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Matematiksel Problem Çözme Etkinliklerinde Küçük Çocukların Üstbilişsel Düzenleme Becerilerinin İncelenmesi

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ÖZ

Bu çalışmanın amacı küçük çocukların problem çözme etkinliklerindeki üstbilişsel düzenleme becerilerini incelemektir. Küçük çocukların üstbilişsel düzenleme becerilerini ortaya koymak için, çocukları doğal ortamlarında gözlemleme imkânı sunan gözlemsel metodolojiden yararlanılmıştır. Çalışmaya 43-73 aylık arasındaki 27 (15 erkek ve 12 kız) çocuk katılmıştır. Bulgular, matematiksel problem çözme etkinlikleri sırasında çocukların bazı üstbilişsel düzenleme becerilerine (planlama, izleme, kontrol ve değerlendirme) sahip olduklarını göstermiştir. Bununla birlikte, amaç ve hedeflerin belirlenmesi, hataların tespit edilmesi ve ilerlemenin gözden geçirilmesi gibi üstbilişsel düzenleme göstergeleri daha sık gözlenmiştir. Çalışmanın sonuçları, küçük çocukların üstbilişsel düzenleme becerileri ile problem çözme becerileri arasında olumlu ve güçlü bir ilişkinin olduğunu göstermektedir. Küçük çocuklara problem çözme deneyimi yaşatan etkinliklerin onların üstbilişsel düzenlemelerini geliştirmeyi sağlayan yollardan biri olarak ele alınmasının önemi tartışılmıştır.

Anahtar kelimeler: Erken çocukluk eğitimi, özdüzenleme, üstbiliş, problem çözme

Investigation of Young Children's Metacognitive Regulatory Abilities in Mathematical Problem Solving Tasks

ABSTRACT

The aim of this study is to investigate metacognitive regulatory abilities of young children in mathematical problem solving tasks. To determine young children's metacognitive regulatory abilities, observational methodology, which provides opportunities to observe children in their natural environment, is conducted. Twenty seven children (15 boys and 12 girls) aged between 43 and 73 months participated in this study. The findings show that young children exhibit some metacognitive regulatory abilities (i. e. planning, monitoring, control and evaluation) during mathematical problem solving tasks. However, indicators of metacognitive regulation, such as setting goals and targets, detecting errors and reviewing on progress are observed more frequently during the tasks. Results of the

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Bu makale Fahretdin Hasan Adagideli'nin 2014 yılında Boğaziçi Üniversitesi Sosyal Bilimler Enstitüsü İlköğretim yüksek lisans programında tamamladığı "Investigation of Young Children's Metacognitive and Self-regulatory Abilities in Mathematics Activities, başlıklı yüksek lisans tezinin bir bölümünü içermektedir. Çalışmanın bulguları 2013 yılında Almanya'nın Kiel şehrinde düzenlenen 37. Conference of The International Group for the Psychology of Mathematics Education isimli konferansta sözlü bildiri olarak sunulmuştur.

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study show that there is a positive and strong association between problem solving skills and metacognitive regulatory abilities of young children. The idea of using tasks that engage young children in problem solving, is discussed as a means for promoting children's metacognitive regulation.
Keywords: Early childhood education, self-regulation, metacognition, problem solving

INTRODUCTION

Early childhood education has influential effects on children's social, behavioral, emotional and cognitive development (Oktay, 2007). Besides, it offers opportunities to decrease gaps among children from different backgrounds and to prepare them for primary education. Recent investigations (e.g. Denham, Warren-Khot, Bassett, Wyatt, & Perna, 2012) demonstrate that development of effective self-regulation during early childhood period is a prerequisite for school readiness and success. In this regard, developing overarching skills such as awareness about self, task, and strategy; planning, monitoring, control and evaluation (i.e. metacognition and self-regulation) are important in this period (Perels, Merget-Kullmann, Wende, Schmitz & Buchbinder, 2009).

Metacognition and Self-Regulation

In the literature, metacognition and self-regulation are derived from two different traditions. While the former depends on the early work of Flavell (1979) from a cognitive information processing tradition, the latter is established on the works of Vygotsky (1978) from a socio-cultural tradition. Both traditions assumed that these abilities were age-dependent and children did not show these abilities until the age of eight (Veenman, Van Hout-Wolters & Afflerbach, 2006; Winne, 1997; Zimmerman, 1990). Therefore, for many years, investigation of these abilities in young children did not get adequate attention (Whitebread & Coltman, 2010). For this reason, there was a lack of a framework of metacognition and self-regulation, which was also appropriate for young children. On the other hand, the framework developed by Whitebread, Anderson, Coltman, Pino Pasternak and Mehta (2004) offered a brief description for metacognition and self-regulation and defined their components for observing and evaluating young children even at the age of three. Moreover, it is the only framework providing indicators of self-regulatory abilities of young children in their natural environment. In this study, the definition of self-regulation was based on Whitebread et al. (2004) framework, which will be presented in detail in the following section.

Assessment of Metacognition and Self-Regulation

While presenting their framework, Whitebread et al. (2004) also suggested the use of a scheme for assessment of metacognition and self-regulation. The scheme constitutes mainly of three parts of self-regulation: metacognitive knowledge, metacognitive regulation, and emotional and motivational regulation. Metacognitive knowledge refers to one's general knowledge of self, others and universals including capabilities, strengths, weaknesses or preferences on cognitive tasks; or one's own long term memory knowledge to compare and

judge elements of tasks; or one's knowledge to explain and evaluate their strategies used in given cognitive tasks. Metacognitive regulation refers to procedural verbalization and behaviors including planning, monitoring, control and evaluation. It enables children to perform tasks in a structured way. Planning is defined as selection of procedure and materials related to task demands and goals. Setting or clarifying task demands and expectations, deciding on ways of proceeding with the task and setting goals and targets are examples of indicator of planning in the scheme. Monitoring means assessment of ongoing task procedures related to determined task demands and goals. Control signifies necessary intervention into the task procedure in relation to task demands and goals as a result of monitoring. While "detection of their errors", "self-commentating" and "reviewing on their progress" are kinds of monitoring; suggesting and using ways as results of their previous monitoring to solve the task more effectively and helping or guiding another child are descriptive of control. Evaluation is conceptualized as reviewing and evaluating the task performance in relation to task demands and goals. Children's "rating the quality of performance" and "observing or commenting on task progress" after dealing with tasks are considered as behaviors indicating evaluation. Emotional and motivational regulation refers to monitoring and controlling of motivational and emotional experiences about given tasks. While assessment of emotional and motivational experiences during and after task is related to monitoring, necessary intervention as a result of motivational and emotional assessment is related to control (Whitebread et al., 2009).

Since the current study focused on metacognitive abilities of young children, the last part of the scheme, emotional and motivational regulation, was excluded during the efforts to code children's metacognitive abilities. Subsequently, the part of the scheme on metacognitive knowledge was excluded since initial findings of the present study showed that while children displayed evidence of metacognitive knowledge occasionally, they exhibited evidence of metacognitive regulation continuously throughout the tasks. This situation was discussed in a study (Robson, 2010). She concluded that metacognitive regulatory abilities are observed more frequently than metacognitive knowledge during tasks. Since the present study addresses metacognitive and self-regulatory abilities during tasks, data analysis has been conducted by using the second part of scheme: metacognitive regulatory abilities.

Metacognition and Self-Regulation in Early Childhood Education

Early childhood education has been shaped by Piaget's theory of cognitive development all over the world (Hinde & Perry, 2007; Ural & Ramazan, 2007). Piaget introduced the notion of stage-wise development, which is central for early childhood education. Research studies adopting ideas of Piaget and using his tasks have supported his initial assumptions (Cavanaugh & Borkowski, 1980; Fritz, Howie & Kleitman, 2010). According to these studies, abstract reflection starts to emerge at the stage of formal operation; therefore, metacognitive regulatory abilities cannot be observed before early adolescence.

On the other hand, modern early childhood approaches bring new insights into theory and practice of early childhood education (Copple, 2003; Hewett, 2001). These approaches have advocated children's independent and interdependent learning where they are encouraged to have knowledge about and regulate their own cognition. They have considered children more autonomous and encouraged them to make choices, become decision makers, plan, initiate and reflect and take responsibility on tasks. In this regard, learning is considered as a more interactive, children centered and collaboratively occurring process (Bodrova & Leong, 2007; Edwards, Gandini & Forman, 1993).

Metacognitive Regulation in Early Childhood Education in a Context of Mathematical Problem Solving

Current early childhood curricula in various countries (e.g. Qualifications and Curriculum Authority, 2000; National Council of Teachers of Mathematics, 2000) have specified which mathematics skills should be taught and how teaching of these skills needs to be done in early childhood education. Similarly, Ministry of Education (MoE) (2012) in Turkey determined which mathematical skills should be developed during early childhood education. According to MoE (2012), problem solving is an integral part of all mathematics learning; mathematical knowledge is developed through problem solving. In this regard, all the tasks children engaged in during the study were planned as problem solving based mathematics tasks. Mathematical skills such as patterning, measurement and classification were addressed during these problem solving based tasks.

Problem solving is considered one of the most important skills that need to be promoted in early childhood period in various countries as well as Turkey. Besides, a number of studies (Lucangeli, Cornoldi & Tellarini, 1998; Teong, 2003) with older children have indicated that higher metacognitive ability provides better problem solving in mathematics while others (Carr & Jessup, 1995; Desoete, Roeyers & Buysse, 2001) have shown that good problem solvers exhibit more metacognitive abilities. These findings suggest that there is a link between metacognitive abilities and problem solving skills. However, these studies examined abilities of older children who were enrolled in primary schools. Whitebread and Coltman (2010), on the other hand, investigated pedagogies that support metacognitive and self-regulatory abilities in mathematical learning of younger children. Yet, their work did not focus on the link between metacognitive regulatory abilities and problem solving skills. In the relevant literature, there is a lack of research on metacognitive regulatory abilities of young children during problem solving tasks. The current study aims to reveal metacognitive regulatory abilities of young children through qualitative methodology during mathematical problem solving tasks. In this regard, the research question of the present study is:

- which metacognitive regulatory abilities young children exhibit during problem solving tasks?

METHOD

Design of the Study

This work was designed as a qualitative study. The data were obtained through observational methodology. Whitebread et al. (2009) argue that observational methods have several advantages: (1) it does not rely upon children's verbal capability and working memory capacity, (2) it allows to gather information about what children do rather than what they believe or recall they do, (3) it allows to observe children in meaningful contexts to them, (4) it can provide verbal as well as non-verbal indicators while examining self-regulated skills, (5) it allows to determine social interactions supporting development of self-regulated skills in young children. Using the observational methods is a particularly good fit for a qualitative study with young children since it allows capturing data in children's natural settings by focusing on what children do.

Participants and Their Settings

Two classes in the same preschool of a public university in Istanbul were chosen for the study. Each class had a teacher and an assistant teacher. Twenty seven (15 boys, 12 girls) out of 34 students in these two classes participated in this study. Seven children could not participate in any tasks due to their absence on the days data were collected. Ages of the children varied between 43 and 73 months (Mean: 60 months, Standard deviation: 8.2). Children came from various family backgrounds. Thirty percent of children's parents worked as faculty members or staff at the university where the preschool was located. Teachers asserted that children were generally from middle and upper income families.

The school was chosen in terms of its cooperation for video recording and its sufficient age range; therefore, the study was conducted in the most convenient school for the researchers. Rapport established between the first researcher and participants can be considered as evidence of validity of the study. However, no claims are made about such a small sample being in any way representative of the students of this age group.

Ethics Concern of the Study

Before conducting the present study, institutional approval was obtained from Boğaziçi University Ethics Committee. Subsequently, consent forms were sent to parents. Twenty seven children whose parental consents were obtained, participated in the study. In order to ensure children's privacy, video episodes recorded during the data collection were watched only by the authors of this study. Children's names were replaced with pseudonyms.

Design of Tasks

This study focused on young children's metacognitive regulatory abilities during three problem solving tasks involving mathematics concepts. These tasks were used in order to examine whether metacognitive regulatory abilities of young

children were revealed in mathematical problem solving. At the beginning of the tasks, children were informed about the problem that they were expected to work on. During the tasks, children tried to solve the problem through a collaborative work. They confronted aspects of problem solving suggested in the literature: devising their plans, carrying out their plans, and reflecting upon works (Polya, 1957). Patterning, measurement and classification were mathematical skills that children were expected to use during the three tasks. These skills were determined since they are important for early mathematical development of young children (MoE, 2012; NCTM, 2000).

Patterning Task: This task was adapted from Bryce and Whitebread (2012). Children were presented with several train track pieces and a pattern printed on a sheet of paper. Children were asked to work in groups of three to construct the given pattern on the sheet using the train track pieces on the table. Therefore, children not only match a given pattern but they also identified the pattern and followed on with this pattern.

Measurement Task: This task was adapted from Whitebread and Coltman (2010). In the task, children were expected to identify attributes of measurement concepts, namely length. Children were involved in constructing a house for a giraffe by using blocks. Since they were not provided standard measurement tools such as a ruler, they decided on the length of the house by using non-standardized measures. Children worked in groups of three on preparing the house for a giraffe with the given pieces.

Classification Task: This task was adapted from Larkin (2006). Children were involved in a classification task of vehicles and animals. All toys were given at the same time to children and they were asked to divide them into two, three and four categories respectively after a brief discussion on nature of animals and vehicles. At the beginning of the task, the researcher showed animals and vehicles to children one by one and discussion on names and features of animals followed. Children made the decisions about when the tasks were completed.

Data Collection

After the tasks were designed, children were randomly assigned and allowed to collaborate in groups of three during the tasks. Nine groups of three children were involved in the patterning task (27 children), and five groups of three children took part in the measurement task (15 children) and the classification task (15 children). Some of the children could not participate in measurement and classification tasks since they were not present on the days scheduled for data collection. Tasks lasted between 10 minutes and 30. Total duration for all the groups working on patterning, measurement and classification tasks were 161 (mean: 17.9), 74 (mean: 14.6) and 80 (mean: 16) minutes respectively. Data were collected over an eight-week period during the spring semester.

Data Analysis

After a total of 315 minutes of video episodes were transcribed, children's metacognitive regulatory abilities were coded according to the coding scheme developed by Whitebread et al. (2009). Code descriptions and indicators of the codes are presented in Table 1. In order to exercise triangulation as a means to ensure validity, multiple data were obtained through video-recording of children, watching the videos with children and watching the videos with the teachers. Since teachers know the children better and have insights about their behavior, they can help researchers to interpret children's behaviors (Yıldırım & Şimşek, 2005). Ten percent of video episodes were watched by two raters and coded according to the framework. Findings showed that there was a high correlation between the coding of the two raters (r= 0.84). Then, discussion on the nature of the components of metacognition they embodied was conducted. Consensus was reached on the items that were coded differently.

Table 1

Code Descriptions and Indicators of the Codes

Metacognitive Regulation Abilities	Descriptions	Indicators
Planning	Refers to the selection of procedure and materials related to task demands and goals	• Setting or clarifying task demands and expectations • Deciding on ways of proceeding with the task
Monitoring	Refers to the assessment of ongoing task procedures related to determined task demands and goals	• Error detection • Reviewing on ongoing progress
Control	Refers to necessary interventions into the task procedure in relation to task demands and goals as a result of monitoring	• Suggesting and using ways as results of their previous monitoring • Helping or guiding another child
Evaluation	Refers to reviewing and evaluating the task performance in relation to task demands and goals	• Assessing the quality of task performance after dealing with tasks • Observing or commenting on task after dealing with tasks

RESULTS

Findings showed that problem solving based mathematical tasks created a medium for young children to exhibit metacognitive regulatory abilities. Descriptive data about manifestations of these abilities during tasks used in the study are shown in Table 2. Averege occurrences of incidents showing children's metacognitive regulatory abilities are standardized for 10 minutes. For example, in the pattern construction task planning incidents occurred 2.55 times in average per group during every 10 minutes spent on the task while these averages per group per 10 minutes were 3.00 and 4.22 in measurement and classification tasks, respectively. In what follows, these abilities of children are presented in detail through the lens of the scheme developed by Whitebread et al. (2009). Results are reported according to metacognitive regulatory abilities. Therefore, examples in contexts of several mathematical skills are presented together for each metacognitive regulatory ability.

Table 2
Average Occurrence of Young Children's Metacognitive Regulation per 10 Minutes per Group for Each Task

	Planning	Monitoring	Control	Evaluation
Pattern	2.55	15.85	9.59	3.06
Measurement	3.00	5.57	5.00	2.71
Classification	4.22	5.11	3.88	0.44

All groups of children exhibited evidence of planning throughout each task because problems presented to them were not straightforward in any of the problem solving tasks. When these plans of children were examined according to the scheme of Whitebread et al. (2009), their metacognitive regulatory abilities were revealed. A typical example of such ways of operation occurred when children said "we'll make a circle" or "we'll make octopus" as soon as they saw the picture of patterns in the patterning tasks. Whitebread et al. (2009) mentioned this type of planning as child "sets or clarifies task demands and expectations." Groups of children "setting goals and targets" presented another way of planning mentioned in the scheme of Whitebread et al. (2009). One example came from a group working on measurement task, when a child expressed his plan with the following words: "the wall should be longer than the giraffe." Deciding on ways of proceeding with the task, another description of behavior for planning (Whitebread et al., 2009) prevailed throughout the tasks. "Firstly, let's allocate animals to this side and vehicles to other side; therefore…" or "we could classify animals as wild or not" were examples of children explaining their opinions about how to proceed. These verbalizations of children during the tasks indicated that they articulated their ways of solution to their friends. Therefore, making

children engage in problem solving tasks could create an environment supporting them to devise plans. Coming up with a plan and articulating the ways of solution, can further support children's thinking through the task and provide them with criteria to compare their progress against.

Findings of the study also showed that these plans established grounds for children to monitor and control their progress while carrying out their plans. For example, while a group was working on measurement task, after the aim of the task was given to children, one of them said: "We should measure the length of the giraffe." She said this at the beginning of the task while they were at a preparation stage of construction. During the task, this group of children continuously monitored whether length of their wall was appropriate for the giraffe. While proceeding with problem solving, children who came up with these plans exhibited monitoring and control abilities of metacognition as well. Therefore, problem solving tasks provided opportunities not only for planning but also monitoring and control. In the following dialogue, Ayşe, Isa and Musa were working on the measurement task:

Ayşe: We need to measure the length of the giraffe *(1)*	*(1) sets or clarifies task demands and expectations*
Isa: I measured (2)	*(2) self- commentates*
Ayşe: No, I think this length is ok *(3)*	*(3)- checks behaviors or performance, including detection of errors*
Musa: I did it very long *(4)*	*(4) self-commentates*
Ayşe: I think this length is enough *(5) (pointing her length of wall)*	*(5)-(6) rates effort on-task or rates actual performance*
Musa: Look, mine is longer than the giraffe *(6)*	*(7) suggests and uses strategies in order to solve the task more effectively*
Ayşe: Let's measure the length of the wall *(7)*	*(8) reviewing progress on task*
Musa compares lengths of his walls and the giraffe *(8)* and shortens his wall by subtracting pieces from his wall *(9)*	*(9) changing strategies as a result of previous monitoring*
(Measurement task)	

While carrying out their tasks, children exhibited evidence of monitoring as described by Whitebread et al. (2009). They categorized children's reviews co-occurring during their performance as monitoring. During problem solving tasks, frequently observed indicators of monitoring were self-commentating, detection of own errors, and reviewing on own progress. Therefore, it could be claimed that involving children in problem solving tasks fosters children's monitoring ability, through self-commentating, detection of their errors, and reviewing on their progress.

Self-commentating was one of the most frequently observed indicators of monitoring during tasks. In a group, while children worked on house constructing for giraffe, two children had already started building their house together. At that moment, the third child brought blocks box, got out some more blocks and said: "I have struck upon an idea." Then, he started to build the back of the house. At the end of the task, they combined their construction and ended up with a very comfortable house for the giraffe. It can be claimed that he monitored what his friends did and as result of his monitoring; he self-commentated that he had an idea.

The findings also showed that children detected errors since their reviews on their performance occurred continuously during the tasks. While the children worked on the classification task, they tried different ways of classification to reach a right conclusion. Therefore, there were wrong attempts, which were eliminated. In a session of the classification task, they had again such a situation and they started to find out another way. However, one of the children again suggested a previously discarded way of classification. At that moment, one of his friends warned him: "We already tried it". Obviously, the child monitored their progress, she also suggested that they should try another strategy as a result of previous monitoring (Whitebread et al., 2009). Children like the one in these examples not only monitored their progress but also controlled their strategy according to their previous monitoring.

Some of the children made mistakes, instantly noticed their mistakes and fixed them while carrying out their plans. This was another important part of problem solving (Polya, 1957). While constructing a house for giraffe, a girl stopped her friend who tried to extend the length of the house and said: "No, I think this length is enough." Another example from the classification task was that while children were categorizing animals in terms of where they live, a boy mentioned that there was a mistake because a particular animal was miscategorized and it actually lived in water. Whitebread et al. (2009) describe this type of monitoring as "checks and/or corrects performance of peer" which was one of the commonly observed metacognitive regulatory abilities throughout the tasks. In some cases, children did not notice their mistakes instantly and they had to review what they had done after a while. Therefore, it was clear that children's monitoring and control of their solution steps continued constantly during carrying out their plans. Towards the end of a group's work on patterning task, one of the children who lead the construction realized that they were mistaken: "Erm, we did it wrong, it should look like women's waist" and he supported his verbalization by showing with his hands. Problem solving tasks in this study created rich opportunities for children to reflect upon their work, not only after they completed the tasks but also during the tasks through reviews of their progress.

According to Whitebread, et al. (2009) control as a metacognitive regulatory ability means suggestions and/or changes of strategy in an ongoing task as a result of cognitive monitoring. Findings showed that throughout all three tasks,

children suggested and used ways as results of their previous monitoring. Control as metacognitive regulation occurred in two ways. First of all, children changed their own way of proceeding according to their review of own progress. In one of the examples, while children were constructing the pattern in the patterning task, one of them, who monitored the ongoing progress, said: "There will be a cambered (rail)." The interesting point of that extract was that he said his sentences after looking at the pattern given in the paper. He obviously kept track of the ongoing process and changed strategies as a result of the previous monitoring. According to the findings, children also guided their friends with their strategy suggestions. For example, while constructing the rail track, one child suggested a strategy to construct the given pattern: "Look Harun! We should first start on this side and then we should do its head." Everyone might have a strategy while solving problem. But this particular child also tried to show and therefore helped his friend about how to solve this type of problem by using gestures, which are evidence for metacognitive regulation. As children come up with plans for problem solving tasks and monitor their progress while carrying out the plans; they not only control their own way of progress but also their friends'. Therefore, problem solving tasks could also be considered as a way of promoting control abilities of children, in more than a single way.

When children's reviews take place after their performances, these are described as evaluation (Whitebread et al., 2009). Results showed that this metacognitive regulation was obtained in a manner where children commented on their work and mentioned their flaws on it. According to results, at the ends of tasks, children applied the last part of problem solving through looking back and reflecting upon their work. Children's evaluation was more evident when they continuously monitored and controlled their progress during the tasks. These children monitoring and controlling their tasks, verbalized phrases such as: "it is done" at the end of the tasks. Therefore, it can be claimed that monitoring and control of progress while carrying out tasks also enable children to evaluate their work once it was completed. The following episode is an example of "it is done" moments after monitoring and controlling the progress. Ali, Yusuf and Hasan were working on the patterning task and they had the following dialogue:

Ali: I was doing the head (1), Yusuf did it wrong. (2)	*(1) reviewing progress on task*
(Yusuf is fixing a right curved piece to the wrong direction)	*(2) checking behaviors or performance, including detection of errors*
Ali: *(changing the direction of the piec*e)	*(3) changing strategies as a result of previous monitoring*
Yusuf, Yusuf like that. (3)	*(4) using nonverbal gesture as a strategy to support own cognitive activity*
Hasan: (*by showing the given pattern to Yusuf)* Just like that, like that. (4)	*(5) seeking help*
Ali: (to Hasan) is it done, what do you think? (5)	*(6) reviewing progress on task*
Hasan: No, no. (6)	*(7) – (10) rating the quality of performance*
Yusuf: It is done. (7)	
Ali: No, it isn't done. (8)	
Hasan: Just leave it like that, it is enough. (9)	
Ali: Enough, enough. (10)	
(Patterning task)	

Children also mentioned deficiencies of their works, suggesting that they were aware of them even if children did not correct their mistakes or even if there is a child claiming that "it is done." They reviewed their tasks and at least suggested ways of enhancing their activities. For example, one of them said by pointing where they made a mistake: "I think we had a problem at this side" while a group of children completed and started to check out whether their construction of the rail tracks was correct. In another example, after a group of the children completed their house for the giraffe, one of them said "we could construct a better door for him". Although they did not fix the door of the giraffe afterwards, she was aware of and mentioned their construction's shortcomings.

The findings indicated that children reviewed their activities and suggested ways of enhancing their activities. While a group of children almost finished the house for giraffe, one of them realized that they constructed one wall smaller than the other: "we should have made this wall taller too." Another example from the patterning task was that one of the children expressed the deficiencies of the product by saying "this side should be taller like in the picture but let it be…" although children considered it was done as a group decision. Since children had the intention to evaluate their progress, they continued to look at the given shape and reflect upon their work. Children's awareness of mistakes and incompletions on patterns indicated their good performance on comparisons of patterns as well as their high metacognitive regulatory abilities. As seen in the examples, evaluation after problem solving tasks had different outcomes. If children monitor and control their progress effectively during tasks, they generally conclude that their works are done. On some occasions, they mention deficiencies of their work, which indicates that they are aware of their work's shortcomings. In some of the occasions where deficiencies are elaborated on, they also suggest ways of improving their works. Whatever outcome they have, evaluation of current tasks provide students with information about how their performance is and have the potential to inform how they deal with similar tasks in the future.

DISCUSSION

Results of this study indicated that children exhibited metacognitive regulatory abilities in problem solving based mathematics tasks they dealt with. Although early studies (Desoete, Roeyers & Buysse, 2001; Lucangeli, Cornoldi & Tellarini, 1998) on older children have indicated the association between problem solving skills and self-regulatory abilities; the current study has revealed that young children display these abilities during problem solving tasks. Based on these findings, teachers working with preschool-age children should take into account the possible contribution of supporting metacognitive regulatory abilities through problem solving tasks.

In the scheme of Whitebread et al. (2009), a detailed description of metacognitive regulatory abilities was presented. Findings of the present study

showed that some indicators of these abilities mentioned in the scheme were observed more frequently during tasks. Setting or clarifying task demands and expectations, deciding on ways of proceeding with the task and setting goals and targets were most frequent types of planning abilities children exhibited. While "detection of their errors, "self-commentating" and "reviewing on their progress" were kinds of monitoring that were observed more frequently during tasks; children generally suggested and used ways as results of their previous monitoring, so-called control, as one of the metacognitive regulatory abilities in the scheme (Whitebread et al., 2009). As a result of evaluation of their tasks, children verbalized phrases such as: "it is done" at the end of the tasks. They did this when they continuously monitored and controlled their progress during the tasks. Yet, there were some children who were aware of mistakes and incompletions on their tasks and reflected on their works and performances.

As targeted by this study, work with children and through analysis of the collected data revealed indicators of metacognitive regulatory abilities of young children during mathematical problem solving tasks. Manifestations of these abilities also pointed to potential interactions among various abilities, particularly planning-monitoring and monitoring/control-evaluation. Such interconnections among metacognitive regulatory abilities require further exploration for better understanding the complexities of children's metacognition. Moreover, the findings of this study showed that observational approach is an effective method to obtain metacognitive and self-regulatory abilities of young children (Perry, 1998; Whitebread, et al., 2009). Observations of teachers on metacognitive regulatory abilities of young children in their settings can be the first step in understanding and supporting these abilities of young children.

Findings of this study have important implications for preschool teachers and those involved in development of preschool tasks. Teachers' use of problem solving tasks, especially those giving students the time and opportunities for engagement could enable teachers to address development of students' metacognitive regulatory abilities. More frequent use of such tasks can support students' exercising of multiple abilities (e.g. planning, monitoring, control, and evaluation) in a context of mathematics tasks. Creating such opportunities addressing various abilities is a key target for many preschool teachers.

Although there are limitations of observational methods, in the present study, a variety of techniques such as inter-rater consistency within researchers' coding, triangulation between coding of the researcher were conducted to assure validity and reliability of the study as suggested in the literature (Veenman, 2005). Hence, findings of the present study can be considered as contributing to a preliminary knowledge base for preschool and mathematics educators.

Despite the evidence of relation between problem solving skills and metacognitive regulatory abilities of young children, this study had some

limitations. This study points out that problem solving tasks create a medium for young children to exhibit their metacognitive regulatory abilities. However, no claims can be made about effects of problem solving tasks on metacognitive regulatory abilities of young children. Further research is needed for examining casual relations between these variables.

The current study was conducted with children from middle and upper income families. Therefore, results of the study might not reflect the case for children from lower income families. Further studies should also include children from lower income families. Moreover, the present study did not aim to determine effects of age on metacognitive regulatory abilities. Studies investigating possible difference between age groups can be considered as a future step.

The tasks in this study involve three mathematical skills emphasized in the current preschool curriculum in Turkey (MoE, 2012). However, they are limited to patterning, measurement and classification. Similarly, metacognition and self-regulation abilities encompass various dimensions as represented in the scheme of Whitebread, et al. (2009). Yet the focus of the study was on metacognitive regulation, i.e. planning, monitoring, control and evaluation. In future studies, scope can be widened to investigate metacognitive knowledge and motivational and emotional regulation as well as metacognitive regulation of young children. Research investigating metacognitive regulatory abilities of young children has been conducted in various studies. In addition to the replication studies investigating these abilities of young children, intervention programs for teachers as well as children can be considered as a future step.

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ÖZET

Giriş

Okul öncesi eğitimi, çocukların sosyal, duygusal, davranışsal ve bilişsel gelişimlerini etkileyen en önemli dönemlerden biridir. Bu eğitim farklı kesimlerden gelen çocukların aralarındaki farkı kapattığı gibi onların ilkokula hazır hale gelebilmeleri için fırsat sunmaktadır. Bu dönemde çocukların farklı alanlardaki becerilerini geliştirmek okul öncesi eğitiminin önemli bir parçasıdır. Bununla birlikte, çocukların plan yapma, izleme ve kontrol etme ve değerlendirme gibi üstbiliş ve özdüzenleme becerilerinin geliştirilmesi de gerekmektedir.

Üstbiliş ve özdüzenlemenin iki farklı teoriden geldikleri görülmektedir. Üstbiliş, bilgiyi işleme teorisine, özdüzenleme ise sosyal-kültürel ve sosyal-bilişsel teoriye dayanmaktadır. Bu iki kavram yıllar içinde öyle iç içe geçmiştir ki köklerinin birbirinden ayrılması neredeyse imkânsız hale gelmiştir. Günümüzde okul öncesi çocuklarının özdüzenleme becerilerini ortaya koyan en önemli teorik çerçevede de özdüzenleme becerilerinden bahsedilirken bilişsel boyutun altının çizilmesi bu durumun göstergelerindendir. Bu teorik çerçeveye göre okul öncesi çocuklarında özdüzenleme becerilerinin üç boyutu bulunmaktadır. Bunlar, üstbilişsel bilgi, üstbilişsel düzenleme ve duygu/motivasyon düzenlemedir. Bu çalışmada çocukların üstbilişsel düzenleme becerileri incelenmiştir.

Problem çözme erken çocukluk döneminde geliştirilmesi gereken önemli becerilerden biridir. Problem çözme etkinlikleri matematiksel becerilerin geliştirilmesine zemin hazırlamaktadır. Öte yandan, problem çözmede iyi olan ilkokul öğrencilerinin üstbiliş ve özdüzenleme becerilerinin daha iyi olduğu ve üstbiliş ve özdüzenleme becerilerini gelişmiş olan çocukların problem çözmede daha başarılı olduğu farklı çalışmalarda ortaya konulmuştur. Bu çalışma, benzer bir ilişkinin okul öncesi çocuklarında da olup olmadığını tespit etmek için tasarlanmıştır. Çalışmanın amacı okul öncesi çocuklarının problem çözme etkinliklerindeki üstbilişsel düzenleme becerilerini incelemektir. Bu bağlamda, okul öncesi çağındaki çocuklar problem çözme etkinlikleri üzerinde çalışırken hangi üstbilişsel düzenleme becerilerini kullanmaktadır sorusunun cevabı aranmıştır.

Yöntem

Bu çalışmaya bir okul öncesi kurumuna devam eden 27 çocuk (15 erkek, 12 kız) katılmıştır. Çalışmanın yürütüldüğü okul öncesi kurumu, video çekiminde sergilediği işbirliği ve kurumdaki çocukların çalışma için uygun olması nedeniyle seçilmiştir. Çocuklar 43 ile 73 ay aralığındadır (AO: 60, SS: 8,2). Öğretmenler çocukların genellikle orta ve üst düzeyde gelire sahip ailelerden geldiklerini belirtmişlerdir. Ayrıca öğrenci velilerinin %30'u anaokulunun bağlı olduğu üniversitede çalışmaktadır.

Araştırmaya başlanmadan önce Boğaziçi Üniversitesi Etik Komitesi'nden gerekli onaylar alınmıştır. Ayrıca, velilere onay formu gönderilmiş ve onay formunu

dolduran velilerin çocukları çalışmaya dâhil edilmiştir. Video kayıtları sadece araştırmacılar tarafından izlenmiştir.
Çalışmada kullanılmak üzere uyarlanan 3 matematik etkinliği örüntü oluşturma, ölçme ve sınıflama becerilerini ortaya çıkarmaya yönelik problem çözme etkinlikleridir. 27 çocuk üçerli gruplar halinde etkinliklerde yer almışlardır. Örüntü oluşturma etkinliğine 27 çocuğun hepsi katılırken, ölçme ve sınıflama etkinliklerinde 15er çocuk yer almıştır. Etkinlikler en az 10 dakika sürerken çocuklar etkinlikleri en fazla 30 dakikada tamamlamışlardır. Toplamda tüm grupların örüntü oluşturma etkinliği 161 (AO:17,9), ölçme etkinliği 74 (AO: 14,6) ve sınıflama etkinliği 80 (AO: 16) dakika sürmüştür.
Toplam 315 dakikalık video kaydının deşifre edilmesinden sonra çocukların üstbilişsel düzenleme becerileri kodlanmış ve analiz edilmiştir. Kodlayıcılar arası güvenirlik çalışması yapılarak çalışmanın geçerlik ve güvenirliği sağlanmıştır.

Bulgular
Araştırmada elde edilen bulgular, problem çözmeye dayalı matematik etkinliklerinin küçük çocukların üstbilişsel düzenleme becerilerini ortaya çıkarmak için uygun bir ortam oluşturduğunu göstermiştir. Araştırma, önceki çalışmalarda ilkokul öğrencilerinde tespit edilen ilişkiye benzer şekilde, okul öncesi çağındaki çocukların üstbilişsel düzenleme becerileri ile problem çözme becerileri arasında bir olumlu ve güçlü bir ilişkinin olduğunu göstermiştir. Ancak bu araştırma, nedensel ilişki bulmak için tasarlanmadığından, matematik becerilerinin mi üstbilişsel düzenleme becerilerini etkilediği yoksa bunun tersi yönde bir etkinin mi var olduğu konusunda bir yargıya varmak mümkün değildir.

Bulgulara göre, etkinlikler sırasında bazı üstbilişsel düzenleme becerilerinin daha sık görüldüğü ortaya çıkmıştır. Etkinlik beklentilerinin belirlenmesi, etkinlikte takip edilecek yollara karar verilmesi, amaç ve hedeflerin belirlenmesi planlama becerisine dair en fazla tespit edilen göstergelerdir. Hataların tespit edilmesi ve ilerlemenin gözden geçirilmesi en fazla ortaya çıkan izleme becerisi göstergeleriyken, yapılan izleme sonucunda çözüm yolları önerilmesi ve bunların kullanımı üstbilişsel düzenlemenin kontrol alt boyutuna dair en sık rastlanan davranış olarak göze çarpmaktadır. Değerlendirme yaparken, çocukların en çok etkinliklerindeki eksiklerden ve yanlışlardan bahsettikleri ve performanslarını nasıl geliştirebileceklerine dair yorumlar yaptıkları gözlenmiştir.

Sonuçlar ve Tartışma
Araştırmada elde edilen bulgular, çeşitli üstbilişsel düzenleme becerileri arasında muhtemel bir ilişkinin varlığını işaret etmektedir. Etkinliklerine planlama yaparak başlayan çocukların bu planlarının etkinlik sırasında izleme yapmalarına zemin hazırladığı görülmüştür. Ayrıca, çocukların etkinlik esnasında sürekli etkinliği ve performanslarını izliyor ve kontrol ediyor olmaları değerlendirme yapmalarını kolaylaştırmıştır. Bu ilişkilerin gelecekteki çalışmalarda ele alınıp incelenmesi küçük çocukların üstbilişsel düzenleme becerilerinin karmaşık yapısını anlamak için faydalı olacaktır.

Gözlemsel yöntemin sınırlılıkları olmasına rağmen kodlayıcılar arası tutarlılık ve üçleme gibi çeşitli teknikler kullanılarak çalışmanın geçerlik ve güvenirliği sağlanmıştır. Bu doğrultuda, çalışmanın okul öncesi ve matematik eğitimcilerine katkı sağlayacağı düşünülmektedir. Ayrıca, bu çalışma çocukların üstbilişsel düzenleme becerileri ve matematiksel problem çözme becerileri arasındaki ilişkiyi ortaya koymasına rağmen, problem çözme etkinliklerinin üstbilişsel düzenleme becerilerine etkisinin olduğu iddia edilemeyecektir. Bu iki değişken arasındaki neden-sonuç ilişkisini inceleyecek çalışmalara ihtiyaç bulunmaktadır. Bununla birlikte, bu çalışmada çocukların etkinlikler sırasındaki üstbilişsel düzenleme becerileri incelenmiştir. İlerideki çalışmaların kapsamı üstbilişsel bilgi ve motivasyon ve duygu düzenlemesini içerecek şekilde genişletilmelidir.

Küçük bir katılımcı grubuyla yapılan bu çalışmanın bulgularından bir genelleme yapılması uygun olmayacaktır. Küçük çocukların üstbilişsel düzenleme becerileri hakkında daha geniş bilgi edinebilmek için çalışmanın farklı katılımcılarla tekrar edilmesi gerekmektedir. Bunun yanı sıra, bu alanda ileride çocuklara ve öğretmenlere yönelik üstbilişsel düzenleme becerileri bağlamında müdahale çalışmalarının yapılmasının gerektiği de ortaya çıkmaktadır.