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Research Article

An investigation on self-regulation activities of novice middle school mathematics teachers

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This study employed a qualitative research design to describe and analyze self-regulation processes (monitoring and control) of the novice middle school mathematics teachers in terms of teaching activities. The participants consisted of six mathematics teachers with five or less years of teaching experience. The data of the study were mainly collected through the observations of the lessons taught by the teachers and semi-structured interviews conducted with the teachers. The results revealed that the teachers' monitoring and control behaviors were affected by the goals they set. With regard to student-oriented monitoring, they generally focused on the cognitive development of the students. Compared to student-oriented monitoring, teaching-oriented monitoring was rarely observed. The most obvious control behaviors of the teachers were emphasizing the rules and algorithms, and taking responsibility for completing the task in challenging situations. It was also revealed that the teachers did not monitor carefully and systematically, and as a result, the mistakes they made during the teaching process were not noticed. These results highlight the need for pre- and in-service training programs that will aid in the development of monitoring and control skills in novice middle school mathematics teachers.

Keywords: Middle school mathematics; Novice teachers; Self-regulation; Monitoring; Control

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1. Introduction

Professional vision is described as a competency that can be acquired over time and involves actions that are unique to teachers' professions, such as observing potential classroom situations and expanding effective teaching environments by drawing insightful inferences from these situations (Goodwin 1994; Sherin 2014). Novice teachers need to consider and observe the potential effects of each situation that arises in the classroom because they are unfamiliar with the features of effective learning environments (Boshuizen & Schmidt 2008). As a result of such evaluations and observations, novice teachers will create concepts, strategies, and practices that will shape their professional lives.

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Research indicates that novice teachers struggle to complete some educational tasks compared to experienced teachers (Borko & Livingston, 1989; Reynolds, 1992; Wolff et al. 2016). For instance, it has been noted that novice teachers rigidly adhere to the lesson plan while lecturing (Borko & Livingston, 1989; Westerman, 1991). These teachers' top concerns during instruction are to get students' full focus on the tasks at hand and finish the lecture as planned, therefore they could act hurriedly (Berliner, 2001; Housner & Griffey, 1985). Additionally, it is argued that novice teachers do not focus on making sense of the student ideas in the teaching process (Jacobs et al., 2010) and have problems in noticing the pedagogical effects of the events in classrooms (Sherin & van Es, 2005). For instance, these teachers struggle with their ability to identify crucial mathematical situations that could enhance student learning, to monitor students, and to provide appropriate feedback in a classroom setting environment (Berliner, 2001; Peterson & Leatham 2009). Furthermore, it has been reported that novice teachers have difficulty in producing appropriate responses and explanations to student questions and comments, rarely make a relationship between concepts in the explanations they made, and have struggle to modify their lesson plans in line considering student needs (Borko & Livingston, 1989; Westerman, 1991). Briefly, it is claimed that novice teachers struggle to put the comprehensive lesson plans they developed into action (Borko & Livingston, 1989) and that they are prone to straying from the educational objectives (Borko & Livingston, 1989; Westerman, 1991).

1.1. Theoretical Framework

In order to successfully control their cognition, motivation, and behaviour to deal with the challenges they face when teaching, novice teachers should regulate themselves. The self-regulation of students and teachers with regard to learning activities is typically explained using Zimmerman's (2000) cycle self-regulation model. The model, which consists of a three-phase cyclical process, views self-regulation as being made up of the following components: *Forethought*, includes people's beliefs and preparation for the task; *Performance*, includes people's self-control and self-observation; and *Self-reflection*, refers self-judgement and self-reaction. In this study, the performance component of the Zimmerman's (2000) self-regulation model and the components of monitoring and control of the Yetkin Özdemir et. al.'s (2020) self-regulated teaching model are used. The latter model relies on the assumption that monitoring is focused on the variables influencing teachers' performance during the teaching process and how their performance affects this process. To get a sense of their own teaching performance, teachers should pay close attention to their own explanations, questions, tips, and directions during the teaching process (Yetkin Özdemir et. al., 2020). By observing their students, teachers can determine whether a newly implemented teaching method serves its purpose and the impact this has on student engagement in the course. By building a connection between the monitoring activities with various objectives, teachers who self-regulate can notice problematic situations related to the teaching process and decide on appropriate adjustments. As well as checking whether the lessons are presented in accordance with the scheduled content and whether different sorts of questions are solved in the classroom, teachers can make revisions as they see necessary.

Zimmerman (2002) refers to two strategies which make it possible to carry out self-monitoring: self-recording and self-experimentation. In order for the monitoring process to be effective, teachers can determine the situations that increase or decrease the effectiveness of different teaching processes by trying different teaching techniques and strategies and by keeping systematic and regular records (Yetkin-Özdemir et. al., 2020). According to Zimmerman (2002), the methods used in the self-control process (imagery, self-instruction, attention focusing, and task strategies) assist individuals in maintaining their attention and completing their activities. The self-regulated teaching model makes the assumption that the control process comprises adhering to the planned teaching process. Teachers can follow the lesson plan from different sources, develop certain routines, and organize the sequence of the lesson by dividing its content into subareas. According to this model, the monitoring and control activities are interrelated processes. Teachers

can make some adjustments, such as making the content easier or harder, depending on the results of monitoring the teaching process (Yetkin-Özdemir et. al., 2020). Self-regulated teachers may relate these two processes and develop effective teaching strategies to solve the problems that they detect during the monitoring activities (Yetkin-Özdemir et. al., 2020).

The majority of research on self-regulation among in-service and pre-service teachers focuses on activities that pertain to their own learning or general teaching practices (Çapa-Aydın et. al., 2009; Klusmann et al., 2008). Studies examining teachers' self-regulation in regard to their activities in the teaching process holistically and within the boundaries of the subject areas are scarce. These limited number of studies generally focused on teachers' self-regulation during the planning process and/or the assessments they made after the instruction (Bozkurt & Yetkin-Özdemir, 2018; Kurt, 2010; Nathan & Kim, 2009). As a result, little is known about the self-regulation activities of mathematics teachers during their teaching practices. There are several ways for novice teachers to get support, particularly when planning lessons (determining goals, making plan etc.), including speaking with more experienced colleagues and guidance teachers. However, the teacher bears full responsibility for overseeing the instructional process in the classroom. In order to better understand this situation, this study aims to describe and investigate the self-regulation processes connected to the activities (monitoring and control) of novice middle school mathematics teachers.

1.2. The Aim

Previous researchers investigating associations between teaching quality and years of experience suggested various phases. For instance, while Veenman (1984) defined teachers working in their second year of the teaching profession as novice teachers, Lavigne (2014) defined teachers who have five year of teaching experience as new teachers. Another researcher, Turner (1995) stated that teachers should have at least three to five years of teaching experience so that they are prepared for any unforeseen events that may arise. Berliner (2001) asserted that the most reasonable estimate for the development of teaching expertise for the teaching profession is five years or more. This study focuses on how six middle school mathematics teachers, who are in their first five years of teaching, regulate their cognitive, motivational, and behavioral processes while carrying out the tasks associated with teaching mathematics. Because it is crucial to have information regarding teacher self-regulation, the results of this study will contribute the field by providing a clearer definition of teacher self-regulation and details on how self-regulated and strategic teaching can be implemented.

2. Method

2.1. Study Design

A case study is employed as a research design because the content and implementation of teaching activities cannot be described independently of the setting and conditions under which teachers work. A case study is a qualitative research design in which researchers examine one or more bounded systems (cases) using extensive data collection techniques based on a variety of data sources (observations, interviews, audio-visual materials, documents, reports, etc.) and then report cases and case-based themes (Creswell, 2007). In this study, in which each teacher was treated as a separate case, the multiple case study design, one of the case study types, was adopted.

2.2. Participants

Six novice teachers with five or less years of teaching experience (Nihal, Özlem, Ayla, Serkan, Hale and Ender) took part in the study. Participants were given pseudonyms. Convenience sampling was used to choose the participants (Yıldırım & Şimşek, 2013). The selection of the participants was based on their willingness and volunteering to participate in the study. In addition, it was required that these teachers could share their ideas freely and were not bothered by being observed in the classroom environment. The teachers who took part in the study were all undergraduates who had completed a middle school mathematics education program. With five

years of teaching experience, Ender and Serkan were the participants with the most experience. Additionally, these two teachers worked at schools that were situated in a city. Other teachers held positions at schools in rural areas serving students with poor social and economic circumstances. Nihal had one year of teaching experience. Two of the teachers, Özlem and Ayla, had two years of teaching experience. Finally, Hale had four years of teaching experience. While Özlem taught in the 6th, 7th, and 8th grades during the study, Ayla and Hale taught at all grade levels (5-8 grades). Other teachers taught at least two different grade levels.

2.3. Data Collection Procedure

Interviews, observations, and document analysis were used to gather the data. Before commencing the data collection process, an ethical evaluation of the study was confirmed, and the required ethics certificate was obtained. Additionally, as the study was conducted in public schools, official approval was obtained from the Ministry of National Education (dated 25.12.2012 and numbered 10230228/44/42696) in addition to an ethics certificate (Hacettepe University Ethical Council's permission dated 27.09.2012 and number B.30.2.HAC.0.70.01.00/431-3629). Through the use of cameras and audio equipment, all observations and interviews were captured. Observations lasted a total of 61 class hours, and 31 interviews were performed. Table 1 provides information regarding the observations and interviews.

Pre-interviews and pre-observations with each teacher were performed, as shown in Table 1, in order to get to know them, learn about the routines they follow in their lessons, and build trust between the authors and the participants. Their lessons were noted after the preliminary observations and interviews (nearly 10 class hours). The purpose of the observations was to identify the control and monitoring behaviors of each teacher during their mathematics instruction. The author who conducted the observations gathered data from the observations regarding the behaviors of the teachers during the teaching process and developed self-regulation interview forms for each instruction. The forms were developed based on the lessons that had been observed. To improve the validity of data collection, the interview forms were finalized and the video recording of the lesson observation were shared with another author on the research team. In the interviews, the teachers were asked to explain the decisions and actions related to the monitoring and controlling of the instruction. The purpose of the final interview was to enable teachers to make an overall assessment of their lessons and the semester, and to obtain participant confirmation of the observation notes. The goal of the document analysis was to obtain data that would contribute to observation and interview data. To this aim, the textbooks, source books and class notes prepared by the teachers in the teaching process were examined.

2.4. Data Analysis

The instructional situations that occurred throughout the lesson, as well as the behavior and decisions of the teacher in relation to these situations, were described in the data analysis process. To prepare for the interviews regarding the observed lessons, a preliminary analysis of the observed data was performed. The analysis framework developed during the study study led on which teacher decisions and behaviors to concentrate on while analyzing the data. The data analysis was guided by the self-regulation model of Zimmerman (2000) and the self-regulated teaching model of Yetkin-Özdemir et. al. (2020). The data analysis framework was revised with the codes identified in the data analysis process which was carried out together with the data collection process. Table 2 provides the final version of the data analysis framework.

The data obtained for each participant were analyzed using the framework presented in Table 2. The findings are discussed in a comparative manner. Various methods were used to increase the credibility, transferability and consistency of the findings. In order to increase the transferability of the findings, the teachers participating in the study and their working environments were defined in detail. Four methods were used to increase the credibility of the findings. A long-term

Table 1
Information on observations and interviews

Teachers	*Observations*	*Interviews*
Nihal	Pre-observation-Measuring length (6-class hours)	Pre-interview (55 min.)
	Observation I- Polygons and their properties (2-class hours)	Interview I (47 min.)
	Observation II- Perimeter of quadrilaterals (4-class hours)	Interview II (65 min)
	Observation III- Area measurement (2-class hours)	Interview III (61 min.)
	Observation IV- Area measurement (2-class hours)	Interview IV (48 min.)
		Final interview (16 min.)
Özlem	Pre-observation- Circle and segment - Basic elements of prisms (5-class hours)	Pre-interview (29 min.)
	Observation I- Surface area of prisms (2-class hours)	Interview I (24 min.)
	Observation II- Surface area of cone and pyramid (2-class hours)	Interview II (31 min.)
	Observation III- Volume of prisms (4-class hours)	Interview III (45 min.)
	Observation IV- Pie chart (2- class hours)	Interview IV (31 min.)
		Final interview (12 min.)
Ayla	Pre-observation- Measuring liquids -Measuring area- Area and volume of prisms (6-class hours)	Pre-interview (45 min.)
		Interview I (42 min.)
	Observation I- Circles (2-class hours)	Interview II (53 min.)
	Observation II- Basic elements of prisms (4-class hours)	Interview III (61 min.)
	Observation III- Angles in circles (2-class hours)	Interview IV (43 min.)
	Observation IV- Surface area of cones (2- class hours)	Final interview (13 min.)
Serkan	Pre Observation - Probability- Addition and subtraction of fractions (6-class hours)	Pre interview (55 min.)
	Observation I- Probability (4-class hours)	Interview I (49 min.)
	Observation II- Multiplication and division of fractions (3-class hours)	Interview II (53 min.)
	Observation III- Decimals (2- class hours)	Final interview (12 min.)
Ender	Pre observation- First order equations with one unknown - Frequency table Bar graph (5-class hours)	Pre interview (51min.)
		Interview I (56 min.)
	Observation I- Coordinate system and linear relations (3-class hours)	Interview II (72 min.)
	Observation II- Basic geometric concepts (5-class hours)	Interview III (50 minutes)
	Observation III- Direct and inverse proportion (4-class hours)	Final interview (28 minutes)
Hale	Pre-Observation- Operations with natural numbers-Angles- Addition and subtraction of fractions (5-class hours)	Pre-interview (38 minutes)
		Interview I (73 minutes)
	Observation I- Multiplication and division of fractions (4-class hours)	Interview II (84 minutes)
	Observation II- Basic geometric concepts (6-class hours)	Final interview (10 minutes)

Table 2
Data analysis framework

Categories *Themes*	*Explanation*
Monitoring	
Student-oriented	*Cognitive*: It includes cognitive monitoring of students. It is the process of observing the solutions offered by the students, their answers to the questions and explanations. *Behavioral*: It includes behavioral monitoring of students. It is the process of observing the psychomotor skills of the students, such as working in groups, participating in the lesson, and expressing their ideas. *Affective*: It includes the monitoring of the students from a motivational point of view. It includes monitoring student interest in the subject and their self-confidence, etc.
Teaching- oriented	It includes the monitoring of the decisions and actions of the teachers regarding the teaching activities. It involves observing the appropriateness/correctness of the explanations, directions, etc. made to the students. It also includes the observations about the course content, the variety of problems. It covers the monitoring of the positive/negative effects of teaching practices on student performance.
Control behavior	
In regard to the course content	It includes the decisions taken and practices to follow, limit or expand the content planned within the scope of the stated objectives specified for the relevant grade level in the mathematics education program.
In regard to the lectures	It includes the decisions related to the instructional materials, the way they are presented and / or the order in which they will be discussed and taught in the lesson and the decisions taken regarding the teaching methods and techniques.

association with the participants which lasted approximately three months was achieved through the interviews and observations. Diverse techniques were used for gathering the data. During the data collection and analysis processes, all researchers collaborated and shared information. Additionally, member checking was applied during the final interview as well as the interim interviews regarding the lectures. The techniques for data collecting and analysis were thoroughly outlined in order to improve consistency. Furthermore, the findings obtained from the observations, interviews and document analysis were examined comparatively, and the consistency of the findings was tested. During the coding process, the researchers collaborated and discussed through any coding issues.

3. Findings

The regulation activities of the teachers regarding their teaching activities were examined in terms of two basic processes, namely, monitoring and control. First of all, the findings on student-oriented and teaching-oriented monitoring behaviors were presented. The findings are then discussed in relation to the teachers' controlling behaviors of the course content, mathematical tasks, and teaching methods and techniques.

3.1. Monitoring Behavior

3.1.1. Student-oriented Monitoring

The findings regarding the student-oriented monitoring behaviors of each teacher are presented in Table 3.

Table 3
Student-oriented monitoring behaviors

	Nihal	Ayla	Özlem	Hale	Serkan	Ender
Cognitive factors						
Conceptual understanding	✓	✓			✓	
Procedural skills	✓	✓	✓	✓	✓	✓
Basic skills (connections, communication, etc.)						
Behavioral factors (e.g., psychomotor skills)	✓	✓				
Affective factors (e.g., interest)		✓	✓	✓	✓	✓

Table 3 shows that the participants frequently monitored the cognitive status and activities of the students. Concerning the cognitive monitoring, they focused on students' procedural skills. Throughout the lesson, teachers observed their students to see if they correctly applied the rules or relations (formulas for surface area or volume of geometric objects, etc.), followed the algorithms (multiplication / division algorithms in fractions, etc.), and used the symbols (line, line segment, ray symbols, etc.) in an appropriate manner. In line with their goals, they concentrated on how well their students performed, paying particular attention to their procedural knowledge and abilities. As they stated in their goals, they focused on the performance of their students, especially in relation to their procedural knowledge and skills, and checked the students' notebooks to monitor whether they made any operational mistakes. For instance, Hale claimed that during these observations, she concentrated on the students' achievements on the topics she gave priority to in the class and on the points she projected they could find challenging.

> Hale: I pay close attention to some aspects and I monitor them such as finding the common denominators in fractions, inverting [referring to invert-and-multiply algorithm] in division, using symbols, or using brackets correctly when using symbols. (Multiplication and division by fractions)

Asking students if there is anything they do not understand and monitoring their reactions is another action teacher do to monitor their students' cognitive performance. This behavior was found to be frequently exhibited by Özlem, Hale and Ender. Özlem claimed that when she asks her students if they understand, she often observes their responses and analyzes them. Making inferences about the class as a whole by focusing on the behaviors or reactions of particular students is another reported monitoring behavior of teachers. Ayla's report demonstrates this tendency. In relation to this strategy which makes the monitoring process easier, she stated, "There are some students that provide me feedback. Using their feedback, I deliver the lesson". In a similar vein, Ayla claimed that she payed attention to her students' verbal cues and that when she received brief responses to her inquiries, she assumed that the content was not grasped.

The majority of the students' performance was monitored based on their procedural knowledge or problem-solving skills. This is consistent with teachers' goal orientations related to standard testing and their low expectations from the students (Yetkin-Özdemir, 2015; Yıldız et. al., 2021). Only Nihal, Ayla, and Serkan, albeit rarely, focused on their students' conceptual understanding. For instance, Nihal challenged fifth-grade students to determine the side length of the square whose area is given as a perfect square integer while teaching the topic of the area of the square. She stated that she wondered how the students would respond when she posed this issue, which calls for a high level of thinking for a student in the fifth grade. Serkan, on the other hand, emphasized the invert-and-multiply algorithm in the division of fractions and did not include any activity to make sense of the operation. However, later in the lesson while tackling the problem of $\frac{1}{2} \div \frac{1}{2}$, he surprised that the students used the algorithm. He expressed his surprise as follows: "How many $\frac{1}{2}$ are there in $\frac{1}{2}$? There is one. I looked for anyone who would give this answer, but no one gave this answer." As can be seen from this example, Serkan questioned his students to monitor their understanding of the procedure. However, because there had never been any activity to explain this procedure, he was forced to draw a poor conclusion about his students' mathematical reasoning as a result of this monitoring activity.

Another important finding regarding the student-oriented monitoring behaviors is that the teachers did not monitor the development of the skills related to mathematical connections (i.e., making connections with other disciplines and daily life) among the students. The fact that Nihal and Ender did not follow up on this skill during the lesson, although it was included in their goal statements, may be related to the fact that they cared less about this goal than other goals.

It is revealed that Nihal and Ayla did, albeit minimally, monitor their students' behavior. These teachers particularly monitored the students' note-taking habits and their their ability to use tools (protractor, compass, ruler, etc.). It can be seen in the following excerpt from Nihal's reports:

> Nihal: Because there is very little space left before the zero with the ruler, students can take that into account. Alternately, they can start from 1. I observed it to watch out for it... Because I know their mistakes. (Measuring area in polygons)

The teachers also monitored the motivational status of their students throught the lesson. Only Nihal was not found to make any monitoring behavior in this regard. The teachers exhibited various behaviors in order to maintain the lesson by supporting the motivation of the students. For example, Hale tried to track both the overall motivation of the class and the motivations of individual students during the lesson. Especially when she used a novel instructional material (such as using a rope in teaching basic geometric concepts), she monitored the participation and interest of the students. In this process, she focused on the quantity of participation (the fact that most students were attracted to the lesson) rather than the quality of participation (does the concrete material help students understand the concept/ how?).

> Hale: In mathematics, it's difficult to visualize much. This course is abstract. The students didn't lose interest in listening to the lesson at least while they were learning something. They made an effort to participate in the class, as I could see. That's why I believe it helps. (Basic geometric concepts)

3.1.2. Teaching-oriented Monitoring

The monitoring behaviors of the participants that are focused on teaching are shown in Table 4.

Table 4
Teaching-oriented monitoring behaviors

	Nihal	Ayla	Özlem	Hale	Serkan	Ender
Monitoring of the content	✓	✓	✓	✓	✓	✓
Monitoring the variety of the problems	✓				✓	✓
Monitoring the adequacy of explanations/descriptions	✓				✓	
Monitoring instructional behaviors (response time, intervention, time management)	✓	✓				
Experimenting with different teaching practices and monitoring their results	✓	✓	✓	✓	✓	✓

The majority of the teachers' monitoring of their own teaching performance consisted of adhering to the content-related curriculum. It has been observed that all of the teachers constantly monitor their own progress in covering the content of the lesson. It is also found that they employ textbooks as a tool to achieve this goal. For instance, Hale's monitoring behavior throughout the lecture was to adhere to the textbook in order to avoid skipping over any of the lesson content.

> Researcher: Throughout the class, I have noticed that you occasionally glanced at the book. What are you looking at in the book?
>
> Hale: I checked to see if there was anything I had neglected. Or, if the book provided a different example. I do not want to miss the information provided in the book we are writing. I then looked at the book. (Basic geometric concepts)

Ender, on the other hand, mostly followed the source book to check the lesson content. It was also observed that Ender used the notes he had prepared before the class. He reported this as follows:

> Ender: I wonder if there is a point I skipped. We solve examples pertaining to each topic after the topic has been taught. I checked it because I was unsure whether there was anything I missed or did not do according to the plan. I took a look at it to see if there was a more intriguing question that I had prepared. (Linear and inverse proportion)

Because they did not systematically monitor their own teaching practices, the teachers were unable to implement some of the activities they had intended. Instead of adding the entire portions of two integer fractions and then continuing the procedure, the students in Hale's class turned both fractions into composite fractions when faced with a question that required an operation with brackets. Hale mentioned in this question that she wanted the students to continue the process by understanding this relationship, but she made no comments in this regard. It was noted that she was unable to follow up in a systematic manner; hence this learning opportunity was missed. She provided the following reports:

> Researcher: In this question, adding the integer parts makes 6. Did you specifically choose this question?
>
> Hale: Yes, but students could not solve it. Instead, they converted it into a compound fraction. But my purpose in giving this question was different. I do not remember if I said it in class but I took it to highlight it.
>
> Researcher: I guess you did not say it.
>
> Hale: I honestly do not remember if I said it or not, but I chose it with that in mind. 4 whole and 1 whole are 5 whole. Actually, I would, but it may have been overlooked. (Multiplication and division by fractions)

Another important finding is that teachers monitored the diversity of the problems they use in their lessons. They used the textbooks and workbooks for this purpose. For example, Ender checked the question styles in the book. Similarly, Nihal's statements "I looked to see if there were any other question styles in the book. ... I wanted to see if I missed any question style. That's why I looked at the book." also indicate that she employed the textbooks to offer various examples of questions to their students.

The teachers stated that they also monitored the accuracy of the definitions they used and the adequacy of their explanations during the lesson. It has been noted that they occasionally consulted the textbooks, workbooks, and notes for this reason. Serkan, for instance, claimed that he utilized the book to confirm the veracity of the definitions he provided in the class. Nihal's decision to alter the way the lesson was taught was influenced by her observations of her own teaching behaviors. For example, she gave a more detailed explanation when she recognized that her explanation was insufficient in regard to the calculating the area of compound figures and to direct her students to calculate the area by converting the shape into a rectangle. Here, Nihal's decision and practice can be seen as a result of her monitoring, focusing on both student performance and her own teaching behavior. She stated that, "I suddenly thought about it. Because I realized that my previous explanation was insufficient. That's why I felt the need to make such a statement (Measuring area in polygons)."

The teachers' monitoring of their own teaching behaviors or habits is found to be quite limited. Among the teachers, Ayla was the most frequent and regular self-observer in this regard. For example, Ayla, whose most obvious teaching goal was to give her students more voice and not be intrusive, stated that she often watches herself in these aspects during the lesson. Nihal, on the other hand, stated that she paid attention to whether she allowed her students enough waiting time for an answer. In her statement below, Nihal expresses her views about the monitoring and evaluating her own performance in terms of giving her students a voice.

> Nihal: While teaching the subjects, I try to involve the students in the process. As far as I can tell, I undoubtedly have some weaknesses. I think I should wait a little while giving a word to the

> students. But I guess I answer the questions myself, thinking that they cannot answer them. I noticed it. (Calculating perimeter in polygons)

It has been observed that the teachers only monitored the effects of teaching process when they used a material or model that they had not used before in their lessons. In particular, Ender stated that he observed the results when he tried different teaching practices. For example, he stated that students made measurements on length and land measurements in the school garden, had poster work on geometric shapes and that he observed that this activity was effective for student learning and motivation. Nihal also stated that she observed that drawing the unit squares while teaching area measurement increased the motivation of the students. In a similar vein, Hale claimed that the students' interest in the lesson was boosted by the use of models like rope and pencil in the lesson in which she taught geometric concepts such as line, line segment, and parallelism. The cognitive impacts of these activities on students' learning, however, were not thoroughly and in-depth monitored by the teachers. It is observed that none of the teachers had the habit of systematic monitoring and record keeping of students' performance or their own teaching performance. In this process, only Ayla stated that she recorded the information she obtained as a result of her teaching-oriented follow-ups, on a notebook or a book, although not regularly.

> Ayla: Yes, I take notes on my difficulty during the lessons, the difficulty of the students and on what I should do to avoid such problems. But, I do not take such notes regularly… When I regard something very important I take notes about it, since later I may forget about it. It would have been much better if I had noted down what I did last year and where the students were having trouble. As I look at these notes, I probably understand what I taught so that it does not need to be repeated. (Angles in the circle)

3.2. Control Behavior

3.2.1. Controlling the course content

Table 5 presents teacher behavior about the controlling the content in a comparative manner.

Table 5
Control behavior concerning the course content

	Nihal	Ayla	Özlem	Hale	Serkan	Ender
Following what was planned	✓	✓	✓	✓	✓	✓
Expanding the content	✓			✓	✓	
Narrowing or limiting the content					✓	

Table 5 shows that the teachers generally followed the content they had planned by engaging in a few rourtine control behaviors. The follow-up of the textbook is identified as a routine that they frequently refer to. For example, Ayla stated that she tried to follow the book, especially checking whether the process in the book and the process in her mind matched. She also stated that she used the textbook specifically to ensure that the definitions were error-free. Nihal, on the other hand, usually observed the textbook, but did not follow the book exactly. However, she adhered to the textbook on the subjects that she did not think she had sufficient knowledge and experience or on the subjects that she did not have the necessary confidence in terms of field knowledge (such as measurement estimation). Below are her opinions in this regard:

> Nihal: I did not have any formal training on the methods of estimation. So, I do not have necessary knowledge about it. I should follow the textbook concerning this topic. That's why I used the textbook in relation to estimation. (Measurement estimation)

Another routine control behavior that the teachers performed in order to maintain the content they planned is to start each lesson by making a short explanation about the content of the lesson and reminding the students of the subject they covered in the previous lessons. For instance, Hale's views are as follows:

> Hale: Sometimes students forget what they have been taught. For example, students forget to invert and multiply in the division. I am going this way so that the children will not be disappointed and

> that they do not feel sorry for not being able to do it, and to remind them from the beginning. I remind them to take precautions. I remind the basics before starting the lesson. (Multiplication and division by fractions)

The teachers introduced a problem, example or explanation in the introduction to a new topic and then asked students to solve similar examples, this may be seen as another control behavior of teachers to follow the lesson plan. In addition, they explained the solutions to questions. The teachers did not give their students many opportunities to do the problem solving and explain the solutions. Serkan's statements in this regard are presented below as follows:

> Serkan: When students solve the problems themselves, they cannot understand the process. Moreover, there is time constraints which do not allow me to make each student solve the problems. I therefore prefer solving the problems and explaining how to do so to the students. (Probability)

In general, the teachers did not go beyond the course content they planned and made limited extensions to the content in line with the interests and needs of the students. However Nihal, Hale and Serkan occasionally did. For example, although it was not included in the curriculum, Nihal asked her students to find the side lengths of a square whose area is given (in the form of a perfect square like 16, 64). Nihal stated that this control behavior aimed at expanding the content and also, at increasing the cognitive complexity in order to test the performances of the students. Similarly, Hale included the concept of right angle, which is not included in the educational program, as a result of a student's question about angles. Serkan's decisions to expand/enrich the content are mostly aimed at supporting students' procedural skills or eliminating deficiencies in their prior knowledge. For instance, he focused on a strategy to develop mental processing skills of the students which is not directly related to the learning outcome. He showed his students how to use "computing by dividing numbers", one of the mental calculation strategies, in solving a problem that requires multiplication in probability calculations. In the interviews held after the lessons, the teachers stated that these additions they made to the content of the lesson were based on the decisions they made during the lesson without making any plans. Extensions other than these examples are additions made as a reminder to the relevant preliminary topics, which are mostly included in the lesson plan. For example, Ender briefly mentioned the concept of ratio before the subject of proportion, and Nihal emphasized the concept of polygons in the introduction to the subject of quadrilaterals. Likewise, Özlem made reminders about the area formulas of the polygons that make up the surfaces, about the surface areas of the prisms.

The teachers did not decide to restrict the content they planned during the classes, nor did they include the topics they believed their students would struggle to understand or that they would find challenging to teach. The fact that Hale did not include the use of models in the division of fractions is one example. Similarly, Nihal adhered to the content she planned during the lesson but made some limitations by not going deep into the issues that she thought were not important or that students might have difficulty with. For example, in problems related to calculating the areas of compound shapes, she focused on the method of dividing the shape into squares or rectangles but did not include the method of converting the shape into a square or rectangle, although it was included in the textbook. She stated that she understood the fragmentation method better and that her students would not understand the converting method as the reasons for this decision.

When students experienced difficulty throughout the lesson, the teachers did not cut back on the information they had intended. However, they either took on the duty of finishing the assignment themselves or provided basic and straightforward examples to teach the subject. The only instance we observed where a decision was made to restrict (narrow) the subject while teaching was in Serkan's class. Serkan's exam-oriented objectives were effective in supporting him narrow the content, particularly during preparation and class activities. For instance, despite the fact that it was in the curriculum, he decided not to utilize a model for the division of fractions since he had problems multiplication of fractions. Likewise, for dividing fractions, identifying common denominators then dividing the numerators and denominators separately were not included in the lesson. The invert-and-multiply algorithm was the sole algorithm presented in the

course. He preferred to incorporate algorithms that would drive students to the outcome fast, as can be seen from his comments below, and he limited the content in this way.

> Serkan: As confusion could arise, when division [referring to invert-and-multiply algorithm] was completely understood by students, I did not make the process much more complex by including finding the common denominators and dividing the numerators and denominators separately. Students rarely encounter this topic. So in our test sources, they do not come across such topics elsewhere. Therefore, I did not focus on it very much. (Multiplication and division in fractions)

3.2.2. Controlling the mathematical tasks

Table 6 compares the control behavior of the teachers in relation to the mathematical tasks.

Table 6
Control behavior concerning the mathematical tasks

	Nihal	Ayla	Özlem	Hale	Serkan	Ender
Classifying the similar tasks to make the content more varied	✓	✓			✓	✓
Breaking down and simplifying the task	✓	✓	✓			
Complicating the task	✓	✓			✓	✓
Variation in representation of the tasks (materials, models/shapes, verbal problems, etc.)						

Table 6 shows that the teachers' control behaviors toward the mathematical tasks mostly involve an effort to carry out their planned lesson or routines. To do this, they divided the mathematical activities into groups and tried to include a range of examples in the lesson. These groupings were often ranked by teachers from simple to complex. The teachers in whom this behavior is most obviously manifested are Nihal, Ayla, Serkan, and Ender. Serkan divided the fraction division problems into three categories: division of a natural number by a fraction, division of a fraction by a fraction, and division of two integer fractions by each other. He covered the problems that could be an example for each group. Ender stated that he chose examples from the types of questions that students might encounter (problems such as distance-time, number of worker-time, etc.) in the subjects of direct and inverse proportion and included them in the lesson. Similarly, Ayla first included activities to find the surface area of the unfolded cone, and then she moved on to activities involving finding the surface area of the cones, which were given folded. Likewise, Nihal first focused on the problems involving calculating the perimeter of a square of which side length is given. Then, she focused on situations involving finding the side length of the square of which perimeter is given. Teachers stated that students should work on different types of examples and problems in order to learn mathematics. For this reason, they made an effort to increase diversity by constantly monitoring the examples and problems they presented to their students in their lessons.

Teachers' student-oriented monitoring has been effective in their instructional decisions. Some of these decisions were in the form of complicating the content or breaking down or simplifying the task. They supported students to focus on the main concepts by using simple numerical values so that students could focus on important mathematical ideas by reducing the cognitive load in the transition to a new topic, albeit at a limited level. For example, Özlem stated that she aimed to make students easily establish the relationship between the angle of the circle slice and the data set by choosing the data set from numerical values that can be easily processed on the subject of pie graph. Similarly, Ayla included examples containing reference values such as 45, 90 and 180 angle degrees so that students could see the relationship between the inscribed angle and the central angle subtending the same arc of the circle. However not all of the teachers used examples that might be easily connected to what students already know. For instance, while Serkan and Hale could use simple numerical values (such as $1 \div \frac{1}{2} =?$ or $2 \times \frac{1}{2} =?$) to make sense of multiplication

and division operations with fractions, they focused on the application of the algorithm and did not include such examples that could support conceptual understanding of the students.

Another way to simplify the task is to break it down into sub-tasks, making it a step-by-step process. For example, Özlem first drew the closed shape for each geometric object in the lessons where she taught the surface area, and then went on to solve sample problems after unfolding the shape and developed the formula for surface area. In this way, breaking up the teaching task is a control behavior that facilitates the operation. Nihal's most obvious control behavior for the lesson was the breaking down the task to reduce cognitive complexity. For example, while teaching the subject of calculating the area of compound shapes, she reminded her students that they should find the side lengths that were not given first to calculate the area.

> Nihal: We can proceed in steps. The aim is to make students achieve it themselves. ... Or they follow me after each step. At the end the students can solve the problems fast. When we proceed step-by-step they can do it. It's considerably better, in my opinion. (Measurement of area)

Decisions and practices aimed at complicating the task are often arrangements that can support the development of computing skills, requiring the use of fractions, decimals, or square roots when performing operations, or converting the different units of measurement. It is observed that Nihal, Ayla, Serkan and Ender included challenging problems that require high-level skills that enable students to think more deeply about concepts. However, they took an active role in solving these problems. Nihal, as a result of her observations on student performance, decided to use different units in the values she gave for the edge lengths in the problem of finding perimeters. She stated that she took a decision in this direction in order to remind the students of prior subjects and make the question more difficult.

The teachers rarely included different forms of representation (material, model/shape, verbal problem, etc.) in their lessons depending on the nature of the subject they were teaching. Nihal, Ayla, Özlem, Hale and Ender, whose lessons we observed including geometry subjects, benefited from geometric object models, drawings and materials such as rope. However, no variation was observed in terms of teaching method or technique in the use of materials and models. The model use occurred generally in the form of teaching the subject through teacher-oriented question-answers. In the lessons, prototype examples were rarely exceeded, and the drawings and models mostly reflected typical examples. In addition, the teachers did not deal with different representations of the same concept together and did not make associations between different representations. For example, Serkan, who dealt with the multiplication of fractions through area model, did not include the relationship between the solutions through this model and the solutions using symbols in his lesson.

3.2.3. Controlling teaching methods and techniques

Table 7 presents the participants' control behavior in relation to teaching methods and techniques in a comparative manner. It has been observed that the teachers lacked flexibility when it came to modifying the lesson. Additionally, they did not moderate the lesson based on the students' existing or emerging knowledge and abilities. This tendency was very clear in the introduction sections of the lesson. The teachers usually started their lessons by reminding the students of related past topics. In this process, they were more active than the students themselves, and they presented the preliminary information that the students had difficulty in remembering in the form of explanations. They did not use these introductory activities for monitoring and organizing the lesson. For example, Ender routinely reminded students of the preliminary information about the subject, but he did not change the sequence of the lesson according to this introductory activity. This also applies to other activities. Similarly, the concluding activities of the lesson were not modified according to the situations that emerged in the teaching and learning activities, and the

Table 7
Control behavior concerning teaching methods and techniques

	Nihal	Ayla	Özlem	Hale	Serkan	Ender
Organizing the sequence of the lesson according to the events in the lesson, flexibility		✓				
Using different/various methods in different situations (question-answer, explanation, demonstration, discussion, group work, etc.)						
Highlighting rules, algorithms, and potential errors	✓	✓	✓	✓	✓	✓
Taking responsibility for completing the task in challenging situations	✓	✓	✓	✓	✓	✓
Using explanation, repetition and demonstration as plan B	✓	✓	✓	✓	✓	✓
Skimming/ superficial explanations	✓		✓	✓	✓	
Limiting/ignoring the right to speak		✓				✓

lessons were carried out as planned. It was observed that Özlem did not go beyond the practices she planned in her lessons, and she mostly used the same type of teaching methods and techniques in her lessons. Therefore, Özlem's monitoring and control behaviors are mostly limited and aimed at maintaining the lesson plan. In all of Özlem's observed lessons, the students' prior knowledge was checked by questions at the beginning of the lesson, and the teacher herself explained the missing subjects. In addition, the teacher presented the definitions and drawings related to the subject on the board and solved the first example herself. Then she asked the students to solve similar examples. Özlem continued to use these methods and techniques even when she faced with an unexpected situation. Only Ayla stated that she often revised the sequence of the lesson according to the reactions of her students. However, she stated that for this reason she could not teach her lessons as she planned. Her views are given as follows:

> Researcher: You said that the lesson went completely different from what you had in your mind. You said that neither where nor how did it go, it never went the way you planned, remember that??
>
> Ayla: The questions they ask are sometimes those that I can answer very briefly and I may continue to teach the topics. But sometimes they confuse the topics. I cannot continue with the topics without eliminating this confusion. Therefore, the reactions from the students guide me about how I will teach the lesson. (Basic elements of prisms)

The teachers preferred different teaching methods in different parts of the lesson in order to continue their lesson as they planned. These behaviors come to the fore especially in the introduction phase of the lessons. For example, Hale, Serkan and Ender generally started their lessons with a short explanation (writing the title, or talking about the importance of the topic) about the content of the lesson. After the introduction, the teachers made the transition to the new topic by presenting a definition and explanation or using the question-answer method. For example, at the beginning of the subject of quadrilaterals, Nihal asked her students to show examples of the quadrilaterals they saw around them. She then asked her students about the properties of each quadrilateral such as sides and corners. Similarly, Serkan studied experimental, subjective and theoretical probabilities by asking questions related to weather forecasting. The question-answer activity mostly took place between the teacher and a student and then ended with the teachers' evaluation (true-false). No observation was made in which students can discuss the topics with each other, allowing them to explore concepts and rules and to ask questions and explain them. A definition, a rule or generalization was mostly presented by the teacher. Then sample problem solutions were made in which the teacher was more active. The students took a more active role in individual problem solving processes, which mostly took place at the end of the lesson.

Situations supporting student explanations and/or solutions were not observed. Even if the student solution was correct, the teachers often took on the task of explaining the solution method.

Serkan himself explained the problem solutions in his classes. He stated that a student who could not explain the solution well could cause confusion among the others. At the beginning of Ender's routine behaviors, his students listened to him while he was explaining the subject and took notes later. He made frequent statements in this direction during the lesson and reminded the students of this expectation. Only Ayla encouraged her students to develop their own ideas and find their own solutions, and tried to create opportunities to develop through these ideas. She expressed her views as, "A student is solving a problem. I know that there is another solution. I want them to find it, these solutions should not be the same as I provided." One of the practices that support this view is asking her students to draw different chords of a circle in their notebooks.

The most typical practice to maintain the sequence of the lesson plan was to highlight the definitions, rules, or algorithms associated with the topic covered in the lesson. All of the teachers emphasized the points they deem important about the subject by writing or repeating. However, these practices differed slightly among the participants. For example, Nihal stated that she consciously expressed the definition in the book with her own words and Hale stated that she included especially important points and possible mistakes and emphasized these statements in the definitions. Ender, on the other hand, stated that he used bullets to highlight the key points in definitions because he thought they were more memorable. Serkan and Hale, who are more senior teachers, frequently emphasized typical student mistakes. Serkan emphasized important points and possible student mistakes about dependent and independent events in probability. For example, he stated "It [referring to the probability of compound events] is multiplied in both the dependent and the independent [events]. There is no such thing as adding [the probability]" and "If the numerator and denominator do not decrease, they are independent [events], if they do, they are dependent [events]." Hale and Serkan emphasized that denominators do not have to be equal in multiplication and division algorithms for fractions. Such practices were especially observed as a defining feature of Hale's lectures. Hale, frequently emphasizes about possible mistakes and error-free solutions without allowing students to make mistakes.

Teachers' monitoring and evaluation of student performance affected their decisions about the ways of teaching. The typical control behavior observed among all teachers is that they are active in a new or different situation or in solving a problem. They took the responsibility of completing the task when they thought that their students might have difficulties, and they retreated in subsequent similar situations and gave the students the opportunity to deal with it on their own. For example, Serkan presented a probability problem that he had not solved before and stated that he wanted his students to follow him while he was solving it. Similarly, Özlem carried out the tasks of understanding the problem situation on the surface areas of geometric objects and forming the relation herself, and the students were left only to write the numerical values in the relation and to perform operations. Özlem, who stated that she had low expectations from her students, took the responsibility of completing the mathematical tasks in almost all stages of her lessons. Nihal herself took an active role in most of her lessons, especially when she thought that her students might have difficulties, and gave her students the right to speak in second or later similar examples. Even when she gave her students autonomy, she took an active role in reaching a solution with her guidance and hints. In order to prevent her students from finding incorrect solutions, she started to manage the process herself when she saw that they had difficulties.

Teachers frequently referred to pertinent previous courses or reiterated what they believed were key themes when they noticed that the students were having difficulty in understanding the topic. For example, Nihal's explanation to her students, who confused the rules for area and perimeter of the square, was to repeat these two rules. Only once did she use a verbal daily life situation (the perimeter and area of Uncle Ahmet's garden) to show the difference between the concepts of perimeter and area. She did not use other different methods (showing the area and the perimeter with different colored pencils, establishing a relationship between the drawing and the rules, etc.) to make students understand the difference between these concepts. On the other hand, it is observed that Serkan and Ender became a model for their students by giving clues, thinking

aloud, using simplification or a different teaching method (visualization, explanation, etc.) in problem solving when they felt that the students did not understand the subject.

The teachers glossed over or gave superficial explanations when answering the students' questions that they thought might negatively affect the direction of the lesson or they would have difficulty explaining. For example, Serkan and Hale glossed over the questions of the students who asked why the invert-and-multiply algorithm worked on division by fractions. Likewise, Özlem did not explain the relationship between the volumes of the right cylinder and the right cone of the same height. Nihal, too, could not provide an adequate explanation to her student who asked why they were making calculations about estimation.

Another control behavior, which is used with the aim of maintaining the sequence of the lesson plan, is to ask for explanations from students who can explain their ideas well, to give the students the right to speak only on simple and basic issues, to ignore the suggestions of the students or to postpone the discussion of ideas in cases where they think that the subject may be disintegrated. While this behavior may have been necessary to preserve the integrity of the lesson, it precluded the opportunity for students to discuss their developing ideas. For example, Ender ignored the student questions about whether parallel lines could be in different directions (except for vertical and horizontal directions) on basic geometric concepts because this question did not fit the sequence of the lesson plan. In a later part of the lesson, he explained the student's question about the parallel lines himself. However, the question of the student could have been directed to other students and they could be asked to reason about the answer to think about the concept of parallelism and the students could be made to think about the concept more actively.

4. Discussion and Conclusion

It is evident from the results of the study that the teachers monitored and controlled the lessons in accordance with their preparation goals. Because they generally set goals for the correct use of rules and algorithms, they regularly followed up on the accuracy of the student answers, whether algorithms, rules and symbols were used appropriately during the lesson. They rarely observed the development of students' conceptual understanding. These results suggest that novice teachers tend to focus on procedural knowledge, which supports the results of Arani (2017). Arani (2017) reported that the experienced teachers focus on conceptual understanding while novice teachers focus on procedural knowledge. Another remarkable result of the study is that the teachers did not monitor the development of the skills related to the mathematical connections that they stated in their objective statements. These results suggest that some goals were not given importance as much as that to others. Therefore, it can be argued that there is no regular and systematic monitoring of whether these goals are achieved or not.

Compared to student-oriented monitoring, teaching-oriented monitoring was quite limited. Following a course book or notes was the most frequently observed monitoring behavior for teaching performance. Although at a more limited level, the teachers attempted to diversify the problems included in the lesson and to ensure the accuracy of the explanations/definitions presented. However, it is observed that there are mathematically incorrect or incomplete definitions that were modified to make them easier to understand. It is also observed that these incorrect statements were not noticed and corrected because there was no careful and systematic monitoring. Another remarkable finding is that only the two least experienced teachers (Nihal and Ayla) are found to monitor their own teaching behaviors (e.g., response time, intervention).

Almost all of the teachers participated in the study monitored the effectiveness of the new or different instructional practices (the use of novel materials, models, etc.). However, this monitoring mostly focused on changes in the student interest and participation. There was no in-depth monitoring of how these practices affected students' understanding of concepts (e.g., How did the material make the concept easier or difficult to understand for the students?). This may be due to the teachers' limited knowledge about the effects of material use on learning or their inability to use this knowledge effectively for monitoring purposes. The studies suggest that teachers' purpose

of using concrete materials is generally to increase student interest and participation in the lesson (Grant & Peterson, 1996; Moyer, 2001). These findings provide explanatory information about the tendency of the teachers participated in the study to focus on the motivational dimension during material use.

Grossman et al. (2009) suggested that teacher training programs should be organized around specific practices (learning practices) that guide teaching, rather than around what teachers should know. However, it is emphasized that teacher trainers should address not only the practical aspect (how to do it?), but also the conceptual aspect (why should we do it?) of these practices. The findings of this study show that one of the learning practices that teachers need to gain experience should be towards student understanding and their ability to monitor their own teaching behaviors during the lesson. In the teacher training some approaches such as the Cognitively Guided Instruction (Fennema et. al., 1996; Franke et al., 2001; Franke & Kazemi, 2001) and the Hypothetical Learning Trajectories (Simon, 1995) might provide the pre- and in-service teachers opportunities to focus student thinking. In order to acquire this habit of keeping regular and systematic records on students' learning processes, teachers, especially those in the first years of the teaching profession, need to engage in practices (workshops, seminars, group activities, and cooperative professional development programs) based on the above-mentioned approaches.

It appears that teachers mostly adhered to the content and process of the lesson they planned. Content was rarely expanded or narrowed based on the development of the lesson, and the outline of the lesson was rarely changed. In the studies comparing the behavior of novice and experienced teachers' teaching performances, it is reported that novice teachers are overly dependent on lesson plans in the teaching process (Borko & Livingston, 1989; Westerman, 1991). It is also reported that the priorities of novice teachers in the teaching process are to attract student attention to teaching tasks and to complete the lesson as planned (Chubbuck et al., 2001; Housner & Griffey, 1985). Zimmerman (2015) argues that novice teachers have four different types of practical intentions in the teaching process: keeping the lesson momentum; covering the content; supporting the student needs and encouraging the independent student thinking. The findings obtained in this study show that the teachers exhibited monitoring and control behaviors in order to cover the content they planned, to maintain the momentum of the lesson (maintaining the order in the lesson plan) and to support student needs (academic-procedural and emotional). However, very limited behavior was observed in only one teacher regarding the intention to encourage independent student thinking.

According to Dreher and Kuntze (2015), representations are an important aspect of mathematics teaching and learning. Furthermore, the related studies show that it is impossible to teach a mathematical object or idea coherently when using only one representation, and that the meaningful use of multiple representations in the process of establishing relationships and teaching is beneficial for students to obtain a coherent understanding of mathematics (e.g. Cengiz et. al., 2011; Duval, 2006). It was observed that the teachers used different materials and models during the lessons. However, they did not use different forms of representation in completing a particular mathematical task. Therefore, it was not observed that different forms of representation of a concept are employed together and the relations are established between these representations. The inability to make adequate regulations during the lesson in terms of using multiple representations may be due to the teachers' lack of knowledge about the structure and properties of teaching materials and their effects on student learning, or their ineffective use.

The most obvious control behaviors of the teachers were emphasizing rules, algorithms and possible errors, and taking responsibility for completing the task in challenging situations. However, such activities did not go beyond showing the correct solution by informing the students about possible mistakes that could be made. Therefore, such behaviors prevented students developing mathematical understandings through discussing incorrect or incomplete ideas. Another control behavior that is carried out in order to maintain the planned sequence of the lesson is to give a voice only to students who can express their opinions well. This practice also

prevented students from learning from mistakes. Similarly, the teachers' taking the responsibility of completing the task in challenging situations caused the students not to have opportunities to develop their mathematical thinking. Such practices may be related to teachers' low expectations for their students, their knowledge of how to learn mathematics, their beliefs and approaches. This finding shows that there is a need for practices (such as workshops, seminars, group activities, cooperative professional development programs) that will question the current approaches of novice teachers to teach mathematics.

Teachers mostly used explanation, repetition, or demonstration as their plan B when their students encountered problems or made mistakes. These results indicate that the teachers are incapable of pedagogical content knowledge for a problematic situation during their instruction. The fact that they avoided unexpected student questions about the ways of the rules or algorithms work, or give superficial answers to them, also supports this interpretation. Related studies also report that novice teachers have difficulty in producing appropriate answers or explanations for students' questions and comments for which they are not prepared, and that they do not change their lesson plans in line with student needs (Borko & Livingston, 1989; Livingston & Borko, 1989; Westerman, 1991).

Experiencing unexpected situations may assist teachers' professional development and allow them to develop better plans for their next teaching cycle of similar concepts (Smith et. al., 2008). Stockero and Van Zoest (2013) defined the pivotal teaching moment (PTM) as moments when teachers notice such situations and take action and change the sequence of instruction based on the students' views, unexpected comments and questions based on misconceptions or confusion. During the unexpected situations in the classroom environment, teachers may choose to ignore PTMs or build their lessons on these moments to extend the lesson they had previously planned (Stockero & Van Zoest, 2013). The results obtained in this study show that the teachers generally ignore these moments and do not prefer to make a change in the lesson based on their students' thinking. One reason for this situation may be that teachers' contingency, defined as necessary teacher knowledge that helps them to face unexpected moments when they have to deviate from their plans, is not sufficiently developed (Rowland et al., 2015).

According to the teachers who participated in the study, they were able to follow the lesson plan they developed. Only Ayla stated that she often could not implement the decisions she made before the lesson to increase the participation of her student. In other studies, it has been reported that novice teachers can get away from their goals during the lesson compared to senior teachers (Borko & Livingston, 1989; Livingston & Borko, 1989; Westerman, 1991).

The teachers generally went through previous material associated with the present subject at the beginning of their lessons. However, they often took an active role rather than giving students opportunity to think about their prior learning. In addition, they did not change their lesson according to this introduction process and continued the lesson as they planned by making explanations about the deficiencies in the students' prior knowledge. The following behaviors observed in senior teachers were not observed among the participants: associating with prior learning (Griffey & Housner, 1991), encouraging students to participate in classroom discussion (Arani, 2017), and allowing students to ask questions and make comments (Borko & Livingston, 1989; Livingston & Borko, 1989; Westerman, 1991). Reform studies in mathematics education call for teachers to shape the teaching process depending on the developments in the lesson, especially the students' thoughts, for effective mathematics teaching (Anthony et al., 2015; National Council of Teachers of Mathematics [NCTM], 2014). It is also stated that recognizing students' mathematical thinking is of critical importance for high-quality mathematics teaching (Jacobs et al., 2010; Walkoe et al., 2020). However, the findings of this study indicate that the teachers did not shape the teaching process based on the situations that developed in the lesson. This finding is consistent with the finding of Arani (2017) that novice teachers do not very often modify the lesson based on the students' thoughts. Complex teaching tasks such as supporting the student (simplifying the task, offering clues, etc.), managing effective classroom discussion, and

responding appropriately to a student question require skills that teachers can acquire over the years. In order for novice teachers to develop such complex skills, it can be ensured that they focus on sub-skills that include these complex skills, so that they experience and become competent in one sub-skill at a time (Grossman et. al., 2009; Kazemi et al., 2009). For instance, in order to gain an ability to conduct effective classroom discussions, the related sub-skills (identifying a debatable problem situation, creating productive questions, vocalizing student answers, etc.) can be focused on individually and practiced one at a time. Novice teachers need to be supported by experts (experienced teachers, academics, etc.) with these skills in order to gain such experiences.

5. Suggestions for Further Studies

In this study, teachers' self-regulation behaviors in teaching mathematics were examined based on Zimmerman's (2000, 2002) self-regulation model. It is found that the forethought and self-reflection processes in this model are successful in explaining the preparation for teaching and self-regulation after teaching (Bozkurt & Yetkin-Özdemir, 2018; Bozkurt et. al. 2022; Yetkin-Özdemir, 2015; Yıldız et. al., 2021). In other words, the processes such as goal setting, planning, evaluation, and self-reflection accounted for the regulating teaching as well as regulating learning. However, it is observed that it is insufficient to explain the regulation regarding the control and monitoring processes during the actual teaching. For this reason, the monitoring process in this study is defined as 1) student-oriented monitoring and 2) teaching-oriented monitoring. Similarly, the control behaviors are defined as the regulation of content and processes during the lesson. However, since the aim of the control behaviors of the novice teachers is mostly to continue the lesson as planned, the situations of making changes/regulations during the lesson were observed at a very limited level. For this reason, it is suggested to examine the monitoring and control behaviors of middle school mathematics teachers, who are especially qualified as senior. Comparative studies with novice and senior teachers are also necessary in order to be able to define teaching self-regulation activities in more detail and to see about which regulation activities novice teachers need support.

In this study, teachers' monitoring behaviors in the lessons were examined through interviews made after the lesson. The use of other methods (i.e., eye tracking) that will help determine the situations that teachers focus and follow during the lessons can support a better understanding of this process (Sherin et al., 2011). It is suggested to use such methods in future studies.

In this study, teachers who have not completed their first five years in the teaching profession were defined as novice teachers. However, the findings suggest that there were differences in terms of self-regulation even within this group. For example, it is observed that the goals of the teachers who did not complete their first two years in teaching are more compatible with the curriculum, and that they formed more specific criteria in terms of evaluating their teaching performance. It is also observed that the conditions at the schools where the teachers work also play an active role in self-regulation. However, the findings of this case study, which was conducted with a small number of participants, do not make it possible to produce generalizable conclusions regarding the effects of seniority and environmental factors on self-regulation. For this reason, there is a need for research with more participants to examine how self-regulation activities for teaching differ in terms of variables such as seniority, school environment, and teacher beliefs.

The concept of professional vision is defined on the basis of two processes: noticing and reasoning based on knowledge (Seidel & Stürmer 2014; van Es & Sherin, 2008). Noticing is the ability of teachers to direct their attention to related classroom situations (van Es & Sherin, 2008), and knowledge-based reasoning refers to the teachers' cognitive processing of perceived instructional events based on their knowledge of teaching and learning (Borko, 2004; Sherin, 2017; van Es & Sherin, 2008). While noticing can be associated with the monitoring behaviors which are described in this study, knowledge-based reasoning is related to the teachers' control behaviors depending on the monitoring process. In this context, examining the regulation skills of teachers

for the teaching process in their professional vision and teaching awareness studies may offer different perspectives in terms of understanding these concepts.

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