel Öğretim Deneyimlerinin İncelenmesi

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ABSTRACT

The purpose of this study is to explore the teaching experiences of mathematics teachers who have received training on metacognition, with a particular emphasis on the instructional practices they employ to enhance students' metacognitive development. Adopting a qualitative research approach, the study was designed within the framework of phenomenology in order to gain an in-depth understanding of teachers' lived experiences. The participants consisted of two mathematics teachers who had undergone formal training in metacognitive strategies. Data were collected through semi-structured interviews using an interview form comprising eight open-ended questions designed to elicit detailed reflections on their teaching practices. The data were analyzed using the phenomenological analysis method outlined by Moustakas (1994), which allowed for the identification of common themes and patterns across participants' experiences. The analysis yielded eight overarching themes: lesson planning, teachers' awareness of students' competencies, strategic interventions to address learning

difficulties, recognition of students' alternative problem solving approaches, participation in and encouragement of the learning assessment process, supporting students' learning strategies, homework assignment practices, and fostering students' metacognitive development. The findings indicate that mathematics teachers trained in metacognition integrate metacognitive strategies throughout multiple stages of their instructional process, including planning, classroom implementation, and evaluation. Moreover, their practices highlight an intentional effort to cultivate students' ability to monitor, regulate, and reflect on their own learning processes. These results underscore the importance of providing targeted metacognition-focused professional development for teachers, as such training equips them with strategies that can meaningfully enhance students' higher-order thinking and self-regulated learning skills within mathematics education.

Keywords: *Metacognition, mathematics teachers, teaching experiences*

ÖZ

Bu çalışmanın amacı, özellikle öğrencilerin üstbilişsel gelişimini artırmak için kullandıkları öğretim uygulamalarına odaklanarak, üstbiliş konusunda eğitim almış matematik öğretmenlerinin öğretim deneyimlerini incelemektir. Nitel bir araştırma yaklaşımı benimseyen çalışma, öğretmenlerin deneyimlerini derinlemesine anlamak amacıyla fenomenoloji çerçevesinde tasarlanmıştır. Katılımcılar, üstbilişsel stratejiler konusunda resmi eğitim almış iki matematik öğretmeninden oluşmuştur. Veriler, öğretim uygulamalarına ilişkin ayrıntılı yansımaları ortaya çıkarmak için tasarlanmış sekiz açık uçlu sorudan oluşan bir görüşme formu kullanılarak yarı yapılandırılmış görüşmeler yoluyla toplanmıştır. Veriler, katılımcıların deneyimlerinde ortak temaları ve kalıpları belirlemeye olanak tanıyan Moustakas (1994) tarafından özetlenen fenomenolojik analiz yöntemi kullanılarak analiz edilmiştir. Analiz, sekiz ana tema ortaya koymuştur: ders planlaması, öğretmenlerin öğrencilerin yeterliliklerinin farkında olması, öğrenme güçlüklerini gidermeye yönelik stratejik müdahaleler, öğrencilerin alternatif problem çözme yaklaşımlarının tanınması, öğrenme değerlendirme sürecine katılım ve teşvik, öğrencilerin öğrenme stratejilerinin desteklenmesi, ödev verme uygulamaları ve öğrencilerin üstbilişsel gelişiminin teşvik edilmesi. Bulgular, üstbiliş konusunda eğitim almış matematik öğretmenlerinin, planlama, sınıf içi uygulama ve değerlendirme de dahil olmak üzere öğretim süreçlerinin birçok aşamasında üstbilişsel stratejileri entegre ettiklerini göstermektedir. Dahası, uygulamaları, öğrencilerin kendi öğrenme süreçlerini izleme, düzenleme ve üzerinde düşünme yeteneklerini geliştirmeye yönelik bilinçli bir çabayı

vurgulamaktadır. Bu sonuçlar, öğretmenler için hedefli üstbiliş odaklı mesleki gelişim sağlamanın önemini vurgulamaktadır; çünkü bu tür eğitimler, öğrencilerin matematik eğitiminde üst düzey düşünme ve öz düzenlemeli öğrenme becerilerini anlamlı bir şekilde geliştirebilecek stratejilerle donatmalarını sağlamaktadır.

Anahtar Kelimeler: Üstbiliş, matematik öğretmenleri, öğretim deneyimleri

INTRODUCTION

In the information age, effective learning depends not only on what individuals know (i.e., content knowledge), but also on how they access, process, monitor, and regulate that knowledge through cognitive and metacognitive processes. In this regard, efforts to develop more conscious and reflective learners have brought the concept of metacognition to the forefront of educational discourse. According to Flavell (1976), metacognition refers to individuals' knowledge about their own cognitive processes. Brown (1978, 1980) defined metacognition as individuals' awareness of the thinking processes they use in problem solving and their ability to regulate these processes. In this context, metacognition, in its broadest sense, encompasses individuals' awareness of their thinking and learning processes, as well as their ability to monitor and control these processes. For example, an individual may recognize that a particular topic is difficult to learn. They may feel the need to verify information before accepting it or realize that additional study is necessary for retention. In some cases, they may also seek confirmation from others to ensure the accuracy of their understanding. Such behaviors reflect engagement in metacognitive activity (Flavell, 1976). The focus of mathematics education is for teachers to ensure that students learn effectively through well-designed instruction. Metacognition plays a critical role in this process (Artzt & Armour-Thomas, 1998; Perfect & Schwartz, 2002; Tachie & Molepo, 2019; William & Maat, 2020). Students use metacognition to explain their ways of thinking (Ebdon, Coakley, & Legnard, 2003). Metacognition is relevant at multiple but interconnected levels in education. At the individual level, it refers to the awareness and regulation of one's own thinking. For students, these processes support learning, problem solving, and self-regulation. For teachers, metacognition has a dual function: teachers are themselves metacognitive individuals who monitor and regulate their instructional thinking, and they are also mediators of students' metacognitive development through the learning environments and guidance they provide. In this way, the individual can instantly realize and correct their mistake in a process such as problem solving, become aware of it when encountering a different situation under the guidance

of previous experiences, overcome difficulties by using different strategies instead of the strategies usually used, evaluate their own learning processes more accurately, and think more strategically (Lewicki, Hill & Bizot; 1988; Schraw & Dennison, 1994; Seli, 2016). Hall and Myers (1998) argue that metacognition is not entirely innate and can, in fact, be taught. A substantial body of research supports the idea that metacognitive skills can be successfully developed, particularly in mathematics education (Chinnappan & Lawson, 1996; Kramarski, 2008; Kramarski & Mevarech, 2003; Lucangeli, Cornoldi, & Tellarini, 1998).

Metacognition is therefore relevant at multiple but interconnected levels in education. At the individual level, it refers to the awareness and regulation of one's own thinking. For students, these processes support learning, problem solving, and self-regulation. For teachers, metacognition has a dual function: teachers are themselves metacognitive individuals who monitor and regulate their instructional thinking, and they are also mediators of students' metacognitive development through the learning environments and guidance they provide. Therefore, teachers should assume roles and responsibilities to help students participate in metacognition processes and take responsibility for their own learning processes (Daher & Hashash, 2022; Williamson, 1996). The more developed the metacognitive skills of the teacher, the more developed the metacognitive skills of the students are likely to be (Curwen, Miller, White-Smith & Calfee, 2010). For this reason, teachers need to be role models for their students in using metacognitive skills and in guiding students to develop these skills. As a matter of fact, equipping students with metacognitive knowledge and strategies is not a straightforward task. It requires the creation of learning environments that support the development of metacognitive awareness, helping students recognize and reflect on their own knowledge, thoughts, and capabilities. Such environments enable students to transfer and apply these skills across various contexts and problem types (National Council of Teachers of Mathematics [NCTM], 2000). Considering that the main task of teachers is to create environments that will enable students to learn, the task of preparing the environments in which students will gain metacognitive skills falls primarily to teachers. However, according to Lai (2011), it cannot be said that teachers are sufficient in terms of teaching metacognition skills to students and measuring these skills. Similarly, Yıldız and Güven (2017) state that the majority of teachers are uninformed about metacognition and the ways to develop their students' metacognitive skills. For this reason, teachers need to have knowledge about metacognition and learn to use metacognitive skills consciously. For good metacognition-oriented teaching, a teacher needs to carefully identify the tasks, processes, materials, and strategies presented in the classroom, plan and use them

well, and take steps to guide students to metacognitive thinking. Indeed, teacher metacognition is believed to significantly influence the processes of teaching and student learning (Prytula, 2008; 2012).

Teacher Metacognition and Strategies to Improve Metacognition

Metacognition is commonly defined as the monitoring and control of one's cognitive processes (Young & Fry, 2008). There are two main theoretical frameworks in metacognition research. The first, proposed by Brown (1978), highlights two essential components: knowledge of cognition and regulation of cognition. The other perspective was developed by Flavell (1979) and emphasized person, task and strategy variables as subcomponents of metacognitive knowledge. While some researchers have categorized metacognitive knowledge into declarative, procedural, and conditional knowledge (Schraw & Dennison, 1994; Schraw & Moshman, 1995), others have maintained the focus on person, task, and strategy components (Peverly, Brobst, & Morris, 2002; Veenman & Spaans, 2005). In addition, metacognitive experiences have been proposed as an important component of metacognition (Flavell, Miller, & Miller, 2002). According to Flavell et al. (2002), metacognitive experiences refer to the cognitive or affective experiences associated with engaging in a cognitive task. More recent perspectives suggest that metacognition should encompass three interrelated components: metacognitive knowledge, metacognitive experiences, and metacognitive skills (Nussinson & Koriat, 2008; Zohar & Barzilai, 2013; Zohar & Ben David, 2009). These frameworks should be understood as complementary rather than competing. Brown's (1978) distinction between knowledge of cognition and regulation of cognition provides a broad conceptual structure, whereas Flavell's (1979) person, task, and strategy variables specify the content of metacognitive knowledge in greater detail. Building on these perspectives, more recent approaches conceptualize metacognition as consisting of metacognitive knowledge, metacognitive experiences, and metacognitive skills. Within this broader structure, teacher-specific categories such as metacognitive content knowledge, metacognitive method knowledge, and knowledge of student understanding can be interpreted as specialized forms of metacognitive knowledge in instructional contexts.

Although metacognition has been widely studied in educational contexts (e.g., Kramarski & Michalsky, 2009; Prytula, 2008, 2012; Spruce & Bol, 2015; Vrieling, Bastiaens, & Stijnen, 2012; Yerdelen-Damar, Özdemir, & Ünal, 2015), more recent research has increasingly focused on teacher metacognition, highlighting its multifaceted nature and its

impact on teaching and student learning, providing deeper understanding of its multifaceted nature, complexity, and impact on teaching and learning. Indeed, research on teacher metacognition suggests that teachers have “more metacognitive” or “adaptive metacognition” (Duffy, Miller, Parsons, & Meloth, 2009; Lin, Schwartz, & Hatano, 2005; Manasia, 2015). Metacognitive teachers deliberately design, monitor, reflect on, and adapt their teaching repertoire as situational demands require (Hiver & Whitehead, 2018; McCormick, Dimmitt, & Sullivan, 2012). Zohar (2006) emphasized the complexity of teacher metacognition, highlighting that, in addition to monitoring and regulating their own cognitive processes, teachers are responsible for enhancing students’ learning and modifying instructional strategies as needed. Teacher metacognition can facilitate student learning (Lin, Schwartz, & Hatano, 2005), help teachers revise unsuccessful lessons or classroom activities, enhance their own professional learning, sharpen their practice more broadly, and foster metacognition in students (Hiver & Whitehead, 2018). Teachers’ metacognitive knowledge related to the person variable can be categorized into three subcomponents: metacognitive content knowledge, metacognitive method knowledge, and metacognitive knowledge of student knowledge (Lin, Schwartz & Hatano; 2005; Yerdelen-Damar, Özdemir, & Ünal, 2015). In general, metacognitive knowledge comprises three main variables: person, task, and strategy. The person variable refers to self-knowledge, which includes awareness of one’s strengths and weaknesses. For teachers, this variable encompasses an understanding of the advantages and limitations of their own teaching abilities-for example, their familiarity with the curriculum and the reasons behind specific instructional decisions. The task variable involves knowledge about the nature, scope, and demands of tasks, as well as the contextual conditions that affect task performance. In the case of teachers, this includes understanding the requirements of instructional tasks, recognizing the criteria for various pedagogical responsibilities, and identifying the components of effective teaching practices. The strategy variable refers to knowledge of both general and specific cognitive strategies, along with the awareness of when, where, and how to apply these strategies effectively. For teachers, this entails an understanding of the pedagogical methods and classroom tactics that can be employed in different instructional scenarios. The metacognitive aspect of this knowledge lies in the ability to select, apply, and adapt strategies based on situational demands. Metacognitive experiences involve the emotional and cognitive responses associated with task engagement, including judgments and real-time awareness during task performance. For teachers, these experiences include both cognitive and emotional reactions that arise during and after teaching activities-for instance, a sense of satisfaction upon successfully delivering a lesson. Metacognitive skills, on the other hand, refer to the deliberate

regulation of cognitive processes. These skills include planning, allocating time and effort, monitoring and organizing cognitive activity, and evaluating outcomes. In educational practice, teachers with well-developed metacognitive skills are able to design instructional plans, monitor their teaching practices, adjust instructional methods as needed, evaluate their performance, and engage in reflective thinking about their teaching.

According to El-Hindi (1996), instructional practices that support the development of metacognitive skills can effectively enhance these skills. Teaching metacognitive strategies allows students to engage in higher-order cognitive processes by enabling them to discover effective problem solving strategies and apply them in various contexts (Victor, 2004). Internalization of knowledge is supported through activities such as problem identification, self-questioning, connecting prior knowledge to new information, monitoring learning processes, and applying learned knowledge to practical situations (Ashman & Conway, 1997). This type of instruction promotes self-regulated learning, where students are equipped to identify appropriate strategies, understand when and how to use them, monitor their problem solving processes, provide feedback based on outcomes, and transfer their knowledge to new situations (Efklides, 2006). From this theoretical background, the discussion can move toward applied metacognition, which connects conceptual models of metacognition with classroom practice. *Applied metacognition* provides a comprehensive and contemporary perspective on the connection between metacognitive theories and their real-world applications (Perfect & Schwartz, 2002). In this context, metacognition research offers strategies and interventions that integrate both theory and practice. When implementing metacognitive interventions in the classroom, both teachers and students have active roles, with particular emphasis on fostering student thinking. Teachers are responsible for creating opportunities for students to identify learning gaps, evaluate their strengths and weaknesses, express their knowledge and skills, set learning goals, assess learning tasks, and select appropriate strategies (Meher & Baral, 2022; Stewart, Cooper & Moulding, 2007).

In practice, support for metacognitive development can be organized into two complementary categories: broader instructional approaches and specific classroom activities. Instructional approaches provide an overarching pedagogical structure, whereas classroom activities represent concrete practices through which these approaches are enacted. There is a wide range of instructional approaches that support the development of metacognition, such as cooperative learning (Erdoğan & Şengül, 2017), e-portfolios (Zellers & Mudrey, 2007), modeling (Deniz, 2017), problem based learning (Setiawan & Supiandi, 2018; Yurdakul, 2004),

research-based learning (Sucianto, Irvan & Rohim, 2019), self-regulated learning (Callan & Cleary, 2019), contextual metacognitive learning (Ahdhianto, Marsigit & Santi, 2020), and schema-based learning (Alghamdi, Jitendra & Lein, 2020). Classroom activities also significantly contribute to the enhancement of students' metacognitive abilities. These include peer tutoring (Acar & Ader, 2017), assuming leadership roles (Daher, Anabousy & Jabarin, 2018), collaborative dialogue (Smith & Mancy, 2018), metacognitive discourse (Shilo & Kramarski, 2019), writing (Coffey, 2009; Hacker, Kihara & Levin, 2019; Demircioğlu, 2008), and think-aloud protocols (Demircioğlu, 2008). Encouraging students to ask effective questions and fostering classroom discussions are also key strategies in promoting metacognition. Teacher questions that prompt high-level thinking, such as “Why do you think that?” or “How can you prove that?”, help activate students' metacognitive processes (Yurdakul, 2004). Moreover, digital tools such as GeoGebra, used in mathematical problem solving, can support the development of metacognitive skills (Baltaci, 2018; Chytry, Rican & Medova, 2019; Fung & Poon, 2020; Hendriana, Setiawan & Aripin, 2019). Students' imagination and creative thinking can also facilitate metacognitive growth. When students take responsibility for their learning and problem solving and engage in reflective thinking, they can use metacognitive skills more effectively (Jagals & van der Walt, 2018; Alghamdi, Jitendra & Lein, 2020). Two primary approaches have been identified for enhancing metacognition: explicit strategy instruction and the creation of a socially supportive learning environment. While much of the literature focuses on strategy instruction, the role of the social environment is often overlooked (Lin, 2001). Techniques such as planning, generating questions about texts, making decisions, and summarizing others' ideas are also recommended (Costa, 1984). These strategies foster metacognitive development and guide students through complex problem solving processes. Wafubwa, Csikos and Opoku-Sarkodie (2022) found that while teachers' metacognitive awareness is generally high, their actual metacognitive skill levels tend to be lower, and that this awareness is not significantly related to gender, academic background, or teaching experience. This finding highlights the continued importance of providing teachers with effective strategies to enhance their metacognitive skills. Furthermore, it is essential for teachers to guide students through metacognitive processes and develop an awareness of how these processes can be applied (Gunstone & Northfield, 1994; Ben-David & Orion, 2013; Lin, Schwartz & Hatano, 2005). In light of this, the present study aims to examine the teaching experiences of mathematics teachers trained in metacognition, with a particular focus on how they foster students' metacognitive development. Specifically, the study explores teachers' experiences related to lesson planning, awareness of student competencies, interventions for

learning difficulties, recognition of alternative problem solving strategies, involvement in evaluating student learning, support for students' learning methods, homework practices, and approaches to promoting metacognitive skills in students.

METHOD

Research Design

A phenomenological design, one of the qualitative research approaches, was adopted in this study to gain an in-depth understanding of mathematics teachers' metacognitive teaching experiences. The phenomenological design is a qualitative research method that aims to gain an in-depth understanding of participants' experiences of a particular phenomenon and the meanings they attribute to these experiences (Creswell, 2013; McMillan, 2004), how they experience this phenomenon, and what these experiences mean to them (Tekindal & Uğuz Arsu, 2020; Yıldırım & Şimşek, 2006). In the present study, the phenomenon under investigation was the metacognitive teaching experiences of mathematics teachers. Accordingly, the researchers focused on the narratives of mathematics teachers to understand their metacognitive teaching experiences. The primary goal of the researcher in phenomenological studies is to discover the "essence" of the participants' lived experiences (Moustakas, 1994). Therefore, this study examined in depth the teaching experiences of mathematics teachers during the lesson planning process, during the lesson, and after the lesson to develop students' metacognition. Another important feature of the phenomenological approach is that the researcher brackets their own biases (epoché) and focuses on the participants' experiences (Groenewald, 2004). This allows for assurance that the data obtained reflects the participants' actual experiences. The phenomenological research process requires a systematic approach encompassing data collection, analysis, and interpretation. For this reason, data were collected through interviews with teachers and analyzed using the phenomenological analysis methods suggested by Moustakas (1994). This process involves thematic grouping of participants' teaching experiences and uncovering their essence.

Participants

Criterion sampling (Patton, 2002), a type of purposeful sampling, was employed to select the participants for this study. Participants were selected based on specific criteria, including having received training related to metacognition, varying years of teaching experience, and different graduation years. In line with these criteria, the study participants

consisted of two mathematics teachers who had received formal training on metacognition. The demographic characteristics of the participants are summarized in Table 1.

Table 1. Demographic Information of the Teachers Participating in The Study

	Gender	Duration of teaching
Teacher 1	Male	11 years (Private tutoring)
Teacher 2	Female	6 years (Ministry of National Education)

As presented in Table 1, Teacher 1 is a male mathematics teacher with 11 years of teaching experience who currently offers private tutoring. Teacher 2 is a female mathematics teacher with 6 years of teaching experience and is employed by the Ministry of National Education. Both teachers are currently enrolled in doctoral programs in mathematics education at different universities. Additionally, both participants have received formal training in metacognition.

Data Collection Instruments

The data for this study were collected through open-ended, semi-structured interviews. An interview is defined as an interaction-based communication process that requires mental attentiveness and follows a predetermined format for asking questions and receiving answers (Patton, 2002). Eight questions were asked to the participants during the interviews. Unlike structured interviews, where participants' responses are confined to specific options, or unstructured interviews, where participants are completely free in their responses, semi-structured interviews strike a balance by guiding participants while allowing them the flexibility to articulate their thoughts in their own words. To develop the interview questions, an extensive review of the relevant literature was conducted, and questions were designed to uncover mathematics teachers' teaching experiences related to metacognition. To ensure content validity, expert opinions were obtained from a mathematics education specialist, an academic, and a practicing mathematics teacher. The final interview questions are as follows:

1. What do you consider when preparing your lesson plans?
2. Do you know your students' strengths and weaknesses? Can you provide examples?
3. What do you do when your students experience difficulties during the lesson?
4. Do your students attempt to solve problems using different approaches?



5. Do your students evaluate their own learning? What do you do to encourage this?
6. Do your students know how they learn best? What do you do to help them recognize this?
7. Do you assign homework? If so, what factors do you consider when preparing assignments?
8. How do you think students' metacognition develops? What can be done in the classroom to enhance it?

Data Analysis

During the research process, data were collected through the responses of participating mathematics teachers to the questions in the interview form. The phenomenological analysis method proposed by Moustakas (1994) was used to analyze the collected data. In this process, reading and coding of the data, thematic grouping, revealing the essence, interpretation and reporting stages were followed. In the data reading and coding phase, the transcripts of the interviews were carefully read and important statements reflecting the experiences of the participants were identified and open coding was performed. In the thematic grouping stage, codes were grouped together under common themes and main themes were formed. In the essence extraction stage, the relationships between the themes were examined to reach the essence of mathematics teachers' teaching experiences towards metacognition. In the interpretation and reporting stage, the findings were interpreted and reported in line with the relevant literature and research objectives. Finally, in the analysis process stage, the researchers focused on the participants' experiences by bracketing their own biases and used direct quotations from the participants' statements to ensure the reliability of the data. In addition, codes were written to ensure the consistency of the analysis. The answers given by the mathematics teachers in the interview are presented with direct quotations.

In qualitative research, data collection tools and research design should be rigorously examined and reported in a way that enables readers to judge their credibility and consistency (Yıldırım & Şimşek, 2006). Accordingly, to ensure credibility in this study, the developed interview questions were reviewed by field experts prior to implementation, and necessary revisions were made based on their feedback. Following this, the interviews were conducted. Before the interviews, the purpose of the study was clearly explained to the participants, and it

was emphasized that their sincere and honest responses were critical for achieving the study's aims. Additionally, efforts were made to create a natural and comfortable interaction environment during the interviews. Each interview lasted approximately 20-25 minutes. The researcher maintained prolonged engagement with the participants and the data to better recognize any potential influence of personal biases and perceptions on the findings (Yıldırım & Şimşek, 2006). To further enhance the credibility of the study, direct quotations from participants were included in the findings section. For transferability, detailed information was provided about the research design, characteristics of the participants, data collection tools, implementation process, and data analysis. The use of purposive sampling and the rich, thick description of the data also support the study's applicability to other contexts. To ensure consistency, the research process was conducted impartially. With the participants' consent, a voice recorder was used during the interviews, and additional notes were taken. Any potential gaps in the data were addressed immediately after the interviews. The use of audio recordings helped prevent data loss, and the collected data were reviewed by multiple experts, which contributed to the objectivity and reliability of the interpretations.

FINDINGS

In this section, the findings obtained as a result of interviews with two mathematics teachers who received training on metacognition are given in detail.

Findings Related to Lesson Plan Preparation

The question "*What do you consider when preparing your lesson plans?*" aimed to investigate whether the mathematics teachers made any preparations to activate students' metacognitive processes prior to instruction. Table 2 presents the themes, categories, and codes related to the teachers' approaches to lesson plan preparation.

Table 2. Themes, Categories and Codes Related to Lesson Plan Preparation

Themes	Categories	Codes	Participant
Academic success	Planning According to Student Level	<ul style="list-style-type: none"> ✓ Resource selection according to student success ✓ Sample preparation appropriate to student level 	Teacher 1
	Use of additional documents	<ul style="list-style-type: none"> ✓ Document preparation appropriate to low success level 	
Attracting student attention	Interesting Introduction Activities	<ul style="list-style-type: none"> ✓ Storytelling ✓ Use of videos 	Teacher 2
	Use of Digital Tools	<ul style="list-style-type: none"> ✓ Reinforcement with digital game applications 	

As summarized in Table 2, the responses of the teachers are discussed under the themes of academic achievement and attracting students' attention. Teacher 1 stated: *"I prepare a plan aligned with the learning outcomes. I prepare materials that facilitate understanding for students with low mathematical achievement. For students with intermediate and advanced levels, I ensure that appropriate course resources are available. I mentally determine the examples I will use for each group of students."* This response indicates that Teacher 1 organizes his lesson plans based on the achievement levels of his students. He prepares accessible materials for lower-achieving students and selects appropriate resources for those at higher levels. He also customizes examples according to different student groups. This suggests that Teacher 1 possesses metacognitive knowledge-specifically, an awareness of his students' learning needs-and aligns his instructional strategies accordingly. Teacher 2 responded: *"There can be stories and video narrations that attract students' attention and interest. Digital game applications can be used during the lesson to learn and reinforce the subject."* Teacher 2 emphasized the use of storytelling and multimedia to engage students and increase motivation, while also highlighting digital tools as a distinct instructional component in lesson planning. In particular, the use of digital game applications may support metacognitive engagement by giving students opportunities to monitor their understanding, check their responses, and reinforce concepts through interactive feedback. These approaches can be interpreted as supporting students' awareness of their own learning processes and indirectly promoting metacognitive strategies. However, it is evident that the two teachers adopt different approaches to lesson planning. While Teacher 1 focuses on the selection of differentiated resources and examples, Teacher 2 prioritizes capturing students' attention and interest in the lesson content, including through the deliberate use of digital tools.

Findings on teacher awareness of student competencies

The question “*Do you know the strengths and weaknesses of your students? Can you give an example?*” was designed to explore the extent to which teachers are aware of their students’ individual capabilities. In this context, the mathematics teachers’ awareness of their students’ strengths and weaknesses was examined, and how they structured their instructional practices in response to these individual differences was evaluated based on the data obtained. The themes, categories, and codes derived from the participants’ responses are presented in Table 3.

Table 3. Themes, Categories and Codes Related to Teacher Awareness of Student

Themes	Categories	Codes	Participant
Student gains	Recognition of individual differences	<ul style="list-style-type: none"> ✓ Recognition of strengths/weaknesses ✓ Developing an approach according to the level of prior knowledge 	Teacher 1
	Support adapted to the learning process	<ul style="list-style-type: none"> ✓ Reminding of missing information ✓ Reinforcement with high-level problem solving 	
Difficulties	Determination of general subject difficulties	<ul style="list-style-type: none"> ✓ Difficulty in exponential expressions ✓ Difficulty in simplifying fractions 	Teacher 2

Competencies

As presented in Table 3, the interview data indicate that the teachers had developed a certain level of awareness regarding the individual competencies of their students. Teacher 1 stated, “...*When I spend a certain amount of time, I know the strengths and weaknesses of the students. I determine my course resources and what to do according to them. When I take into consideration a student’s lack of prior knowledge, I remind them of their prior knowledge about that topic at every new topic. If my other student does not have any deficiencies about the previous topics, I ensure that they reinforce the topic by solving higher-level problems...*” This response suggests that Teacher 1 is able to identify the strengths and weaknesses of students over time and structures instructional materials and activities accordingly. He emphasized that he supports students with limited prior knowledge by offering reminders, while providing more advanced tasks to those who demonstrate topic readiness. This reflects an instructional approach attuned to the diverse learning needs of students. Teacher 2 remarked, “...*My students generally have difficulty learning some topics in mathematics. They may have difficulty with important and basic topics such as exponential expressions and simplifying fractions...*” This response indicates that Teacher 2 has developed a broader awareness at the classroom level by identifying common areas of difficulty among students. Overall, both teachers’ responses



demonstrate their ability to observe student competencies and adjust their instructional practices in a flexible and responsive manner. Such awareness aligns with components of metacognitive knowledge, particularly in terms of recognizing individual differences and engaging in strategic decision-making.

Findings Regarding Strategic Teacher Interventions for Learning Difficulties

The question “*What do you do when your students have difficulty learning during class?*” was posed to identify the strategies mathematics teachers employ to monitor and support their students’ metacognitive processes during instruction. This question is critical in revealing whether teachers encourage students to think critically, engage in inquiry, and reflect on their learning when faced with difficulties. The themes, categories, and codes generated from the participants’ responses are presented in Table 4. As illustrated in Table 4, the data obtained from the interviews were discussed under two themes, conceptual and instructional, by the teachers. Teacher 1 answered this question as follows, “*...If the student is disinterested in learning, I give examples from his/her immediate environment. I make jokes about the lesson context to include him/her in the conversation. I give goals for the next lesson by giving a motivational talk. If there is no lack of prior knowledge, I give clues for solutions. If there is a lack of prior knowledge, I remind him/her of prior knowledge that will be included in solving the questions. Then, I solve questions at the comprehension level...*” This statement reveals that Teacher 1 adopts a multi-layered and conscious approach in situations such as students’ disinterest or lack of knowledge. The teacher uses examples and jokes related to daily life to increase student motivation, and also ensures that the student sets goals for the next lesson through motivational talks. These statements are conscious interventions aimed at supporting the student’s awareness of the learning process (metacognitive knowledge) and goal-setting skills (metacognitive regulation). If the student lacks prior knowledge, the teacher tries to include him/her in the process by giving reminders; If there are any deficiencies, he provides clues and guides students toward a solution. He also tries to deepen students’ understanding with comprehension-level questions. In these respects, Teacher 1’s approach is based on strategies that support metacognitive awareness. Teacher 2 responded, “*...I increase the number of examples. I strive to ensure they learn the concepts well, not the procedures...*” In this context, Teacher 2 stated that when students are struggling, she prioritizes conceptual understanding and increases the number of examples. Focusing on conceptual-based learning rather than procedural repetition helps students understand why they are doing what they are doing, which contributes to strengthening their metacognitive knowledge.

Table 4. Themes, Categories and Codes Related to Strategic Teacher Interventions for Learning Difficulties

Themes	Categories	Codes	Participant
Instructional Guidance	Increasing Attention and Motivation	<ul style="list-style-type: none"> ✓ Giving examples from the immediate environment ✓ Making jokes in the context of the lesson ✓ Making a motivational speech 	Teacher 1
	Intervention Based on Prior Knowledge	<ul style="list-style-type: none"> ✓ Reminding prior knowledge ✓ Giving clues based on prior knowledge 	
Conceptual difficulty	Guidance at the Comprehension Level	<ul style="list-style-type: none"> ✓ Question solution at comprehension level 	Teacher 2
	Supporting Conceptual Understanding	<ul style="list-style-type: none"> ✓ Prioritize conceptual learning ✓ Increase the number of examples 	

Overall, the findings show that teachers view moments when students are struggling not only as a lack of knowledge but also as an opportunity for metacognitive development. Participants demonstrate a conscious teaching approach that both recognizes students' current level and develops supportive strategies appropriate to this level.

Findings Regarding Students' Awareness of Alternative Problem Solving Approaches

The question “*Do your students try to solve problems in different ways?*” was designed to examine teachers' observations concerning their students' metacognitive strategy development and flexible thinking skills. In particular, the aim was to determine whether teachers recognized their students' tendencies to explore alternative problem solving strategies. Encouraging students to approach problems from multiple perspectives is considered an important component in fostering metacognitive growth. The themes, categories, and codes generated from the participants' responses are presented in Table 5. As seen in Table 5, both Teacher 1 and Teacher 2 reported adopting similar approaches. During the interviews, the teachers stated that they demonstrated alternative solution methods while solving problems in class, aiming to serve as role models for their students. Teacher 1 remarked, “*Although there are students who explain problems in different ways, they are in the minority among the general,*” whereas Teacher 2 commented, “*Yes, sometimes they can find different solutions*” These findings suggest that both teachers recognize students' attempts to generate alternative solutions, even though such attempts are not common among all students. In response, the teachers appear to model multiple solution methods during instruction, thereby encouraging flexible thinking and helping students become aware that mathematical problems can be

approached in more than one way. Such practices can support students' metacognitive development by broadening their strategy repertoire and prompting reflection on the suitability of different solution paths.

Table 5. Themes, Categories and Codes Related to Teacher Observations of Alternative Problem Solving Approaches

Themes	Categories	Codes	Participant
Students' Different Problem Solving Approaches	Students' Search for Alternative Solutions	<ul style="list-style-type: none"> ✓ Students finding solutions in different ways ✓ Some students finding different solutions 	Teacher1 Teacher 2
Prevalence of Different Solution Strategies	Diversity and Mainstreaming	<ul style="list-style-type: none"> ✓ A minority of different solution attempts ✓ Occasional different solutions 	Teacher1 Teacher 2

Overall, the findings suggest that both teachers observe students' use of alternative strategies and value flexible problem solving as part of mathematical thinking. Such practices demonstrate a conscious engagement with students' strategy awareness and support metacognitive development by encouraging comparison, reflection, and strategic choice.

Findings on Students' Participation in the Process of Assessing Their Own Learning and the Role of Teacher Encouragement

The question “*Do your students evaluate their own learning? What do you do to encourage their evaluation?*” was designed to explore whether mathematics teachers observe and assess their students' self-evaluation practices and how they support this process. Specifically, the aim was to determine whether students engage in evaluating their own learning, whether teachers are aware of such behaviors, and what strategies they employ to foster this metacognitive activity. The themes, categories, and codes derived from the participants' responses are presented in Table 6. As outlined in Table 6, the data were organized under two main themes: “Students' Behaviors in Evaluating Their Learning” and “Strategies to Encourage Learning Evaluation.” The first theme reflects students' individual awareness of their learning. According to the teachers' statements, students are able to recognize what they understand and what they do not, with some even engaging in daily self-assessment. Notably, Teacher 1 indicated that he supports students in monitoring their progress by linking unsolved questions to previously learned topics, demonstrating active oversight of the learning process. The second theme focuses on the strategies teachers use to facilitate this evaluative process. Teacher 1 explained, “*We prepare the weekly plan together and review it the following week.*”

Since students complete the plan themselves daily, they engage in ongoing self-evaluation. Additionally, I encourage them to assess their progress by connecting the questions they can or cannot solve with prior topics.” Teacher 2 noted, *“Students are able to evaluate their understanding and difficulties. Encouraging them to ask questions during lessons fosters individual problem solving skills.”*

Table 6. Themes, Categories and Codes on Students' Participation in The Process of Assessing Their Learning and Encouraging This Process

Themes	Categories	Codes	Participant
Behaviors for Assessing Students' Learning	Individual awareness	✓ Recognizing understanding or lack of understanding ✓ Daily self-assessment	Teacher 1 Teacher 2
	Monitoring the learning process	✓ Associating with previous topics ✓ Evaluating the distance covered	Teacher 1
Ways to Promote Assessment of Learning	Planning and reflection	✓ Preparing the weekly plan together ✓ Weekly evaluation	Teacher 1
	Effective classroom strategies	✓ Encouragement to ask questions ✓ Guidance to individual problem solving	Teacher 2

These findings indicate that teachers employ diverse strategies to enhance students' metacognitive awareness, enabling them to actively evaluate and regulate their own learning processes.

Findings Related to Recognizing and Supporting Students' Learning Methods

To explore the strategies teachers employ to foster their students' metacognition, the question “Do your students know how they can best learn a subject? What do you do to raise their awareness of this?” was posed. Teachers' awareness of how their students learn most effectively reflects their own metacognitive understanding. The themes, categories, and codes derived from the participants' responses are presented in Table 7.

Table 7. Themes, Categories and Codes Related to Recognizing and Supporting Students' Learning Methods

Themes	Categories	Codes	Participant
Developing learning beliefs	Student's belief in learning	✓ Creating belief in learning	Teacher 1
		✓ Motivating students by communicating in class	
Teaching methods	Active learning methods	✓ Cooperative learning	Teacher 2
		✓ Using digital content	
		✓ Problem solving and board assignment suggestions	
Teaching methods	Discovery of Learning Methods	✓ Discovering the way in which students learn	Teacher 2
		✓ Using active learning methods instead of lecturing	

When examining teachers' awareness of how students learn, Table 7 indicates that teachers generally make instructional decisions based on the feedback they receive from their students. Under the category of Students' Learning Beliefs, teachers emphasize the importance of fostering students' confidence in learning and maintaining effective communication during the course. Teacher 1 noted, *"...In general, since mathematics courses are focused on exam preparation, it becomes difficult to implement methods such as those mentioned in the literature, including cooperative learning, due to the intensity of the curriculum..."* This statement highlights that, despite challenges posed by curriculum demands and exam preparations, Teacher 1 considers students' belief in their own ability to learn as crucial. He further explained, *"...what matters is not so much how students learn the subject but rather their belief in learning. If their self-efficacy and learning beliefs are developed, prior knowledge gaps are addressed, and sustained communication that keeps the student engaged in the course is established, then learning will occur..."* The category Active Learning Methods reflects the strategies teachers use to engage students more actively. Teacher 2 emphasized that *"...Students tend to get bored with direct instruction. Incorporating digital content, group work, and collaborative learning activities can increase their engagement"* Accordingly, it is suggested that such active learning approaches—digital resources, cooperative tasks, problem solving, and board assignments—can foster students' interest and participation. Teacher 2 also added, *"...Should we solve more problems on this topic? Or should we assign board work? We often receive such requests..."* In the Discovery of Learning Methods category, teachers reported employing strategies to identify how students learn most effectively. Teacher 2 pointed out that direct instruction alone is insufficient, emphasizing the need to explore and offer more student-centered, participatory learning methods. These findings demonstrate that teachers develop a

range of strategies aimed at enhancing the efficiency of students' learning processes and actively work to improve their attitudes towards learning.

Findings on Methods of Assigning Homework

The question, "Do you assign homework? If so, what do you take into consideration when assigning?" was posed to explore whether teachers engage in reflective evaluations during homework assignment and to analyze their approaches to homework. Homework serves as a valuable tool for both students' self-assessment and teachers' evaluation of student learning. The themes, categories, and codes derived from participants' responses are presented in Table 8.

Table 8. Themes, Categories and Codes Related to Methods of Assigning Homework

Themes	Categories	Codes	Participant
Homework time	Homework time	✓ Homework assignment when the topic is finished	Teacher 1
Cognitive Adaptation in Homework	Suitability to student level	✓ Selecting resources appropriate to the level of the student ✓ Observing the student's harmony with the resource	Teacher 1
Metacognitive Activity in Homework	Assignment variety	✓ Board assignments ✓ Open-ended questions ✓ Modeling and animation activities	Teacher 2
	Purpose of the assignment	✓ Reinforcement of the subject ✓ Open-ended questions and modeling for deeper student understanding	Teacher 2

As presented in Table 8., teachers generally regard homework as an effective tool for enhancing students' metacognitive skills and reported frequently assigning homework during the interviews. Regarding the timing of homework, Teacher 1 stated, "...when the topic is over, I give homework from sources that are appropriate to the student's level..." This indicates that homework is assigned following the completion of topics to reinforce learning. Within the category of Suitability to Student Level, Teacher 1 emphasized the importance of aligning homework tasks with students' individual levels. When selecting resources, the teacher considers both the students' developmental stages and the appropriateness of the materials to their needs, thereby facilitating more effective learning by tailoring goals to each student's readiness. Teacher 1 noted, "...The things I pay attention to are; the suitability of the source to the student, the student to the source..." Regarding the category of Homework Variety, Teacher 2 reported using diverse homework formats. Teacher 2 explained, "I give homework. The assignments I give can be board tasks aimed at naming the topic covered and open-ended

questions...” Such tasks, including board assignments, open-ended questions, and modeling activities, encourage students to actively engage with the content and reflect on their understanding in a practical manner. Specifically, Teacher 2 added, “...*Sometimes I want them to model the questions given, or even role-play them if they can...*” In the Purpose of Homework category, Teacher 2 emphasized that homework serves not only to reinforce content but also to foster active learning. Open-ended and modeling tasks help students deepen their understanding and enhance their critical thinking skills. Overall, these findings demonstrate that teachers employ varied homework strategies tailored to individual student needs and developmental levels, while utilizing multiple homework types to promote active student participation in the learning process.

Findings Related to Supporting Students' Metacognitive Development

The question, “In your opinion, how do students’ metacognition develop? What can be done to develop it in the classroom?” was posed to explore teachers’ perspectives on fostering metacognitive growth among their students, as well as the strategies they implement in the classroom to support this development. Teachers who had received training on metacognition were invited to reflect on general approaches to enhancing students’ metacognitive skills, drawing upon their theoretical knowledge and practical experience. The themes, categories, and codes derived from the participants’ responses are presented in Table 9. As illustrated in Table 9, the responses are discussed under two main themes: “Metacognitive Development Strategies” and “Classroom Practices.” Under the category of metacognitive development strategies, Teacher 1 emphasized the importance of identifying the current knowledge level of the student in order to foster metacognition. Teacher 1 stated, “...*I incorporate the variables of person, task, and strategy to develop metacognition...*,” reflecting her awareness of metacognitive knowledge components. Additionally, Teacher 1 highlighted his efforts to enhance students’ metacognitive skills by encouraging multiple solution methods and guiding students to select the most reasonable approach: “...*I try to follow ways such as revealing what the student knows about a problem, determining how the student will reach the result, increasing different solution ways, and choosing the most reasonable one.*” This approach aims to cultivate deeper thinking and informed decision-making in students. In the category of classroom practices, Teacher 2 emphasized the importance of creating an environment conducive to the efficient development of metacognition. She remarked, “...*Metacognition can best be developed by efficiently advancing concept teaching. It can be developed not by rote memorization or prescriptive teaching, but through activities that allow students to discover...*”

and “...*Group activities and project assignments in the classroom can support the development of metacognition...*” Accordingly, Teacher 2 advocates for discovery-based learning, collaborative work, and project-based assignments as effective means of fostering metacognitive growth. Such active learning strategies engage students more fully and facilitate the development of metacognitive skills.

Table 9. Themes, Categories and Codes Related to Supporting Students' Metacognitive Development

Themes	Categories	Codes	Participant
Metacognitive Development Strategies	Ways to develop metacognition	✓ Revealing the student's existing knowledge	Teacher 1
		✓ Increasing the ways of solution	
		✓ Selecting the most reasonable solution	
Classroom Practices	Focus on the learning process	✓ Metacognition development through concept teaching	Teacher 2
		✓ Discovery-based activities	
		✓ Learning by understanding instead of memorization	
Classroom Practices	Learning activities	✓ Group work	Teacher 2
		✓ Project assignments	
		✓ Activities focused on exploration and problem solving	

Overall, both teachers underscore the significance of supporting students' metacognitive development through active learning methods and strategic interventions. It can be concluded that a learning environment which encourages exploration of multiple solution paths and self-discovery plays a critical role in enhancing metacognition.

CONCLUSION AND DISCUSSION

This study examined the teaching experiences of mathematics teachers who received training on metacognition. The findings are presented under the following subheadings: preparing lesson plans, teacher awareness of student competencies, strategic teacher interventions for learning difficulties, awareness of students' alternative problem solving approaches, student participation in evaluating their own learning, recognizing and supporting students' learning methods, homework assignment methods, and supporting students' metacognitive development. Each of these dimensions represents a critical variable influencing the teaching process. When reviewing the literature on metacognition, these topics are often studied independently; however, given that teachers receive training to enhance students' metacognitive skills, their experiences across all these dimensions are essential. Metacognitive development begins in childhood and continues throughout the teaching process (Fisher, 1998; Hanten et al., 2004; Hartman, 2001, 2002). This development is particularly supported when

learners actively engage in metacognitive activities (Hennessey, 1999) and through meaningful teacher-student interactions (Branigan & Donaldson, 2020). The more students engage in metacognitive activities at each stage of the learning process (before, during, and after learning), the more their metacognitive development is supported. In other words, a student who engages in metacognitive activities before, during, and after learning will show greater metacognitive development than children who engage in metacognitive activities only before or after learning. This notion is supported by research conducted by Kapa (2001).

In the study, teachers reported that they planned lessons beforehand and used activities and materials appropriate for students during these plans. Accordingly, the teachers in this study reported that they planned lessons in advance and incorporated activities and materials tailored to student needs, consistent with the planning stage defined by Blakey and Spence (1990). Meher and Baral (2022) also emphasize that effective teaching requires facilitating equal student participation throughout the learning stages and incorporating metacognitive interventions such as think-aloud, brainstorming, concept mapping, and self-assessment into lesson plans based on the 5E teaching model. Although the participating mathematics teachers did not explicitly mention such metacognitive interventions related to lesson planning, it was observed that Teacher 1 selected course-related resources and examples based on students' strengths and weaknesses, in other words, in line with their learning needs, while Teacher 2 focused on engaging students with stories, videos, and digital games. In line with the participant information presented in Table 1, Teacher 1 had experience in private tutoring, whereas Teacher 2 worked within the Ministry of National Education. This distinction may help explain differences in their lesson-planning practices and suggests that teaching context, class size, and instructional environment can shape how metacognitive support is incorporated into planning. Findings regarding teacher awareness of student competencies indicate that Teacher 1 is able to identify students' strengths and weaknesses through time spent with them and plans the instructional process accordingly. He also noted that he takes into account students' lack of prior knowledge and provides reminders as they transition to new topics and offers higher-level problem solutions for students who are ready. This demonstrates that the teacher organizes instruction sensitively to students' individual learning needs. Teacher 2, on the other hand, stated that students generally experience difficulties in certain subjects in mathematics. This statement demonstrates that the teacher develops a classroom-level awareness by observing general student tendencies. The responses of both teachers indicate that teachers are able to observe student competencies and plan their instructional processes flexibly and adaptably

accordingly. This awareness can be linked to teachers' ability to "recognize individual differences" and "strategic decision-making," within the scope of metacognitive knowledge. In the study, teachers stated that they know their students' strengths and weaknesses and that they get to know them after spending time with them. This allows them to address their weaknesses and emphasize their strengths. In this way, it can be said that they support students' metacognitive development. Teachers who stated that they understand students' difficulties generally stated that they take initiatives to increase their students' motivation. They stated that they demonstrate different problem solving methods during class and serve as role models to encourage students to develop different solutions. Despite this, they also stated that students occasionally resort to finding different solutions. This may be related to students' metacognition not yet being fully developed. According to Çakıroğlu (2007), metacognition develops with age. In other words, metacognition develops increasingly from childhood.

In findings regarding strategic teacher interventions for learning disabilities, Teacher 1's statement reveals a multilayered and deliberate approach to situations such as student disinterest or lack of knowledge. The teacher uses examples and jokes related to daily life to increase student motivation and also encourages students to set goals for the next lesson through motivational speeches. These statements are deliberate interventions aimed at supporting students' awareness of the learning process (metacognitive knowledge) and goal-setting skills (metacognitive regulation). If a student lacks prior knowledge, the teacher tries to engage them in the process by providing reminders; if not, he provides clues and guides them toward solutions. He also attempts to deepen students' understanding by asking comprehension-level questions. In these respects, Teacher 1's approach is based on strategies that support metacognitive awareness. Teacher 2 stated that when students are struggling, she prioritizes conceptual understanding and increases the number of examples. Focusing on conceptual-based learning rather than procedural repetition helps students understand why they are doing what they are doing, which contributes to strengthening their metacognitive knowledge. Overall, the findings indicate that teachers view student challenges not only as a sign of a lack of knowledge but also as an opportunity for metacognitive development. Participants demonstrate a deliberate teaching approach, both recognizing students' current learning levels and developing supportive strategies appropriate to that level. It appears that teachers specifically strive to implement motivational and attention-grabbing activities to help students understand how to better learn the material. The study indicates that teachers contribute to students' metacognition by assigning homework. Homework can be said to contribute to students' self-assessment and

development. Findings regarding students' awareness of Alternative Problem Solving Approaches indicate that teachers implement pedagogical and metacognitive interventions when they identify students' cognitive difficulties. Teacher 1's statement suggests that they develop various strategies when students are disinterested in learning or experiencing conceptual difficulties. Providing examples from the immediate environment to boost motivation, using humor within the context of the lesson, and engaging in goal-setting conversations for future lessons are all practices designed to engage students' attention. This approach aims to initiate the cognitive process by ensuring students' affective engagement. Furthermore, the teacher employs different teaching methods, taking into account students' prior knowledge. When prior knowledge is lacking, reminders and restructuring are provided to address this deficiency; when there is no deficiency, prompts are used to guide the student toward a solution. These interventions demonstrate that the teacher monitors the student's learning process and develops strategies appropriate for them. Teacher 2, on the other hand, stated that she observed that students needed more examples and time to grasp the concepts, and therefore, she structured her instruction by increasing the number of examples and emphasizing conceptually based explanations. This approach is a form of instructional guidance that prioritizes students' conceptual, not just procedural, learning. Overall, the findings indicate that teachers monitor students for moments of difficulty during the lesson and provide guidance sensitive to students' knowledge and learning needs. This suggests that teachers focus on both cognitive and affective processes and consciously structure instructional interventions.

The findings regarding student participation in and encouragement of student learning assessment revealed data on students' individual awareness levels within the first theme. According to teachers, students are able to recognize what they understand and what they don't, and some even engage in daily self-assessment. Teacher 1's statement that he helps students assess their progress by relating unsolved questions to previous topics demonstrates that he actively monitor students' learning. The second theme addresses the strategies teachers use to support this process. Teacher 1 stated that he prepares weekly lesson plans with students and that these plans are evaluated together each week. This practice aims to develop both students' planning and reflection skills. Teacher 2 stated that by encouraging questioning and individual problem solving during class, students are able to structure their thinking processes. These findings suggest that teachers implement various strategies to increase students' metacognitive awareness, and that these strategies allow students to assess their own learning. To develop metacognition, students should be encouraged to engage in self-assessment. According to Huitt

(1997), for students to acquire metacognitive skills, they need to seek answers to questions such as, "How did I do it? Can I apply it to other problems? Are there other criteria I should go back and consider?" Teachers in the study stated that they helped students evaluate themselves and the process.

Findings regarding recognizing and supporting students' learning styles focus on the strategies teachers use to make students more effective. According to Perry, Lundie, and Golder (2019), metacognitive assessment and evaluation tools that can be used easily and clearly by teachers will enable teachers to embrace the concept of metacognition and develop it in a fully professional manner within their own contexts. Regarding recognizing and supporting various learning styles, Teacher 1 acknowledged that there are challenges in implementing cooperative learning due to curriculum requirements, but emphasized the importance of increasing student confidence and addressing prior knowledge gaps to facilitate success. He stated that learning will occur successfully when student confidence is instilled and prior knowledge gaps are addressed. However, cooperative learning is referred to as a metacognitive intervention in many studies (Kramarski & Mevarech, 2003; Su, Ricci, & Mnatsakanian, 2016). According to Su, Ricci, and Mnatsakanian (2016), when a student uses metacognition, they become aware of their own learning style and are able to recognize and apply strategies; this is often most effective when solving problems in groups or during cooperative learning. Similarly, Kramarski and Mevarech (2003) stated that cooperative learning and metacognitive groups significantly outperformed individual and metacognitive groups. However, Teacher 2 stated that students were bored with lectures and emphasized the need to engage them in active learning processes, and emphasized the need to implement digital content, group, and collaborative learning activities that encourage students' active participation in the process. Teacher 2 emphasized the importance of active learning, incorporating digital content and collaborative activities to maintain engagement. As a matter of fact, digital contents and the integration of some software into the process can improve metacognitive knowledge and skills (Baltacı, 2018; Hendriana, Setiawan & Aripin, 2019; Lee, Irving, Pape & Owens, 2015). Hendriana, Setiawan, and Aripin (2019) used the metacognitive guidance approach supported by GeoGebra software. Baltacı (2018) stated that GeoGebra contributes to the declarative knowledge, procedural knowledge, conditional knowledge, planning, monitoring, evaluation, debugging, and information management sub-dimensions of metacognitive awareness.

In terms of homework practices, Teacher 1 assigns homework after topic completion to reinforce learning, ensuring tasks are tailored to individual student levels and needs. Teacher 2 uses diverse homework types, including open-ended questions and modeling activities, which encourage deeper thinking and application, promoting active learning and metacognitive engagement. Both teachers highlighted the importance of supporting students' metacognitive development through active, discovery-based learning. Teacher 1 focuses on identifying students' current knowledge levels and delivering activities targeting metacognitive knowledge, while Teacher 2 emphasizes creating classroom environments conducive to metacognition through group work, projects, and discovery activities rather than rote memorization. Such active learning environments foster students' ability to explore multiple solution strategies and reflect on their thinking, key to metacognitive growth. Research supports that teachers' own metacognitive awareness is critical for effectively fostering metacognition in students (Jiang, Ma & Gao, 2016; Wafubwa, Csíkos & Opoku-Sarkodie, 2022). Teachers must be metacognitive themselves to teach these skills effectively. In this study, teachers demonstrated knowledge of metacognition and reported conducting related activities, including lesson planning, frequent questioning, encouraging student self-evaluation, and serving as metacognitive role models. Previous studies corroborate that metacognitive skills training improves student achievement (Hattie, 2013; Van Der Stel & Veenman, 2010), contingent on teachers' metacognitive competence. Metacognition is vital for guiding students to become independent thinkers who control their learning processes. Developing metacognitive awareness enables learners to regulate what and how they learn. Since teachers serve as role models, their metacognitive awareness significantly impacts their students.

The findings of this study should also be interpreted in light of its scope. Because the study was based on the experiences of only two mathematics teachers who had received formal training in metacognition, the findings provide an in-depth but context-bound picture of metacognitive teaching practices. In particular, the conclusions are shaped by teachers' self-reported practices and by the specific instructional contexts in which they work.

Future research may therefore build on these findings by including larger and more diverse participant groups, comparing teachers from different instructional settings, and incorporating student perspectives in addition to teacher accounts. Further studies may also examine more closely how specific practices identified in this study—such as differentiated lesson planning, encouragement of self-evaluation, use of digital tools, and support for

alternative problem solving strategies-contribute to students' metacognitive development in mathematics classrooms.

Etik Kurul Belgesi

Etik Kurul Komisyon Adı: T.C. SİVAS CUMHURİYET ÜNİVERSİTESİ REKTÖRLÜĞÜ
Eğitim Bilimleri Araştırma Önerisi Etik Değerlendirme Kurulu

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Yazar Katkı Beyanı

Tuğçe ÇINARGİL: Verilerin toplanması, işlenmesi, analizi, yorumlanması, inceleme yazma, düzenleme (%50).

Handan DEMİRCİOĞLU: Kavramsallaştırma, metodoloji, verilerin analizi ve yorumlanması, denetim, inceleme-yazma, düzenleme (%50).

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