INVESTIGATION OF YOUNG CHILDREN'S METACOGNITIVE AND SELF-REGULATORY ABILITIES IN MATHEMATICS ACTIVITIES

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To Emine Erktin, for her faith in me

and for her inspirations and supports

To Engin Ader, my idol ever,

for everything he taught me

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Thesis Abstract

Fahretdin Hasan Adagideli, “Investigation of Young Children’s Metacognitive and Self-Regulatory Abilities in Mathematics Activities”

The aim of this study is to investigate metacognitive and self-regulatory abilities of young children at the age of 4 and 5 in mathematics activities. Meanwhile, another aim is to understand interactions of these abilities of young children with their mathematical skills and pedagogical context that support these abilities of young children. The observational method to display metacognitive and self-regulatory abilities of young children provides opportunities to observe children in a naturalistic manner. Moreover, it helps to collect evidence of these skills during children’s mathematics activities which are meaningful for children. 16 children from 4 year old group and 17 children from 5 year old group participate in this study. The findings show that young children exhibit metacognitive knowledge of persons (i. e. self, other), tasks and strategies; and metacognitive regulation (i. e. planning, monitoring, control and evaluation). Besides, the interaction between metacognitive and self-regulatory abilities of young children and their mathematical skills is identified. Moreover, the pedagogical context where children are supported emotionally, they are challenged in cognitive activities, they are provided with opportunities of feeling of control and of articulating their thinking is pointed out as the important factors to support these abilities of young children.

Tez Özeti

Fahretdin Hasan Adagideli, “Küçük Çocukların Matematik Etkinliklerindeki Üstbiliş ve Özdüzenleme Becerilerinin İncelenmesi”

Bu çalışmanın amacı 4 ve 5 yaşındaki çocukların matematik etkinliklerindeki üstbiliş ve özdüzenleme becerilerinin incelenmesidir. Bununla birlikte, çocukların bu becerileri ile matematik becerileri ve bu becerileri destekleyen eğitsel ortamlar arasındaki ilişkinin anlamlandırılması amaçlanmaktadır. Çocukları doğal ortamlarında izleme imkânı sağlayarak veriler sunan gözlem metodu, onların bu becerilerini ortaya çıkarmayı sağlamaktadır. Bu çalışmaya 4 yaş grubundan 16, 5 yaş grubundan 17 olmak üzere toplam 33 okul öncesi dönem çocuğu katılmıştır. Bulgular, çocukların kişisel (kendilerini ve başkalarını), görevsel ve stratejik üstbilişsel bilgi ve üstbilişsel düzenleme (planlama, izleme, kontrol ve değerlendirme) becerilerini ortaya koymuştur. Ayrıca, bu çalışmayla çocukların bu becerileri ile matematiksel problem çözme, ölçme, sınıflandırma ve örüntü oluşturma becerileri arasındaki ilişki ortaya konmuştur. Bununla birlikte, çocukları duygusal olarak destekleyen, onlara en uygun zorluk derecesinde görevler veren, onlara sahiplenme ve düşüncelerini dile getirme imkânı sağlayan eğitsel ortamlar çocukların bu becerilerini destekleyen önemli faktörler olarak belirlenmiştir.

CONTENTS

CHAPTER 1: INTRODUCTION 1
CHAPTER 2: LITERATURE REVIEW 3
Metacognition 3
Early Childhood Education 14
CHAPTER 2: STATEMENT OF THE PROBLEM 23
CHAPTER 3: METHOD 25
Design and Aim 25
Instruments 25
Participants and Their Settings 27
Design of Activities 28
Application of Activities and Role of the Researcher 28
Data Collection 30
Data Analysis 31
CHAPTER 4: RESULTS 33
Reliability and Validity of the Study 33
Observations of Metacognitive Knowledge and Regulation 36
Mathematics and Metacognition 42
Context that Foster Metacognition and Self-Regulation of Young Children 49
CHAPTER 6: DISCUSSION 54
Educational Implications 59
Limitations of the Study 60
Suggestions for Further Research 61
APPENDICES 63
Appendix A: C.Ind.Le. Coding Scheme: Verbal and Non-verbal Indicators of Metacognition and Self-regulation in 3-5-Year-Olds 63
Appendix B: Checklist of Independent Learning Development (CHILD) 3-5 65
Appendix C: Monthly program of the institution 66
Appendix D: Coding Sample from Episodes 68
Appendix E: Average occurrence of children's metacognitive and self-regulatory abilities in 10 minutes 71
REFERENCES 72

TABLES

1: Correlation coefficients between scores from main and co-teachers of children . 33

2: Correlation coefficients between total score provided and frequency of occurrence of abilities in activities 34

3: Results of Wilcoxon Signed-Ranked Test 35

4: Average occurrence of young children's metacognitive knowledge in each activity 36

5: Average occurrence of young children's metacognitive regulation in each activity 39

FIGURES

1: Theoretical framework of Nelson and Narens (1990) 6

2: Metacognition and self-regulation framework of Whitebread, Anderson, Coltman, Pino Pasternak, Mehta (2004) 7

CHAPTER 1

INTRODUCTION

Early childhood education is one of the influential elements which have effects on children's social, behavioral, emotional and cognitive development (Oktay, 2007). It offers opportunities to decrease gaps among children from different background and to make them ready for primary education. Although teaching skills to promote development of basic subject areas such as mathematics, science could be seen as most important part of early childhood education; developing overarching skills such as awareness about self, task, and strategy; planning, monitoring, control and evaluation -i.e. metacognition and self-regulation- are also important (Perels, Merget-Kullmann, Wende, Schmitz, Buchbinder, 2009).

Metacognition was originally defined as cognition about and regulation of cognition (Flavell, 1979). In early studies, metacognitive and self-regulatory abilities of young children were underestimated since the initial works of Flavell (Flavell, 1979; Flavell, Beech, Chinsky, 1966). It was assumed that these abilities were age-dependent and children did not show these abilities until the age of 8 (Veenman, Van Hout-Wolters, Afflerbach, 2006; Winne, 1997; Zimmerman, 1990). Therefore, for many years, investigation of these abilities on young children did not get adequate attention (Whitebread & Coltman, 2010). Even when studies had been conducted on this topic, early research had aimed to investigate what children cannot do (Kreutzer, Leonard, Flavell, 1975). Besides, as recent research suggests, early research methods had been inadequate to obtain these abilities of children (Perry. 1998; Whitebread, 1999). Recent research, moreover, has revealed that young children are more capable of these abilities than previously assumed and nowadays, studies was conducted on how to foster these abilities of young children (Perels, Merget-Kullmann, Wende,

Schmitz, Buchbinder, 2009; Robson, 2010; Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al., 2009).

Similarly, there are lack research studies on investigation of young children's metacognitive and self-regulatory abilities in Turkey (Karakelle & Saraç, 2007). On the other hand, there have been changes on theoretical framework of early childhood education in Turkey (MEB, 2012). In this regard, considering a potential focus on development of metacognition and self-regulation of young children, "attaining self-control" and "developing independent behaviors" stand out among the main principles of the Pre-school education curriculum that has become valid in 2012 (MEB, 2012). However, these changes depend on limited studies in our country. In order to close gaps between theory and practical grounds, it is very important to conduct a study investigating what type of metacognitive and self-regulatory abilities young children have.

CHAPTER 2

LITERATURE REVIEW

Metacognition

Definition of Metacognition

Metacognition was originally conceptualized as the knowledge about and regulation of one's cognitive activities in learning processes (Brown, 1978; Flavell, 1979). The term metacognition is most often associated with John Flavell. According to Flavell's main frame (1979), metacognition is cognition and knowledge about and monitoring of cognitive processes. His theory suggested that metacognitive experience can affect metacognitive knowledge (monitoring) or be affected by it (control) throughout cognitive processes (Flavell, 1979). Under this overarching definition, research on different aspects of metacognition has detailed the main theoretical model. Many subcomponents of metacognition, therefore, have been revealed through the years: Metacomponents, executive skills, metacognitive knowledge, feeling of knowing, metacognitive experiences, metacognitive awareness, judgment of learning, self-regulation, theory of mind, metamemory, metacognitive skills, comprehension monitoring, learning strategies, heuristic strategies (Larkin, 2009). Despite a growing body of knowledge on different aspects of metacognition, a widely accepted description of metacognition has been structured in a three faceted manner including metacognitive knowledge, metacognitive monitoring and metacognitive control (Dunlosky & Metcalfe, 2009; Veenman, Van Hout-Wolters, Afflerbach, 2006).

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) and his

collogue Brown (1987) from cognitive information processing tradition, the latter is established on works of Vygotsky (1978) from a socio-cultural tradition. Despite a large body of research to investigate the relation between these two constructs, there is no unequivocal agreement: some researchers structured metacognition as an overarching term of self-regulation (Brown & DeLoache, 1978; Kluwe, 1987) and some others suggested that self-regulation was an umbrella term including metacognition (Winne, 1996; Zimmerman, 1995). The major review of Dinsmore, Alexander, Loughlin (2008) illuminating relations between these two terms suggested that their convergence have become entangled in a structure that is very difficult to separate their roots. That is, over time researchers from cognitive tradition have begun to be interested in behavior area which is obviously more associated with self-regulation. Moreover, cognitive aspects of regulation gained importance since socio-cultural researchers have started to explore cognitive area. Finally, the only major distinction has been considered as the role of environment. The socio-cultural perspectives assumed environment as the key element to activate regulatory processes while researchers from cognitive information processing tradition emphasized on the mind of individual to initiate knowledge about and regulation of cognitive processes.

As Zimmerman (1986) suggested, considering self-regulation as an umbrella term over metacognitive, emotional and motivational, and behavioral regulation with the environment as the key element of regulation could represent current theoretical picture used in this study. Moreover, by using metacognition and self-regulation together, the present study also aims to provide an insight to recognize effects of cognitive tradition on theoretical models of self-regulation (Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al., 2009).

Components of Metacognition and Self-regulation

There are various components of metacognition mentioned in the literature and researchers have combined these components on the basis of their theoretical orientation (Brown 1987; Flavell, 1979; Nelson & Narens, 1990). All these theoretical frameworks have been divided into main areas: metacognitive knowledge and metacognitive regulation including monitoring and control.

Flavell (1979) explained what metacognitive knowledge is in his initial studies on metacognition in detail. In Flavell's main conceptualization (1979) metacognitive knowledge referred to one's own general knowledge or beliefs that act or interact on cognitive processes. He suggested three main categories of these knowledge and beliefs: personal, task-related and strategy related. His explanation of metacognitive experience differed from metacognitive knowledge in terms of content and function. Metacognitive experience is conceptualized as any cognition that accompany intellectual processes such as setting, revising and evaluating, abandoning general goals; determining necessary strategies and activating them. Therefore; metacognitive experience affected metacognitive knowledge (monitoring) or has been affected by it (control) throughout cognitive processes (Flavell, 1979)

In latter studies on metacognition, Brown (1987) defined the frame of metacognitive regulation more explicitly. She conceptualized metacognitive knowledge as metacognitive awareness by dividing it into there: declarative, procedural, conditional knowledge. That is, metacognitive awareness was one's knowledge of his memory and problem solving processes; of how to use cognitive strategies during problem solving processes; of where and when to use cognitive strategies. Metacognitive awareness was closely related to regulation of cognition; it referred to processes coordinating cognition through planning, monitoring and

evaluation (Jacobs & Paris, 1987; Kluwe, 1987). Although Flavell's metacognitive experience and Brown's regulation of cognition were two different constructs; they basically meant one's monitoring on and control of their own cognitive processes (Dunlosky & Metcalfe, 2009).

Theory of Nelson and Narens (1990) on metacognition suggested a procedural framework of how metacognitive knowledge and regulation interact. In their theory, they suggested monitoring and control as main components of regulation. Metacognitive regulation occurs between two main levels: one of them is object level where cognitive activities occur; other one is meta-level where knowledge regulating object level activities are stored (Nelson & Narens 1990; see Figure 1).

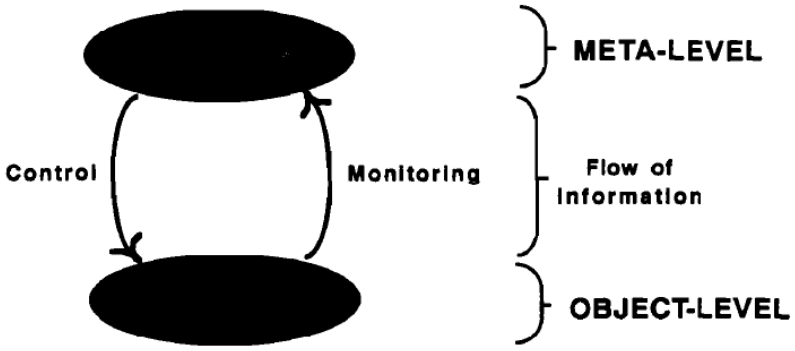

Fig. 1 Theoretical framework of Nelson and Narens (1990)

Although earlier theories have described components of metacognition and suggested a procedural framework; there had been a lack of a framework of metacognition which conceptualized theory of metacognition under the umbrella of self-regulation theory and which was also appropriate for young children. The framework developed by Whitebread, Anderson, Coltman, Pino Pasternak, Mehta (2004) offered a brief description for metacognition and self-regulation; and defined components of them for observing and evaluating young children even at the age of 3 (see Figure 2).

In this framework, metacognition and self-regulation are divided into three main components; metacognitive knowledge, metacognitive regulation; and emotional and motivational regulation are subsequently detailed in one of Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al.'s recent work (2009).

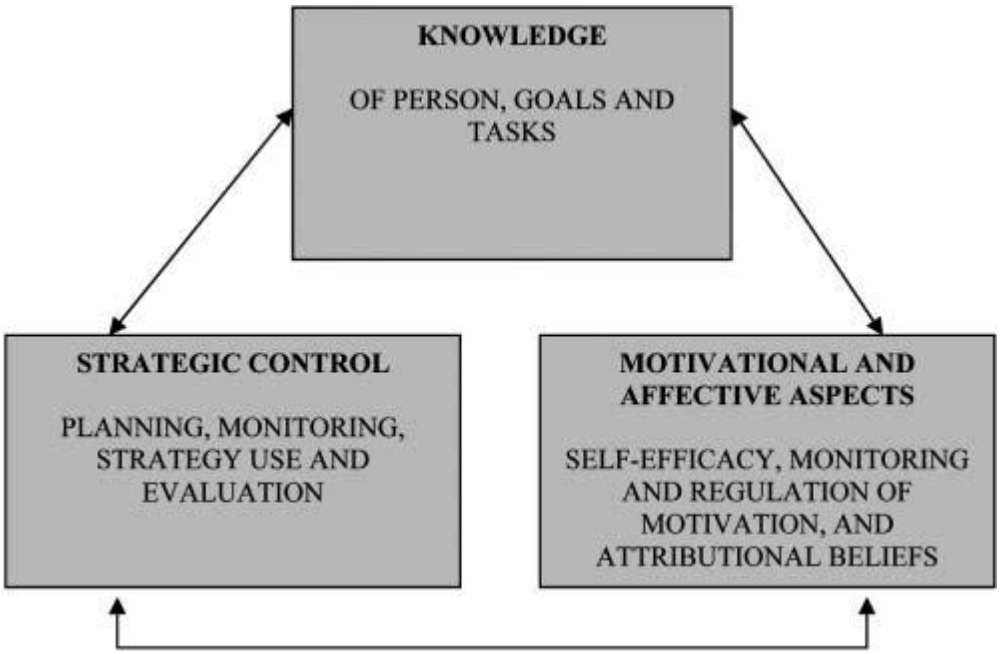

Fig. 2 Metacognition and self-regulation framework of Whitebread, Anderson, Coltman, Pino Pasternak, Mehta (2004)

Metacognitive knowledge refers to one's general knowledge of self, others and universals including capabilities, strengths, weaknesses or preferences on cognitive activities; 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 activities.

Metacognitive regulation refers to some procedural verbalization and behaviors including planning, monitoring, control and evaluation which enable to perform activities in a more structured way. Planning is defined as selection of procedure and materials related to activity demands and goals. Monitoring means assessment of ongoing activity procedures related to determined activity demands

and goals. Control signifies necessary intervention to activity procedure in related to activity demands and goals as a result of monitoring. Evaluation is conceptualized as reviewing and evaluating of activity performance relation to activity demands and goals.

Emotional and motivational regulation refers to monitoring and controlling of motivational and emotional experiences about given activities. While assessment of emotional and motivational experiences during and after activity is related to monitoring, necessary intervention as a result of motivational and emotional assessment is related to control.

Importance of Metacognition and Self-regulation

Considering metacognitive and self-regulatory abilities, studies where children's all verbal or nonverbal signs are evaluated through observation during play time in their natural class environment have shown that Piaget's views on children's metacognition and self-regulation do not reflect the reality (Bowman, Donovan & Burns, 2000). Studies have indicated that these skills start to arise much earlier than it was thought (Perry, 1998, Whitebread, 1999). Many recent studies have showed that these abilities are associated with children's school readiness and success. Blair and Razza's (2007) longitudinal study has pointed out that children's metacognitive and self-regulatory abilities at the age of 5, predict their reading-writing and mathematical skills developing at the age of 6. In a similar study, Denham, Warren-Khot, Bassett, Wyatt & Perna (2012) have found out that there is a relation between children's self-regulatory abilities assessed at the age of 3 and school readiness (e.g. learning behaviors and social behavior) assessed at the age of 4. Review studies published in recent times have also revealed that there is a significant relation between self-regulatory abilities and school success (McClelland & Cameron, 2012;

Ursache, Blair & Raver, 2012).

Effects of Developmental Processes

Although effects of age on emergence of metacognition have always been a consideration of researchers since Flavell (1979) coined the term metacognition; he emphasized inabilities of young children in their knowledge and cognition about cognition; and limited monitoring of their own memory, comprehension, and other cognitive abilities. Flavell's assumptions on metacognition of young children have heavily depended on his earlier studies suggesting that young children's failure of verbal labeling task due to production deficiency rather than their mediational deficiency. That is, young children's failure did not result from their verbal incapability. He concluded that young children under the age of seven are incapable of appropriate memory strategy due to their production deficiency (Flavell, Beach, Chinsky, 1966). Similarly, Piaget (1977) asserted that children cannot operate in an abstract manner until stage of formal operation.

Parallel to aforementioned assumptions, earlier studies on metacognition and self-regulation focused on what young children are not capable rather than what they can do (Kreutzer, Leonard, Flavell, 1975; Pressley, Forrest-Pressley, Elliott-Faust, & Miller, 1985; Winne, 1997; Zimmerman, 1990). In fact, in one of the recent major reviews of metacognition and self-regulation, Veenman, Van Hout-Wolters, Afflerbach (2006) concluded that it is a relatively late emergent skill at the age of 8-10. On the other hand, recent research on younger children, in contrast to earlier studies, has obtained evidence of early emergent of metacognition and self-regulation in young children at the age of 3-5 (Flavell, 2004; Perels, Merget-Kullmann, Wende, Schmitz, Buchbinder, 2009; Perry, 1998; Robson 2010; Whitebread, 1999). Therefore, conducting research studies on investigating metacognitive abilities of

young children through an appropriate method can be beneficial for early childhood educational settings (Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al., 2009).

Assessment of Metacognition and Self-Regulation on Young Children

Early studies concerned with metacognition, used several methods which make difficulties to obtain metacognition for the following reasons.

Firstly, studies using self-report methods to investigate metacognitive knowledge in young children have had an influential role on the results of these studies because these measures have relied upon children's verbal capacities which are generally assumed to be at very low level in young children (Veenman, 2005). The work of Kreutzer, Leonard, Flavell (1975) was one of the studies which did not concern about children's limited verbal abilities. Therefore, in the study; hypothetical questions relying upon young children's verbal abilities were conducted. They concluded that young children were limited in their metacognitive ability was presented as an example of biases in early research. Many other research relying less upon the children's verbal abilities have indicated that these children were more capable then originally suggested (Annevirta & Vauras 2001; Perry, 1998; Whitebread, 1999).

Secondly, there has been another theoretically controversial issue related to self-report method since Flavell's main experiment on children's memory. That is, whether metacognitive abilities are conscious or implicit and automatic. Although recent research has indicated that the implicit metacognitive processes which might not occur at a conscious level also have a significant role on development of metacognitive abilities (Fitzsimmons & Bargh 2004; Reder 1996; Siegler 1996); Flavell (1979) articulated metacognition processes as a conscious processes. Flavell,

Beach, Chinsky (1966) conducted a memory task with children at ages of 5 and 10. They reported that 25% of younger children who displayed ability of rehearsing in the experiment did not report that they had done so

Thirdly, studies using think aloud protocols have influenced the results of early studies because young children have limited working memory capacity which would be overloaded during think-aloud protocols. Therefore, these studies (Garner 1988; Thorpe & Satterly 1990) ignored children's metacognitive abilities since protocols could not be completed due to distractions of performance. Recent studies (Blöte, Resing, Mazer, Van Noort, 1999) minimizing memory demands have showed that young children have also displayed metacognitive abilities.

Lastly, the experimental contexts which have been unfamiliar to young children have again resulted in children's incapability of self-regulated skills. There has a growing body of evidence, on the other hand, showing naturalistic and age-related settings rather than experimental and laboratory-based ones are advantageous to have an idea how capable young children are with respect to metacognitive abilities (Cultice, Somerville, Wellman, 1983; Perry 1998; Turner, 1995). In this regard, Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al. (2009) reported the work of Istomina showing, in even 1970s, young children involved in pretend play in meaningful context to them displayed evidences of metacognitive abilities.

Although early research investigating metacognition of children generally showed children's incapability on metacognition due to the aforementioned reasons, recent studies using observational methods indicated early emergence of metacognition (Perry, 1998; Whitebread, 1999).

Systematic observation is one of the concurrent assessments of metacognition

and self-regulation conducted during activity performances or afterwards through watching episodes of a videotaped performance (Veenmann, 2005). Although this technique has its own limitations, its effectiveness on assessing young children who are not verbally fluent have been widely accepted in current literature (Alexendar, Carr, Schwanenflugel, 1995; Perry, 1998; Whitebread, 1999). In his wide review of assessment techniques of metacognition, Veenmann (2005) suggested ways of solution to these limitations. Firstly, a detailed framework should be used to describe all possible metacognitive verbal and non-verbal behaviors. Secondly, in order to provide internal consistency, observation should be conducted by several observers. Thirdly, in order to ensure construct validity triangulation should be conducted through use of other assessment techniques.

The observational methods has several advantages which eliminate the aforementioned shortcomings: (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 (Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al., 2009; Winne & Perry, 2000). Therefore, studies conducted with observational methods would contribute to both current metacognition and self-regulation theoretical background, and also developing early childhood settings supporting children's metacognitive and self-regulatory growth.

Contexts that Foster Metacognition and Self-Regulation

The significance of classroom context to foster children's metacognitive and self-regulatory abilities has been emphasized in recent studies (Meyer & Turner 2002; Perry 1998; Whitebread & Coltman 2010). The advantages of naturalistic and age-related settings rather than experimental and laboratory-based ones to assess young children's metacognition and self-regulation have been reported in various studies. (Cultice, Somerville, Wellman, 1983; Turner, 1995). Therefore, impacts of types of activities, forms of assessment and authority structures on young children's metacognition and self-regulation during performance, and perceptions of support and control have become primary interest of researchers as reported in a current meta-analysis of Dignath, Buettner, Langfeldt (2008).

The recent work of Whitebread and Coltman (2010) suggested four basic principles to foster emergence of metacognition and self-regulation of young children: establishment of emotional warmth and sensitivity; pedagogical practices which give children feelings of control over their activities; classroom environment which present children with cognitive challenges; learning context which allow children to articulate their thinking.

In the literature, establishment of emotional warmth and sensitivity between the teacher and child was suggested as one of the most significant pedagogy to support metacognitive and self-regulatory abilities of young children (Peryy, 1998; Whitebread & Coltman, 2010). In this regard, it was expected to create an environment to encouraging and relaxing informal environment in an unstructured manner in which both children and teachers have fun; therefore, children are not threatened due to presence of teacher, besides they feel encouraged.

The second important pedagogy was practices which give children feelings of

control over their activities (Meyer & Tuner, 2002). According to them, children should be offered with opportunities of being autonomous and taking responsibility of their own performance for them. Enabling them to decide what and how to do; to monitor and control their own progress; and to evaluate their own performance was indicated as ways of making children feel control over their activities (Whitebread & Coltman, 2010).

Thirdly, results of previous studies revealed that classroom environment which presents children with cognitive challenges helped children to display metacognitive and self-regulatory abilities (Perry, 1998; Perry, Vandekamp, Mercer, Nordby, 2002). In this regard, context should be provided with presences of optimal level of cognitive challenge offered through familiar problem solving environments in which children could find out their own way of solution and control over challenge through demonstrating metacognition and self-regulation.

Lastly, learning context should be offered opportunities for children to articulate their thinking as reported in the literature (Whitebread & Coltman, 21010). In this context, children should be encouraged to reflect upon their own performance for children through unthreatened evaluation. Therefore, early childhood contexts should be embedded with aforementioned features to foster metacognitive and self-regulatory abilities of young children (Perry, Vandekamp, Mercer, Nordby, 2002; Whitebread & Coltman, 2010).

Early Childhood Education

Throughout history, there has been several approaches related to how early childhood education should be designed and applied. Piaget's theory of cognitive development is one of the most influential approaches shaping early childhood education all over the world (Bowman, Donovan & Burns, 2000; Hinde & Perry,

2007; Ural & Ramazan, 2007).

Piaget introduced notions of stagewise development to the early childhood education (Bowman, Donovan & Burns, 2000). According to Piaget, education should be appropriate to children's cognitive stage. Preschool children are developmentally at the pre-operational stage. Although pretend play, language acquisition, imitation are major symbolic abilities occurring during the pre-operational stage, children do not have abstract abilities such as hierarchical categorization and reasoning. Children should be provided with concrete materials since abstract concepts are not appropriate for children's development. Moreover, children at this stage are egocentric and have difficulty in understanding life from any other perspective than their own. Therefore, children could not reflect upon their own behaviors and cognitions. Research adopting ideas of Piaget and using his tasks has supported his initial assumptions (Cavanaugh & Borkowski, 1980; Fritz, Howie & Kleitman, 2010; Kreutzer, Leonard & Flavell, 1975; Tunmer & Herriman, 1984).

Modern early childhood approaches give new insights into theory and practice of early childhood education (Bloom, 2004; 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 to them make choices, become decision makers, plan, initiate and reflect on and take responsibility. Moreover, learning is considered as a more interactive, children centered and collaboratively occurring progress.

Montessori Approach

Montessori is one of the approaches which theoretically and practically suggest that children should be offered a liberty environment to develop them as inner disciplined

and self-regulated individuals (Bloom, 2004).

The normalization process which Montessori referred to as "the most important single result of our whole work" is sort of basic pedagogy suggested in metacognition and self-regulation literature (Montessori, 1949). Whitebread & Coltman (2010) suggested that giving children a feeling of control and autonomy on activities through allowing them to make own choices is one of the basic pedagogy to foster metacognition and self-regulation of young children. Montessori suggested that through continuous liberty inherent environment where children make their own choice, a child becomes an inner disciplined individual who is the "master of himself, and can, therefore, regulate his own conduct when it shall be necessary to follow some rule of life" (Montessori, 1964, p. 86). Moreover, Koh and Frick (2010) investigated features of Montessori classrooms and concluded that Montessori Approach honors students' voice. Therefore, the approach's way of evaluation and correction through unthreatened criticism, respecting children's feelings could also be considered as a factor to enhance metacognition and self-regulation.

High Scope Approach

The main concern of High Scope approach is to foster metacognitive and self-regulatory abilities as well as to support pre-skills for the preparation of reading and writing (Weikart & Hohmann, 1973). In this process, children are considered as active learners who can engage and regulate social, physical and emotional problems in a self-regulated manner. (Schweinhart, 1993).

The plan-do-review sequence which is the essence of High/Scope approach (Hohmann & Weikart, 2002) is closely related to fostering metacognitive and self-regulatory abilities categorized in C.Ind.Le Coding Scheme (Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al., 2009). Epstein (2003) has

summarized the basic assumption of High Scope approach as valuing and supporting children's thoughts and actions rather than criticizing and controlling. The way of approaching children mentioned by Epstein (2003) has a positive influence on metacognitive and self-regulatory abilities (Whitebread & Coltman, 2010). In addition, implementations of High Scope approach such as encouraging children to become decision makers and problem solvers; to plan, initiate and reflect on work chosen by them; and to work effectively individually, and with other children are closely related pedagogy suggested in the literature to foster metacognitive and self-regulatory abilities of young children (Whitebread, Bingham, Grau, Pino Pasternak, Sangster, 2007). These abilities valued in the approach, such as planning, decision making, problem solving, reflecting are considered as indicators of metacognitive and self-regulatory abilities in young children in the literature (Perry, 1998).

Reggio Emilia Approach

The Reggio Emilia approach has emphasized its focus on importance of various elements in early childhood education. These are children's independence, their discussions and predictions going on before their activities, documentation of activities and on teachers' and children's reflection upon documentation repeatedly (Copple, 2003) which are also suggested principles in the metacognition and self-regulation literature (Whitebread & Coltman, 2010).

Strategy of documentation (Katz & Chard, 1996; Oken-Wright, 2001) is the hallmark of the approach encouraging teachers to observe children throughout the activities they work; to conduct formative assessment and to make ongoing decision for children (Gandini & Goldhaber, 2001). Therefore, teachers are encouraged to take ideas from the children and "produce strategies that favor children's work or can be utilized by them" for further exploration (Malaguzzi, 1993, p. 82). With help of

documentation, teachers not only provide opportunity for children to reflect upon their works but also children are offered with cognitive challenge to enhance their previous work and with feeling of control on their future work.

Curriculum and materials suggested in the approach are designed to promote metacognition and self-regulation of young children in an appropriate way. It has offered having no planned curriculum determining what is going to be learned. Children possess rights to make decisions, abilities to construct knowledge and curiosity to explore and investigate. In this sense it can be claimed that metacognition can be considered as a major element within the Reggio Emilia approach (Edwards, Gandini, Forman, 1993; Gandini, 1993).

Curriculum Guidance for the Foundation Stage

Early Years Curriculum Group (1998) has determined key factors deriving from research evidence that would contribute to early childhood education. Subsequently, The Qualifications and Curriculum Authority (QCA) have published Curriculum Guidance for the Foundation Stage to determine acquisitions expected from children at age of 3-5 and pedagogy expected from teachers to achieve these acquisitions in the UK (2000). The Qualifications and Curriculum Authority (2000) has great emphasis on importance of children's becoming of self-regulated learners. It has encouraged teachers to provide opportunities for children and encourage them to become metacognitively active and self-regulated learners through a guideline. The guideline was parallel to the principles suggested in the literature to foster metacognitive and self-regulatory abilities of young children (Perry, Vandekamp, Mercer, Nordby, 2002). Therefore, development of these abilities in young children has been valued and encouraged in early childhood education by Qualifications and Curriculum Authority (2002).

Tools of the Mind

Tools of the Mind approach has considered school readiness as the extent to which children are ready to regulate their cognitive, emotional and social behaviors rather than how ready children are to learn (Bodrova & Leong, 2003). That is, this approach's main aim is to foster metacognition and self-regulation of young-children. According to Tools of the Mind, the main issue that should be resolved in early childhood education is development of a curriculum embedded with standards and training teachers equipped with the pedagogy to foster children's self-regulatory abilities. Tools of the Mind approach has suggested planning beforehand and reflection after their play as principles to foster metacognition and self-regulation.

Current Development on Metacognitive and Self-regulatory Abilities of Young Children in Turkey

In recent years, the content of pre-school education system in Turkey has been arranged in a way to help children develop abilities necessary to succeed in today's conditions in the most effective way (MEB, 2006). Subsequently, "attaining self-control" and "developing independent behaviors" stand out among the main principles of the pre-school education curriculum that was introduced in 2012 (MEB, 2012). As culture and context play a big part in the assessment of self-regulation in early-childhood (McClelland & Cameron, 2012), not only in western countries such as England, Canada and the USA, but also in Far East countries, many new studies have been conducted regarding self-regulation. Whereas investigation of metacognitive and self-regulatory abilities in early-childhood is gaining more and more importance all around the world, there has been a limited research on these abilities in Turkey (Karakelle & Saraç, 2007). The only research study that has been conducted with primary school students in Turkey has analyzed the effect of one of collaborative learning techniques (Jigsaw IV) on self-sufficiency belief and self-

regulation abilities (Arslan, 2011). Therefore, there is a need for studies examining metacognitive and self-regulatory abilities of young children in early childhood education (Karakelle & Saraç, 2007).

Mathematics Education for Young Children

Importance of mathematics education has been considered as one of the most critical elements of early childhood education after nationwide research studies investigating benefits of effective early childhood education has been conducted all over the world (e.g., Effective Pre-School And Primary Education 3-11 Project). The Effective Provision of Pre-school Education project was the first study eliciting evidence of the positive effects of preschool education in the UK (Sylva, Melhuish, Sammons, Siraj-Blatchford & Taggart, 2004). Results have showed that high quality pre-school education could help to eliminate disadvantage deriving from social background and could provide opportunities for children to get a better start to formal schooling (Melhuish, Ramoniuk, Sammons, Sylva, Siraj-Blatchford, Taggart, 2006). Results have showed that the high quality early mathematics education promotes better mathematics outcomes for children in long term. Early childhood approaches have suggested that instruction of mathematics in young children should focus on process skills as well as content.

The National Council of Teachers of Mathematics (NCTM) has published mathematics standards in 2000. The mathematics framework determined by National Association for the Education of Young Children (NAEYC) & NCTM (2002) has affirmed content of mathematics learning for young children. Two of the early childhood approaches that fits with early mathematics framework suggested by NAEYC & NCTM (2002) are High Scope (Epstein, 2003) and Reggio Emilia (Clements, 2001). High Scope has suggested that purpose of early mathematics

education should be emergence of number concept through process skills such as classification, pattern construction, and one-to-one correspondence (Epstein, 2003). Malaguzzi (1997) explained Reggio Emilia perspective which aims to teach process skills such as measurement through problem solving based activities.

Current early childhood curricula in various countries (e. g., Curriculum Guidance for the Foundation Stage) as well as early childhood curriculum in Turkey (MEB, 2012) have specified what children should be and how it needs to be taught in terms of mathematics in early childhood education. Examining these curriculums reveals that reasoning, problem solving, classification, matching, measurement, estimation, constructing pattern are basic process skills that are expected to be taught to young children as an early mathematics.

Metacognition and Self-regulation in Mathematics Education

Research on metacognition and self-regulation in mathematics education has increased after the shift in epistemology of mathematics education (Larkin, 2010). That is, a larger understanding and instruction of mathematical content knowledge and strategy rather than direct instruction of a basic mathematical knowledge has been considered as a valuable epistemology. Therefore, children's monitoring of and control on their understanding of their mathematical knowledge and skills have been considered as valuable to take into account on mathematics education since metacognition and self-regulation are demonstrated as important factors to support development of mathematical knowledge of children (Kuhn, 2002; Mevareck,1995).

According to Carr, Alexander and Bennett (1994); even in young children, correct mathematical knowledge and skills can influence metacognition and self-regulation positively; which subsequently result in mathematical development. In addition, relationship between problem solving abilities and metacognitive abilities

of young children in mathematics has been investigated. While a number of studies has indicated that higher metacognitive ability provides better problem solving in mathematics (Lucangeli, Cornoldi & Tellarini, 1998; Toeng, 2003); others have showed that good problem solvers exhibit more metacognitive abilities (Carr & Jessup, 1995; Desoete, Roeyers & Buysse, 2001). Therefore, metacognition and problem solving abilities are interrelated and affect each other even in young ages (Heirdsfield & Cooper, 2002).

CHAPTER 2

STATEMENT OF THE PROBLEM

Early childhood education has gained tremendous importance within the education system since reform movements in 2006. Efforts to increase early childhood enrollment rate and adoption of current theoretical background can be considered as worthy improvements in comparison with the previous situation. However, considering which subjects and abilities should be taught are as important as enrollment rate and theoretical background adoption. In order to determine worthy subjects and abilities to teach in early childhood education; utility of the adoptive theories are needed to be examined through studies. These studies should not only check appropriateness of adoptive theory in Turkey but also should serve an important role to close gaps between theories and practices in all subject area in early childhood education.

This study is designed to the close gap between theory and practice with an important area of early childhood education: mathematics education. In particularly, the study examines metacognitive and self-regulatory abilities of young children through observational method. Existence of these abilities has been underestimated in early childhood education for several years (Perry, 1998; Whitebread, 1999). In this regard, aim of the study is to investigate metacognitive and self-regulatory abilities of young children in mathematics activities through addressing the following questions:

- Is the observational method reliable and valid technique to obtain metacognitive and self-regulatory abilities of young children?
- What type of metacognitive and self-regulatory abilities do young children exhibit in mathematics activities?

- What sort of relationships are there between mathematical process skills and metacognitive and self-regulatory abilities of young children?
- What sort of relationships are there between metacognitive and self-regulatory abilities of young children and the context designed to foster these abilities of young children?

CHAPTER 3

METHOD

Design and Aim

This study has a mixed design. While qualitative methods constituted the main structure of the study, quantitative methods were conducted to support the qualitative part (Caracelli & Green, 1993; Onwuegbuzie & Teddlie, 2003; Tashakkori & Teddlie, 1998). Mixed methodology offers several benefits to researchers; however, most importantly it allows better understanding by converging numeric data and specific details from qualitative data (Creswell, 2007). In the qualitative part, this study aims to investigate what type of metacognitive and self-regulatory abilities young children exhibit during mathematics activities. Accordingly, in the quantitative part, it aims to investigate relationship between actual children's metacognitive and self-regulatory abilities during activities and their general metacognitive and self-regulatory ability scores derived from teacher ratings.

Instruments

In this study, C.Ind.Le Coding Scheme developed by Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al. (2009) was used for qualitative data collection and analysis. In the quantitative part, Checklist of Independent Learning Development (CHILD) 3–5 developed by Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al. (2009) was administered to teachers and C.Ind.Le Coding Scheme was used to quantify children's metacognitive and self-regulatory abilities.

C.Ind.Le Coding Scheme (C.Ind.Le)

Coding Scheme was prepared to investigate verbal and nonverbal indicators of metacognition and self-regulation on young children at the early childhood period

(Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al., 2009; See Appendix A). As suggested in the literature, it has a detailed definition and description of each category and subcategory; it also constitutes brief examples of each subcategory as suggested in the work of Veenman, (2005). It constitutes mainly three categories of self-regulation: Metacognitive knowledge, metacognitive regulation and emotional and motivational regulation. Since this study focused on metacognitive abilities of young children, first two categories of scheme were used to code children's verbal and non-verbal metacognitive abilities. The first category constitutes three main subcategories: knowledge about persons, tasks and strategies. The second part has four subcategories: Planning, monitoring, control and evaluation.

Checklist of Independent Learning Development (CHILD) 3–5

This checklist was prepared as a teacher observation instrument and originally constituted 35 statements deriving from literature (Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al., 2009). At the end of a two year study, some of the statements were eliminated. Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al. (2009) reported that the 22 remaining statements had very high internal consistency (Cronbach Alpha=0,97). It consisted of four main categories which were parallel to those listed by Bronson (2000) as dimensions of self-regulation: emotional, Prosocial, Cognitive and Motivational (See Appendix B). It is a likert-type scale assessing whether statements are "always", "often", "usually", "rarely", "never" true for a child. Children get points ranging from 1 to 5 for each item according to their teachers' responses from the five options. Total score of scale is, therefore, 110 for a child who gets "always" for all items. In the present study, inter-rater reliability of the scale was very high (r= 0, 91).

Participants and Their Settings

There were two classes in the same pre-school of a public university in Istanbul. Each class had a main teacher and a co-teacher. Teachers used several strategies derived from Montessori and High Scope to support children's cognitive, behavioral, social and emotional development (See Appendix C for a monthly program of the institution).

Participants in the study were 16 children from the 4 year old group and 17 children 5 year old group. Children in the 4 year old group were from 43 to 63 month old with an average of 59 month old. Children in the 5 year old group were between 65 and 73 month old and their average was 70 month old. Children came from various family backgrounds. While 30% of children's parent worked in Istanbul University as faculty member or officer, rest of them was worked in several jobs. Children were generally from middle and upper income family according to their records at the preschool. Moreover, 60% of their parents completed undergraduate program.

The institution 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 to the researcher. Rapport established between researcher and participants could be considered as evidence of validity of the study. Since the researcher has rapport through one year previous experience with the participating children, it could be considered as a factor increasing validity. However, no claims were made about such a small sample being any way representative of the students of this age group in Turkey.

Design of Activities

This study focused on young children's metacognitive and self-regulatory abilities during problem solving based mathematics activities. Three activities were adapted at the beginning of the study from the literature (Bryce & Whitebread, 2012; Larkin, 2006; Whitebread & Coltman, 2010). While designing and applying the activities, the contexts that fostered metacognitive and self-regulatory abilities of young children and of mathematical process skills were taken into account. Each activity had challenges that children could have control over and offered opportunities of feeling of control and of articulating their thinking, and during the activities children were supported emotionally (Whitebread & Coltman, 2010).

Mathematical process skills were embedded in all the three activities in order to investigate relationship between these skills of young children and their metacognitive regulatory abilities. Measurement, classification and pattern construction were other process skills that children were expected to be involved in while doing three activities (MEB, 2012).

Application of Activities and Role of the Researcher

After activities were designed, children were chosen randomly and allowed to collaborate in groups of threes during activities. While 9 groups of three children were involved in the rail track activity (27 children), 5 groups of three children took part the house for giraffe (15 children) and the classification activities (15 children). Activities lasted at least 10 minutes and there were groups of children who completed their activities in 30 minutes. Average duration of rail track, house for the giraffe and classification activities were 161 (mean: 17.9), 74 (mean: 14.6) and 80 (mean: 16) minutes, respectively.

The role of the researcher during the activities changed according to nature and necessities of activities: in the first two activities, researcher tried to be a non-participatory observer. In the last activity, researcher was a participant of the activity as a member of problem-solving community; that is, the researcher was actively involved in the activity but avoided behaving as an authority figure.

Pattern Construction Activity

Children are involved in an activity constructing a rail track with pieces of tracks provided to them according to three differently shaped models for rail tracks given on paper. Children work in groups of threes on preparing the tracks with the given pieces.

These three shapes can be classified as easy, normal and difficult according to expert opinion, nature of children's duration of completion and correctness of children's result during the study. In each session, easy, medium and difficult activities are given to children respectively. Decision-making whether the activity is completed belonged to children in the activity. Problem solving and pattern construction are process skills that are expected to be used by the children during this activity. Giving three levels of difficulty is for the sake of exploring how much metacognitive knowledge of tasks young children can exhibit at this age range.

Measurement Activity

Children are involved in constructing a house activity for a giraffe by using blocks. Children work in groups of threes on preparing the house for a giraffe with the given pieces. Decision-making whether the activity is completed belonged to children in the activity. Problem solving and measurement are process skills embedded in this activity to make children exhibit their metacognitive regulatory abilities.

Classification Activity

Children are involved in a classification activity of vehicles and animals. All toys are given at the same time to children and they are 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 activity, the researcher shows animals and vehicles to children one by one and discussion on names and features of animals occurs. Since the researcher introduces the animals and vehicles; children invite the researcher to join their discussion making. Although the researcher is involved in the activity, children decided about how they categorize on their own; some of them categorize as vehicles and animals, some others categorize according to equal number of toys regardless of vehicles or animals. Decision-making relating to whether the activity is completed belonged to children in the activity.

Problem solving and classification are process skills embedded in this activity. These skills embedded in this activity are for the sake of making children exhibit their metacognitive regulatory abilities. While the discussion at the beginning of the activity is for the sake of determining how much children exhibit metacognitive knowledge of persons; asking children for different classification is to observe how much children exhibit metacognitive knowledge of strategies between classifications.

Data Collection

Triangulation which is defined as use of multiple data sources, researchers, and data collection techniques in the literature (Yıldırım & Şimşek, 2005) is an important factor to check validity of qualitative studies. In this study, multiple data were obtained through observation of children, video watching with children and video watching with teachers. Since teachers closer to children and have insights about

their behavior, they would interpret their behaviors more appropriately.

In the qualitative part, children were video-recorded during each activity. Video episodes of activities were watched and particular episodes were selected according to metacognitive elements they represented. Concurrently, some parts of selected episodes were watched with three children who were involved in these episodes and one of their teachers to assure whether the researcher coded what was expected to be coded one day after the activities they involve in activities. During reflective dialogues, how and why questions were asked to children as suggested in the study of Larkin (2006). It was claimed that, if researchers use 'how?' questions such as "How do you know that?", they can facilitate metacognitive knowledge. In parallel to how questions, 'why?' questions such as "why do you act like that" can provide opportunity for evaluation of activities. Reflective dialogues that occurred during the video-watching with children and their teachers were also video-recorded.

In the quantitative part, two teachers of each class were administered checklist for each child. Moreover, data derived from the video-recording were used for the quantitative data analysis.

Data Analysis

In this study, qualitative and quantitative data analyses were conducted in a mixed method design.

In the qualitative part, since the present study focused on the cognition aspects of young children's metacognition apart from emotional and motivational aspects of metacognition, only the first two main components of Cambridge Independent Learning (C. Ind. Le) scheme (Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al., 2009) (metacognitive knowledge and metacognitive regulation) were used. After total 315 minutes of video episodes were transcribed,

indicators of metacognitive and self-regulatory abilities were coded according to the coding scheme (Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al., 2009; See Appendix D for coding sample).

Inter-rater consistency of data analysis is an important indicator of establishing the quality of the study in qualitative part (Yıldırım & Şimşek, 2005). That is, multiple researchers should produce similar interpretations of the same data. It could be considered as an indicator of reliability since the researcher and one of his collogue code some part of video episodes. 10% of video episodes were watched by two raters and coded according to the framework. Then, discussion on the nature of the components of metacognition they embodied was conducted until an agreement was reached. Moreover, reflective dialogues with three children and their teachers provided insights on validity of the researcher's coding.

In the quantitative part, data comes from mainly two instruments. First data source is average metacognitive and self-regulatory scores of children collected via Checklist of Independent Learning Development. The second one was derived from C.Ind.Le Coding Scheme through quantifying coded metacognitive and self-regulatory abilities of young children. That is, frequencies of children's metacognitive and self-regulatory abilities that they exhibited during each activity were calculated. Wilcoxon Signed-Rank Test was also conducted to investigate whether there was a difference between occurrence of metacognitive knowledge and regulation of young children. The relationship between children's checklist scores and frequency of metacognitive and self-regulatory abilities on each activity was examined through Spearman Rank Correlation.

CHAPTER 4

RESULTS

Throughout this study, observational method was conducted to investigate metacognitive and self-regulatory abilities of young children. Observational method is a new technique to obtain these abilities of young children. Therefore, reliability and validity of the study, particularly of observational method was investigated at beginning of the results part. Subsequently, the second research question of the study was answered through displaying metacognitive and self-regulatory abilities of young children in a manner suggested in coding scheme of Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al. (2009). Finally, interaction of these abilities of young children with mathematical skills and context suggested to foster these abilities of young children were examined in detail.

Reliability and Validity of the Study

The first part of this research focused on the inter-rater consistency between children's metacognitive and self-regulatory scores according to CHILD 3-5 provided by their main and co-teachers. The Pearson product moment correlation coefficients for inter-rater consistency was calculated since level of measurement and the number of children was statically appropriate (n>30). Findings showed that there was a very high significant positive correlation between teachers' scores for children.

Table 1. Correlation Coefficients between Scores from Main and Co-Teachers of Children

Variables	n	Correlation coefficient	Significance
Scores from main teachers- scores from co-teachers	33	0.91	.001

Moreover, inter-rater consistency between coding of the researcher and a faculty member from faculty of education was also calculated in the first part. Two researchers coded 10% percent of transcriptions of video episodes. Findings showed that there was a high correlation between coding of observers (r= 0.84). Subsequently, consensus was reached on the items that were coded differently. Reflective dialogues were also conducted with three children and one of their teachers in order to validate the coding of the researcher. Results of reflective dialogues indicated objectiveness of the researcher's coding.

The second part of this research focused on the relationships between children's metacognitive and self-regulatory scores provided by teachers through Checklist of Independent Learning Development developed by Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al. (2009) and frequencies of occurrence of their metacognitive and self-regulatory ability in activities. The level of measurement for the variables required the use of the Spearman rank order correlation coefficients for all the correlation analysis because of number of children participate in activities (n<30).

Table 2. Correlation Coefficients between Total Score Provided and Frequency of Occurrence of Abilities in Activities

Variables	n	Correlation Coefficient	Significance
Total score-rail track activity	27	0.54	.004
Total score-house for giraffe activity	15	0.58	.024
Total score-classification activity	15	0.58	.023

Findings indicated that metacognition and self-regulation scores of children provided by their teachers had significantly moderate correlation with frequency of occurrence of their abilities obtained from the activities. Since the findings revealed that coding

of the researcher was ensured statistically valid; qualitative analysis of metacognitive and self-regulatory abilities of young children was represented in the following parts.

Data showed that there was extensive evidence of metacognition of young children in the activities. Findings also matched with current literature on metacognition of young children. Results of Wilcoxon Signed-Rank Test indicated that the average occurrences of metacognitive regulatory abilities were significantly more frequent than the average occurrences of metacognitive knowledge in all three activities (Robson, 2010, Table 3). In the following part, example episodes of main components of metacognition-metacognitive knowledge and metacognitive regulation- were displayed in detail. That is, each main component was divided into sub-categorizes as suggested in the study of Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al. (2009) and then example sentences were displayed with explanations of their non-verbal behaviors.

Table 3. Results of Wilcoxon Signed-Rank Test

	n	Z value between children's metacognitive knowledge and regulatory abilities	p
Rail track activity	27	-4.54	.001
House for the giraffe activity	15	-3.23	.001
Classification activity	15	-3.00	.003

Observations of Metacognitive Knowledge and Regulation

Metacognitive Knowledge

Metacognitive knowledge refers to one's knowledge about persons (including self and others), tasks and strategies. Average occurrence of metacognitive knowledge in 10 minutes for each activity was shown in the table 4. These averages were symbolized how many metacognitive knowledge children exhibited as a group (Table 4; See Appendix E for average occurrence of children's metacognitive and self-regulatory abilities for each children in detail).

Table 4. Average occurrence of young children's metacognitive knowledge in each activity

	Metacognitive knowledge		
	Persons	Tasks	Strategies
Rail track activity	2.62	2.51	1.82
House for the giraffe activity	1.00	2.63	1.70
Classification activity	1.20	0.96	1.03

Knowledge about Persons

According to the findings; children exhibited evidence of metacognitive knowledge during each activity; especially in the discussion part of classification activity. At the beginning of the classification activity while we were discussing about animals' features, a child said: "Of course, there are animals that we couldn't know." That sentence was interesting because of her response after "why don't you know all animals": "Because we are young and we can't learn all of them." In the example, she was not only aware of inadequacy of their knowledge but also she had a reason for why they could not know all animals.

Metacognitive knowledge of persons was also obtained frequently while

children confronted cognitive challenges. In the rail track activity, for example, children exhibited sorts of knowledge about persons, accordingly they expressed their opinion about the difficulty level of the activity. In one of the examples, after children finished very quickly constructing the first and easy shape; the second shape was shown to them. The child, who leaded the work on the first shape, said "it is very difficult but I can do this". This verbalization demonstrated how much he knew about his own strength because he leaded the completion of the second.

Knowledge about Task

The results showed that children made several sorts of judgments about the level of difficulty of cognitive activities several times during all activities they were involved in. However, particularly in the rail track activity which included three levels of difficulty, their judgments were very clear: After one group of children accomplished the first shape in 45 seconds, the second shape was shown to them. Although they did not comment on the first shape as easy or difficult, they said: "This is very difficult." As they have suggested, the activity might be difficult for them because they could not accomplish the second as well as third one (which was most difficult).

Metacognitive knowledge of tasks was also observed in other activities. One group of children, for example, planned to build a roof for the giraffe's house. Since they needed a big roof from small pieces, it could be difficult to build. One of them mentioned this as difficult: "Building a roof is very difficult." Then, they decided not to build a roof but used the box of pieces they used to build the house as roof. Therefore, the child's judgment directed them to finding another way of solution.

Knowledge about Strategy

According to findings, children exhibited metacognitive knowledge of strategies to resolve their confusions confronted during activities and to enhance their

performance while achieving their goals. While a group of children worked on the classification activity, they could not reach an agreement for an animal's name. To resolve the disagreement, one suggested voting to decide its name. Result of voting was again equal. Another one child suggested making a count to decide who would be the winner whereas a girl objected the idea and explained her reasoning: "If we make a count, the one at the end always wins." As seen in the example, she had already applied this method in her life and knew the shortcomings of the method.

Knowledge about strategy was also observed while there was a discussion on which strategy was better. While one group of children was engaged in the classification activity, each of them came with plans; therefore, they could not decide which plan they would carry out in the first hand. Subsequently, one of them said: "I think my plan would be more appropriate". Still, children carried out another plan but they did not like their classification. The child again said: "that's why; I have said to classify so." Therefore, they gave up with first plan and started to carry out the child's plan. It was clear that the child whose plan was finally accepted by the group had a better understanding of strategies, evaluated the effectiveness of strategies and helped his friends to achieve their goals (Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al., 2009).

Metacognitive Regulation

Metacognitive regulation has mainly four subcomponents: Planning, monitoring, control and evaluation. Average occurrence of metacognitive regulation in 10 minutes for each activity was shown in the table 4. These averages were symbolized how many metacognitive regulation children displayed as a group (Table 5).

Table 5. Average occurrence of young children's metacognitive regulation in each activity

	Metacognitive Regulation			
	Planning	Monitoring	Control	Evaluation
Rail track activity	2.55	15.85	9.59	3.06
House for the giraffe activity	3.00	5.57	5.00	2.71
Classification activity	4.22	5.11	3.88	0.44

Planning

The results showed that children make plans at the beginnings of activities. They decided on their ways of proceedings at the beginning of the activities. While children started the rail track activity, immediately after the first shape which had only a cambered rail; a child said: "My opinion is that we will use spherical (cambered) rails." He said his sentences while pointing at the track shapes on the paper with his finger. His non-verbal behavior and his verbalization indicated that he was quite sure what construction was needed and he had a plan for it in his mind.

Findings of the study also showed that these plans established grounds for children to monitor and control their progress. For example, in one of the house for giraffe activity, after the aim of the activity was given to children, one of them said: "We should measure the length of giraffe". She said this sentence at the beginning of the activity while they were at some sort of preparation stage of construction. During the activity, these group of children continuously checked whether length of their wall was appropriate for the giraffe. While talking about the episode in reflective dialogues session, she reasoned her verbalization as: "If we do not measure it (length of giraffe), house mightn't fix."

Monitoring

While carrying out their activities, children exhibited evidence of reviews described in Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al. (2009). According to him and his collogues (2009), when children's reviews co-occur during their performance, these are described as monitoring. Detection of their errors, their self-commentating and reviews on their progress were kinds of monitoring that are observed more frequently during activities.

According to results, self-commentating was one of the most obtained indicators of monitoring during activities. In an example, while children worked on house constructing for giraffe; two children had already started building their house together. At that moment, the third one 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 activity, they combined their construction and ended up with a very comfortable house for the giraffe. It can be easily said that he monitored what his friends did and as result of his monitoring; he self-commentated: "I got an idea."

The findings also showed that children detected errors since their reviews on their performance occurred continuously during the activities. While the children worked on the classification activity; they tried different ways of classification to reach a right conclusion; therefore, there might be wrong attempts which were eliminated. In a session of the activity, we had again such a situation and we 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 suggested that they should try another strategy as a result of previous monitoring (Whitebread,

Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al., 2009).

Control

According to Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al. (2009) control as a metacognitive regulatory ability means suggestions and/or changes of strategy in a going activity as a result of cognitive monitoring. Findings showed that throughout three activities, children suggested and used ways as results of their previous monitoring.

Results showed that children changed their way of proceeding according to their review on their progress. In one of the examples, while children were constructing the second shape in the rail track activity, one of them, who monitored the on-going progress, said: "There will be a cambered (rail)." The interesting point of that extract was that he said his sentences after looking at the shape given in the paper. He obviously kept track of the on-going 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 shape: "Look Harun! We should start firstly this side and then we should do its head." Everyone might have a strategy while solving problem. But the child also tried to show and therefore helped his friend about how to solve this type of problem (a sort of puzzle activities).

Evaluation

After carrying out their activities, children exhibited evidence of reviews described by Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al. (2009). When children's reviews take place after their performances, these are described as

evaluation. Results showed that this metacognitive regulation was obtained in a manner where children commented on their work and mentioned absences on it.

The findings indicated that children reviewed their activities and suggested ways of enhancing their activities. While a group of children completed and started to check out whether their construction of the rail tracks was correct, one of them said by pointing where they made a mistake: "I think we had a problem at this point." Since the child also looked at the given shape, he evaluated their progress. Therefore, the correct evaluation provided opportunity to correct their mistake.

According to the results, even if children did not correct their mistakes, they were aware of them. In one of the examples, 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.

Mathematics and Metacognition

Findings showed that children's mathematical skills and their metacognitive and self-regulatory abilities influenced each other in parallel to previous studies (Carr, Alexander and Bennett, 1994; Desoete, Roeyers, Buysse, 2001; Toeng, 2002). In the following part, sample episodes of components of metacognition and self-regulation were displayed from a mathematical perspective in detail.

Problem Solving

According to NCTM (2000), problem solving is an integral part of all mathematical learning; mathematical knowledge is developed through problem solving. In this regard, all activities children were involved in were mainly problem solving based mathematics activities. Mathematical skills such as classification, measurement,

constructing pattern were expected to be displayed during these problem solving based activities.

At the beginning of the activities, children were informed about the problem that they were expected to involve. During the activities, children tried to solve the problem through a collaborative work. They confronted all aspects of problem solving suggested in the literature: understanding the problems, devising their plans, carrying out their plans, and reflecting upon works (Polya, 1957).

Results showed evidences of children's understanding the problem at the early stages of three activities. Children who understood problems had opinions on difficult levels of problem. When a problem looked like easy for them, they solved it smoothly. For example, the researcher asked children to construct a house for or classify animals and vehicles; some of the children considered activities as easy for them. Some of them told: "It is as easy as pie." Same children, who used the idiom "as easy as pie" for the first shape, also remarked for the second and the third shape of the rail track activity that these were difficult.

Results indicated that children started to solve problem with planning which could be considered as an important part of problem solving. A typical example of such ways of operation occurred when children say "we'll make a circle" or "we'll make octopus" as soon as they saw the picture of shapes in the rail track activity. By doing this they articulated their ways of solution to their friends. In the classification activity, they also displayed lots of evidences of planning while explaining their opinions on their way of proceedings: "Firstly, let's allocate animals this side and vehicles to other side; therefore…" Children who came up with these plans exhibited one of regulatory abilities of metacognition and self-regulation through proceeding of problem solving.

According to results, some of children made mistake and instantly noticed their mistake and fixed it while carrying out their plans which 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 activity was that while children categorizing animals in terms of where they live, a boy mentioned that there was a mistake because that animal lived in water.

Findings showed that children did not always noticed their mistakes instantly and they had to review what they have done after a while; therefore, it was very clear that children's monitoring and control of their solution steps continued constantly during carrying out their plans. In rail track activity, while children almost finished the second shape, one of the children who leaded construction at that moment realized that they are mistaken: "Aaa, we did it wrong, it should look like women's waist" and he supported his verbalization through showing by his hands. Similarly, in the house for giraffe activity, one of the children who worked individually at the beginning said that you should enlarge because the giraffe did not fix this house. Then, they realized none of their houses was appropriate and decided to reconstruct the house together. Children in these examples not only monitored their progress but also controlled their strategy according to their previous monitoring.

Findings in this study indicated that children's evaluation was much easier when they continuously monitored and controlled their progress during the activities. These children monitoring their activities, verbalized phrases such as: "it is done" at the end of the activities. Therefore, it could be claimed that monitoring and control of progress while carrying out activities rather than afterwards make children accomplish their goals more appropriately.

According to results, at ends of activities, children applied the last part of problem solving through looking back and reflecting upon their work and also mentioning its absences. While a group of children almost finished the house for giraffe, one of them realized that they constructed one wall smaller than other one: "we should make this wall taller too." Similarly, in rail track activity, although children considered it was done as a group decision, one of them told its absences: "this side should be taller like in the picture but let it be…"

Measurement

NCTM suggested that children were enabled to understand processes of measurement from early childhood education and to apply appropriate techniques for measurement. In this regard, measurement was embedded in one of activities- house for giraffe- to investigate whether there was a relationship between this mathematical skill of young children and their metacognitive and self-regulatory abilities.

It was important to mention here that the children were not asked to measure the length of giraffe. They were only asked to construct a house for giraffe; however, almost all of children tended to measure length of the giraffe. They tried to construct a door that the giraffe enter its house even if not they constructed whole house according to the length of the giraffe. Children measurement skills and their metacognitive and self-regulatory abilities influenced each other. Findings showed that in particularly children's metacognitive regulatory abilities had remarkable relations with children's measurement skills.

Results showed that almost all of children started their construction with planning "let's measure its length." In the cases that children did not start with a plan to measure the giraffe's length; they started construct and after a while, they monitored their construction: "let's check if the giraffe fix our wall." Therefore, it

could be said that in both cases whether they verbalize their plan or not, they had a plan to construct their house according to giraffe's length.

According to findings, throughout the activity, children continuously monitored and controlled their construction according to their plan. For example, one group of children decided seven pieces of blocks were appropriate for the giraffe: "All of them should be seven." One of the children counted her pieces which were five and added 2 more pieces. After she added 2 more pieces, she counts again. Therefore, she monitored her works, controlled her work according to her previous monitoring, and continued to monitor her work.

Results also showed that some child not only monitored and controled his/her own construction; but also they monitored and controlled his/her friends' construction according to the length of the giraffe. In an episode, for example, in which children did not mention a number but decided on an appropriate length by rule of thumb, a child says: "There should not be more pieces, I have measured its length" removes more pieces her friend add. According to findings, children also evaluated their work at the end of their activity. They mentioned absences of their work and commented on what else they needed to do more for the house. One of the children, for example, who constructed two walls facing each other, said: "It would be better if this wall was taller as other one."

Classification

According to NCTM (2000), classification was natural and interesting to children. Tucker, Singleton, Weaver (2002) have emphasized the importance of developing this skill starting from early childhood education: "Concept development is based on classification, so helping children develop this skill is an important responsibility of a teacher of young children" (Tucker, Singleton, Weaver, 2002, p. 51).

In the classification activity, children were asked to classify animals and vehicles directly; children exhibited metacognitive regulatory abilities during classification abilities. Planning of children was obtained in all of classifications while classifying into two, three and four. Their monitoring and control of their classification occurred subsequently based on their planning.

According to findings, all children suggested plans at the beginning of the classification activity such as: “I think vehicles are here and animals are here” and “I can’t find… Ohh, I find… these which are living in water here, which are flying here…” The child in the second example verbalized what he did not do which was also remarkable example of monitoring on his cognition.

Results showed that discussion makings on their plan occur for a while. A group of children, for example, could not classify into 3 groups; one of them said, “In that case, let’s classify according to another feature because they have lots of features that do not fix”. Then, one of her friend replied her: “let’s classify according to where they live more, this for example, lives more in water…” After children commented on each other’s plan and the plan which was considered as more appropriate was applied by children.

Decisions on whether classifications were completed or not were always made by children; therefore, children always evaluated their classification. Findings indicated that since monitoring and control of their planning were continuous during the house for giraffe activity; their evaluations always occurred in such verbalization of them: “it is done.”

Pattern Construction

According to NCTM (2000), an important element of reasoning for students in the early grades was pattern-recognition. In the rail track activity, children were asked to construct patterns having three levels of difficulty.

Findings showed that children not only recognized and described patterns given to children but also constructed patterns by looking at models continuously. While children's monitoring and control of their cognition and each other could be considered as the most remarkable metacognitive regulatory abilities, their metacognitive knowledge of tasks was another significant point to be considered.

According to results, children's mentioning difficulty levels of patterns and their planning how to construct the patterns could be considered as their recognizing and defining patterns. Almost all children, for example, commented on first pattern as "it is easy" and they say "we'll make a circle." Children defined especially the third pattern as "hard" or "very hard" and it lasted the longest time. Results also showed that children suggested way of solutions after they recognized patterns: "Firstly, let's construct its head" or "we'll start from this side" by showing which side from model to his friend.

Findings of this study revealed that monitoring and control of their pattern construction continued throughout the rail track activity. Children not only monitored and controlled their own construction but also their friends'. A child who found her own mistake and said "this side is not enough long" and a child's comment on their friends' construction such as "you're doing wrong" were common examples from video episodes of children in the rail track activity. After children monitored their construction, they controlled it according to their monitoring. While "let's add this piece" was the suggestion from the child who thinks that it is not long enough; "we

need to remove this, we should add a straight piece" was a comment from a child who was aware of his friends' mistake.

Results showed that since children were allowed to decide whether pattern construction was completed on their own, they always had chances to evaluate their construction. While evaluating, children's commented on absences of their construction were evidence showing their recognition of patterns: "we're done but this side should have been swollen", "this side have still remained straight." Children's awareness of mistakes and incompletions on patterns indicated their good performance on recognition of patterns as well as their high metacognitive and self-regulatory abilities.

Context that Foster Metacognition and Self-Regulation of Young Children

The data showed that four basic context features to foster metacognitive and self-regulatory abilities of young children suggested in the literature make them exhibit these abilities (Whitebread & Coltman, 2010). In the following part, examples of episodes providing evidences of the relation between the four context features and these abilities of young children were displayed in detail.

Context offering emotional warmth and sensitivity

In all of the activities children involved, since establishment of unthreatened emotional warmth environment was suggested as a key component of context to foster young children's metacognitive and self-regulatory abilities, the researcher did not evaluate the children in a threatened manner. In fact, the researcher did not involve in any of activities except classification activity and encouraged them to evaluate their work on their own.

Findings showed that even in the classification activity, since the researcher offered a relaxed context and evaluated in an emotionally warm manner, children had

opportunities to articulate their opinion and generally did not hesitate to reply. While involving in the classification activity, one of the children suggested an opinion which actually was also correct way of solution. However, others suggested a similar classification, and they completed the activity in a manner that the other two children suggested. After children finished classification into three groups, the researcher congratulated children's work: "I congratulate all of you." The child who suggested his opinion in the first hand: "That means what I said already is true." The researcher's emotional warmth approach to all of children encouraged the child and made him exhibit a clear verbalization of reviewing the activity performance.

According to results, while children tended to hesitate answer the researcher's questions during classification activity, he tried to make them more comfortable; subsequently, they displayed their metacognitive and self-regulatory abilities. In one of the examples, a girl who tried to lead classification into four groups had difficulties to find forth group. In addition, one of the others tried to tell her answers. In that case, the researcher allowed the second girl to tell her opinion. Then, the researcher turned again to the first girl and asked: "Now, we listen to Ayşe again." She again replied with her same answers. The researcher paraphrased her opinion: "you mean that here are sea animals…" She interrupted: "No, you are wrong; I do not say animals are here…" Since there was a relaxed context encouraging children, she comfortably interrupted the researcher and showed his mistake.

Feelings of control over their activities

Feeling of control over their activity was another context feature that was suggested in the literature to foster metacognitive and self-regulatory abilities of young children. Results showed that providing them with opportunities to be autonomous and to have their own responsibility made them exhibit these abilities.

Findings of this study indicated that since children in the examples felt control over their activity, they set up their own rules for the activity and played according to their own rules. In the classification activity, for example, while children classified vehicles and animals according to their features, they realized that they had confusion about features of an animal; for example, they could not decide what an animal really was. Their final decision about this issue was that there should be a group of "undecided animals". After a while, they confused where an animal lived more. One of them said "it lives in water more; it should go to water group." One of them replied "it should go to "undecided animals" group since we cannot decide."

According to results of present study, children who had much more feeling of control and therefore leaded completion of shapes tried to show their way of solution to their friends. In the rail track activity, children showed their way of proceedings to their friends in lots of occasions. In one of examples, two children thought, they had completed the construction of given shape. The third child, on the other hand, had another plan which was more similar to given shape. Although two children had used all of pieces while constructing their shape, the third one convinced them that his construction would be better: "Give me pieces and I'll show you" and he took enough pieces from his friend construction: "I need 4 more pieces". Therefore, he completed his construction. The child monitored given shape and his friends' construction and was aware of a need for new construction. At the end of his construction, he asked not the researcher but his friend whether his construction was appropriate or not. They stated that it was done; therefore, they started next construction.

Context which present children with cognitive challenges

Findings showed that children found out their own way of solution and had control over challenge through demonstrating metacognition and self-regulation in activities offering cognitive challenge for them.

According to results, since all activities were problem solving based activities, children confronted challenges during all activities. Therefore, almost all activities were started with planning indicating phrases by children because solutions of challenge were not straightforward in any of the activities. A few such examples were: “we could classify animals as wild or not” or “the wall should be longer than the giraffe”. While carrying out their plan, children monitored and controlled their own and friends’ progress continuously. For example, after a child explained why hippopotamus and rhino could be a new group, her friend replied: “I see, since it lives both in water and land.” Then, the child mentioned completion of classification into four: “Since these are a new group, we have 1, 2, 3, 4 groups at all.”

Results of this study showed that particularly the rail track activity having three levels of difficulty has offered cognitive challenge to children gradually which made children exhibit their metacognitive and self-regulatory abilities. While children completed first shape in one or two minutes, they needed more time and exhibited more metacognitive regulation during medium and difficult shapes given to them during the rail track activity. They displayed not only metacognitive regulation, but also metacognitive knowledge of persons and tasks: “we can’t do it”, “it is easy” or “it is very difficult.”

Context which allow children to articulate their thinking

Findings showed that encouraging children to reflect upon their own performance rather than giving answers made children display metacognitive and self-regulatory

abilities.

At the beginning of activities, children were informed that they would decide whether activities were completed or not. In cases where children requested evaluation from the researcher on their progress, the researcher replied with such response: “you could decide yourself.” In these situations, children were expected to reflect upon their progress and if necessary, to come up with a new strategy to complete their activity. In one example, after the researcher asked children to decide on their own, monitoring and control of progress occurred in such manner. A child said: “I think, it isn’t done, this is wrong” and removed the wrong pieces. One of his friends objected his removing by showing model shape: “No, look here is curled, this is wrong.” Their construction was continued under children’s reflection rather than direction by the researcher.

CHAPTER 6

DISCUSSION

This research study investigated metacognitive and self-regulatory abilities of young children as they took part in mathematics activities. Activities that children were engaged in were embedded mathematical skills such as problem solving, measurement, classification and pattern construction. In particular, the study analyzed the interaction between children's metacognitive and self-regulatory abilities and their mathematical skills. Observation of 27 children at the age of 4-6 during mathematics activities and assessment of teachers of their general metacognitive and self-regulatory abilities constituted the data of the study. The evidence from the data presented in this study showed that children at the age of 4-6 demonstrated various components of metacognition during activities. Investigation of this phenomenon has not only educational implications, but also is crucial for understanding metacognitive and self-regulatory abilities of young children.

In the first part of the study, whole video episodes of children during three activities were coded according to categories suggested in C.Ind.Le Coding Scheme (Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al., 2009) by the researcher. All children exhibited a variety of metacognitive and self-regulatory abilities in each episode from the beginning of the activities to end. The findings showed that while children displayed evidence of metacognitive knowledge occasionally; they exhibited evidence of metacognitive regulation continuously throughout the activities. This situation was discussed in a previous research study (Robson, 2010). The study revealed that although metacognitive regulatory abilities are observed more frequently than metacognitive knowledge during activities; metacognitive knowledge is more frequent than metacognitive regulation in

reflective dialogue sessions. Therefore, the present study is consistent with the previous findings when abilities of young children are examined during activities.

In the literature, children's exhibiting of a rich extent of metacognitive and self-regulatory abilities has been linked to two different factors: the mathematical skill requirements of the activities (Carr & Jessup, 1995; Desoete, Roeyers, Buysse, 2001) and the use of pedagogy to foster these abilities while preparing and applying activities (Whitebread and Coltman, 2010). Therefore, what sort of interactions there are between these abilities of young children and their mathematical skills as well as context suggested in the literature to foster these abilities of young children are examined in the second part of the study. The findings represented that what sort educational implications should be taken into consideration in the early childhood education.

The relationship between these abilities of young children and their mathematical skills are investigated in detail to provide themes through use of coding scheme as a lens to understand what type of interaction between them is going on in mathematics activities. Examination of the interaction between metacognitive and self-regulatory abilities of young children and four mathematical skills reveal that they have strong links with each other during activities (Whitebread & Coltman, 2010). Therefore, in learning contexts, both of them should be supported along the same line in order to assure improvements of children on each area.

The findings are in parallel to previous studies which have indicated that good problem solvers exhibit more metacognitive abilities (Carr & Jessup, 1995; Desoete, Roeyers, Buysse, 2001). Problem solving based activities that children are expected to involve offers great opportunities to children because of the close relation between metacognitive and self-regulatory abilities and problem solving

steps. While understanding the problem which is the first step of problem solving, requires metacognitive knowledge of tasks, carrying out plans in problem solving provide opportunities to monitor and control progress on their plan. Children apply the last part of problem solving through looking back and reflecting upon their work and also mentioning its absences.

The findings of the present study justifies the claims of Carr, Alexander and Bennett (1994) that mention that even in young children, correct mathematical knowledge and skills might make them exhibit metacognition and self-regulation positively; which in return provides mathematical development. According to findings, children, who have a plan suggesting measurement at the beginning of the house for giraffe activity, monitor and control the length of the wall they build during the activity. Planning at the beginning of activities requiring pattern construction and classification also results in monitoring and control of progress. Children possessing mathematical skills of measurement, classification and pattern construction reflect upon their activities at ends of activities.

Investigation of interaction between metacognitive and self-regulatory abilities of young children and context designed to foster these abilities of young children point out how these abilities and mathematical skills of young children could be supported in an appropriate manner together. Since use of four principles supported in the literature (Perry, Vandekamp, Mercer, Nordby, 2002; Whitebread & Coltman, 2010) for mathematics activities provides opportunities to foster these abilities of children; they, in turn, result in development of mathematical skills of young children.

Four principled suggested in the literature (Whitebread & Coltman, 2010) were used while preparing and applying activities. While preparing the activities,

their possessing of an optimal level of cognitive challenge and their offering feelings of control over the activities were the main concerns in terms of pedagogy to foster metacognitive and self-regulatory abilities of young children. Establishment of the context offering emotional warmth and sensitivity to children and allowing children to articulate their thinking are other principles that are used during activities to foster these abilities. Present findings showing interaction between metacognitive and self-regulatory abilities of young children and these four principles are considered to be a validation for previous studies to foster these abilities of young children (Perry, 1998; Perry, Vandekamp, Mercer, Nordby, 2002) and accordingly an opportunity to create an appropriate environment to develop their mathematical skills.

The results of this study point out that the establishment of the context offering emotional warmth and sensitivity to children makes children feel relaxed; therefore, they review their activity more comfortably and feel free to verbalize their thinking. Moreover, children's metacognitive knowledge about themselves is encouraged because of unthreatened context during activities.

Studies in the literature have suggested that offering feeling of control during activities is an important factor to foster metacognitive and self-regulatory abilities of young children (Perry, Vandekamp, Mercer, Nordby, 2002). Findings of this study show that children tend to suggest ways of proceedings since they feel autonomy over their activities. Subsequently, they monitor and control progress during activities according to their plans.

An optimal level of cognitive challenge during activities demonstrates whether children have metacognitive knowledge of tasks (Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al., 2009). Findings related to cognitive challenge validate previous studies (Whitebread & Coltman, 2010) that it makes

children to think about possible ways of proceeding to continue their activities since activities do not have straightforward solutions. Therefore, children make mistakes since activities are not straightforward; they have to monitor their progress. As a result of their previous monitoring, children suggest and apply new strategies to fix their mistakes.

The context offering opportunities to articulate their thinking was highlighted as another important factor to foster metacognitive and self-regulatory abilities of young children (Whitebread & Coltman, 2010). Results of the present study justify that it encourages children to reflect upon their activities. When they are allowed to articulate their thinking, they continue to work collaboratively on their activities, think about what is going on and decide what would be next steps.

Findings show that the four principles have a strong link with each other. While establishment of emotionally warm contexts provide children with opportunities to feel control over their activities, cognitive challenge embedded activities in the relaxed contexts make children articulate their thinking more comfortably. Therefore, each principle can be more effective when other three principles are also provided.

Current studies indicate that the observation of young children to investigate their metacognitive and self-regulatory abilities should be considered as the most valuable method among the other common methods reported in the literature (Perry, 1998; Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al., 2009). Findings of this study also show that observational method offers several opportunities to investigate these abilities of young children. Most importantly, it helps to observe non-verbal evidence as well as verbal evidence and to identify the importance of social interaction within the group member. As given in the sample

episodes, when children work collaboratively in groups, they have a chance to regulate cognitive performance of self and others. Metacognitive incidents during such interactions can be taken as indicators of possible shifts between regulation of cognition at an individual and collective level. Non-verbal behaviors provide powerful means to support children's knowledge and regulation for researchers to identify their verbalization. It provides further opportunities through reflective dialogues for children to articulate on their thinking so that the researcher can have a deeper understanding of children's behaviors. Although there are limitations of observational methods; in the present study, a variety of techniques such as inter-rater consistency within researchers' coding and teachers' scoring, triangulation between coding of the researcher and reflective dialogues with teachers and children 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 a preliminary knowledge base for preschool educators and mathematics education.

Educational Implications

Results of this study indicated that children exhibited a variety of metacognitive and self-regulatory abilities in mathematics activities they dealt with. The existence of these abilities cannot be underestimated as current literature suggested (Perry, 1998; Whitebread, 1999).

The findings of this study showed that observational method is an effective method to obtain metacognitive and self-regulatory abilities of young children (Peryy, 1998; Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al., 2009). Observations of teachers on metacognitive and self-regulatory abilities of young children in their settings can be the first step to understand and support these abilities of young children.

Four principles suggested by the present study and in the literature can be considered as the basic learning context features (Whitebread & Coltman, 2010). These principles can be provided by teachers regardless of what skill of children they aim to support in early childhood settings. These principles should be offered together since they are closely related to each other.

As the findings of this study showed, there were interactions between metacognitive and self-regulatory abilities of young children and their mathematical skills. Particularly, problem solving steps were closely related to metacognitive regulatory abilities (Polya, 1957). Therefore, children should be offered opportunities to be involved in problem solving based mathematical activities to support their metacognitive and self-regulatory abilities. Subsequently, these abilities can result in mathematical development for young children (Carr, Alexander & Bennett, 1994).

Limitations of the Study

In this study, a small group of children participated in the activities. Quantitative part of the study necessitates a larger number of samples to conduct parametric tests. Besides, the small sample size of this study imposes a limitation to the generalizability of findings. On the other hand, the number of children can be considered as an appropriate sample size since this study has mainly used qualitative methodology focusing in detail what sort of metacognitive and self-regulatory abilities young children exhibit.

Reflective dialogues conducted with the children and their teachers in the previous studies (Robson, 2010; Whitebread & Coltman, 2010) have tended to display evidences of children's metacognitive and self-regulatory abilities. However, in this study, reflective dialogues were conducted to examine reliability and validity of study. Therefore, reflective dialogues were conducted on only three episodes with

three children who engage these episodes and one of their teachers.

Although the nature of qualitative studies requires identifying themes according to codes during data analysis, themes of this study were already determined. The children's metacognitive and self-regulatory abilities were coded according to predetermined codes and themes developed by Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al. (2009). Although the scheme of Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al. (2009) consists of a variety abilities mentioned in the literature, findings of the study were restricted to these themes: metacognitive knowledge of persons, tasks and strategies; and metacognitive regulation (planning, monitoring, control and evaluation).

Activities in this study were redesigned mainly for problem solving. Moreover, they consist of three mathematical skills suggested in valid curriculum of Ministry of Education (2012). The findings represent relationship between children's mathematical skills and their metacognitive and self-regulatory abilities. The mathematical skills in this study were mainly limited to problem solving, measurement, classification and pattern construction.

Suggestions for Further Research

Due to the generalizability concerns mentioned in the previous section, the study may be replicated with a larger group of children at the age of 4-6 to be able to obtain more general idea about metacognitive and self-regulatory abilities at this age group.

Studies investigating metacognitive and self-regulatory abilities of young children have been conducted in various studies. Very recently, intervention studies to foster these abilities of young children have been conducted with children and teachers. Therefore, 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.

The focus in this study was metacognitive components of self-regulation; therefore, two parts in the scheme of Whitebread, Coltman, Pino Pasternak, Sangster, Grau, Bingham, et al. (2009) were used while coding abilities of young children and the third part addressing regulation of motivation and emotions was excluded. In the future studies, scope can be widened to investigate motivational and emotional regulation as well as metacognitive knowledge and regulation of young children.

This study indicates that problem solving, measurement, classification and pattern construction as mathematical skills have relationships with metacognitive and self-regulatory abilities on young children. Future studies can investigate whether metacognitive and self-regulatory skills have relationship with other mathematical skills and other fields such as science and reading.

This study points out that metacognitive and self-regulatory abilities of young children have links with contexts suggested in the literature to foster these abilities and their mathematical skills. Further studies examining casual relations between these variables are needed.

APPENDICES

Appendix A: C.Ind.Le. Coding Scheme: Verbal and Non-verbal Indicators of Metacognition and Self-regulation in 3-5-Year-Olds

C.Ind.Le Coding Scheme: Verbal and Nonverbal Indicators of Metacognition and Self-Regulation in 3- to 5-Year-Olds

Category name	Description of behavior	Examples
Metacognitive knowledge		
Knowledge of persons		
A verbalization demonstrating the explicit expression of one's knowledge in relation to cognition or people as cognitive processors. It might include knowledge about cognition in relation to: - *Self*: Refers to own capabilities, strengths and weaknesses, or academic/task preferences; comparative judgments about own abilities - *Others*: Refers to others' processes of thinking or feeling toward cognitive tasks - *Universals*: Refers to universals of people's cognition	Refers to his/her own strengths or difficulties in learning and academic working skills Refers to others' strengths or difficulties in learning and academic working skills Talks about general ideas about learning	*I can write my name* *I can count backwards* *I don't know how to sing the song*
Knowledge of tasks		
A verbalization demonstrating the explicit expression of one's own long-term memory knowledge in relation to elements of the task.	Compares across tasks identifying similarities and differences Makes a judgment about the level of difficulty of cognitive tasks or rates the tasks on the basis of pre-established criteria or previous knowledge	*They need to put their boots on. And when they put their boots on, they dig a hole*
Knowledge of strategies		
A verbalization demonstrating the explicit expression of one's own knowledge in relation to strategies used or performing a cognitive task, where a strategy is a cognitive or behavioral activity that is employed so as to enhance performance or achieve a goal.	Defines, explains or teaches others how she/he has done or learned something Explains procedures involved in a particular task Evaluates the effectiveness of one or more strategies in relation to the context or the cognitive task.	*We don't need to use the sticky tape, we can use the glue* *You have to point it up this end so that it is going to grow*
Metacognitive regulation		
Planning		
Any verbalization or behaviour related to the selection of procedures necessary for performing the task, individually or with others	Sets or clarifies task demands and expectations Allocates individual roles and negotiates responsibilities Sets goals and targets Decides on ways of proceeding with the task	*I'm going to make a big circle* *I know... me and Harry could be the knights and you could be the peasant* Child compares two objects before deciding which to use on task

Category name	Description of behavior	Examples
Monitoring		
Any verbalization or behaviour related to the ongoing on-task assessment of the quality of task performance (of self or others) and the degree to which performance is progressing towards a desired goal	Self- commentates Reviews progress on task (keeping track of procedures currently being undertaken and those that have been done so far) Rates effort on-task or rates actual performance Rates or makes comments on currently memory retrieval Checks behaviors or performance, including detection of errors Self-corrects Checks and/or corrects performance of peer	*I think we've got one left* *This bit doesn't fit anywhere* *Hang on, we've got it a bit wrong here* Child stops mid-way through an action (placing puzzle piece), pauses and re-directs action to place it somewhere else
Control		
Any verbalization or behaviour related to a change in the way a task had been conducted (by self or others), as a result of cognitive monitoring	Changes strategies as a result of previous monitoring Suggests and uses strategies in order to solve the task more effectively Applies a previously learnt strategy to a new situation Repeats a strategy in order to check the accuracy of the outcome Seeks help Uses nonverbal gesture as a strategy to support own cognitive activity Copies from or imitates a model Helps or guides another child using gesture	*Let's have a practice* *Can you help me do it?* Child points to spots on a die as he counts Child looks at a physical model (example: word on whiteboard) repeatedly while completing a task Child points at computer screen or interactive whiteboard to indicate where another child should click the mouse
Evaluation		
Any verbalization or behaviour related to reviewing task performance and evaluating the quality of performance (by self or others).	Reviews own learning or explains the task Evaluates the strategies used Rates the quality of performance Observes or comments on task progress Tests the outcome or effectiveness of a strategy in achieving a goal	*He's done really well* *We learnt how to cut, and how to stick things together* Child rotates scissors in hands while opening and closing them before initiating cutting activity
Emotional and motivational regulation		
Emotional/motivational monitoring	Express awareness of positive or negative emotional experience of a task Monitors own emotional reactions while being on a task	That wasn't very nice It's a bit sad I don't want to be a peasant
Any verbalization or behaviour related to the assessment of current emotional and motivational experiences regarding the task		
Emotional/ motivational control	Controls attention and resists distraction or returns to task after momentary distraction Self-encourages or encourages others Persists in the face of difficulty or remains in task without help	Mine is going to be a lovely one Child looks towards activity of others in the classroom, then re-focuses on task at hand and resumes activity
Any verbalization or behaviour related to the regulation of one's emotional and motivational experiences while on task		

Appendix B: Checklist of Independent Learning Development (CHILD) 3-5

Checklist of Independent Learning Development (CHILD) 3–5

Name of child: _____ Teacher: _____

Date: _____ School/setting: _____

	Always	Usually	Sometimes	Never	Comment
Emotional					
Can speak about own and others behaviour and consequences					
Tackles new tasks confidently					
Can control attention and resist distraction					
Monitors progress and seeks help appropriately					
Persists in the face of difficulties					
ProSocial					
Negotiates when and how to carry out tasks					
Can resolve social problems with peers					
Shares and takes turns independently					
Engages in independent cooperative activities with peers					
Is aware of feelings of others and helps and comforts					
Cognitive					
Is aware of own strengths and weaknesses					
Can speak about how they have done something or what they have learnt					
Can speak about future planned activities					
Can make reasoned choices and decisions					
Asks questions and suggests answers					
Uses previously taught strategies					
Adopts previously heard language for own purposes					
Motivational					
Finds own resources without adult help					
Develops own ways of carrying out tasks					
Initiates activities					
Plans own tasks, targets and goals					
Enjoys solving problems					

Other comments:

Appendix C: Monthly program of the institution

KASIM AYI EĞİTİM PROGRAMI

TARİH: 1 KASIM – 2 ARALIK

KONU: VÜCUDUMUZ - SAĞLIĞIMIZ – BESLENME

KONUNUN TEMEL AMAÇLARI

- Vücudun bölümlerini tanıyabilme
- Vücut bölümlerinin işlevlerini ayırt edebilme
- Duyu organlarını ve görevlerini ayırt edebilme
- İç organların isimlerini söyleyebilme
- İç organların işlevlerini söyleyebilme
- Sağlığın ne olduğunu anlayabilme
- Sağlıklı bir insan olmak için neler yapılması gerektiğini söyleyebilme
- Sağlığımızı bozan nedenleri kavrayabilme
- Temizliğin sağlığımız için önemini kavrayabilme
- Vücut temizliğinin önemini kavrayabilme
- Ev temizliğinin önemini kavrayabilme
- Çevre temizliğinin önemini kavrayabilme
- Beslenmenin ne olduğunu söyleyebilme
- Beslenmenin önemini kavrayabilme
- Besin gruplarını tanıyabilme **(**proteinler, karbonhidratlar, vitaminler)
- Beslenmedeki sağlık kurallarının önemini kavrayabilme
- Yemek yerken uyulması gereken kurallar hakkında bilgi sahibi olma

❖ ***Kasım ayı içerisinde çocuklarla birlikte konuşacağımız haftanın konuları ise;***

- Fransa (31 Ekim- 4 Kasım)
- 10 Kasım (10-11 Kasım)
- Atletizm (14-18 Kasım)
- Pasteur (21-25 Kasım)
- Japonya (28 Kasım-2 Aralık)

KAVRAMLAR

Zıt Kavramlar:
Az/Çok, İnce/Kalın, Sıcak/Soğuk (Küçük Grup)
Çift/Tek, Taze/Bayat, Tatlı/Ekşi/Tuzlu (Büyük Grup)

Sayı Kavramı:
3 ve 4 sayılarını tanıyabilme, 1' den 10 ' a kadar ritmik sayma (Küçük Grup)
20 – 30 arası sayıları tanıyabilme, 10'ar 10'ar ritmik sayma (Büyük Grup)

Renk Kavramı:
Yeşil ve sarı renklerini tanıyabilme (Küçük Grup)

Şekil Kavramı:
Üçgen şeklini tanıyabilme (Küçük Grup)
Elips ve Eşkenar dörtgen şeklini tanıyabilme (Büyük Grup)

DİL GELİŞİMİNE YÖNELİK ÇALIŞMALAR

Şarkılar;
Vücudumuz, Bir Çocuk, Beş küçük Ördek, Atatürk Ölmedi (Küçük Grup)
İzindeyiz, Erken Kalkarım, Vücudumuz, Ellerim Tombik Tombik, Sebzeler (Büyük Grup)

Şiirler;
Beş Duyu, Besinler (Küçük Grup)
Sağlık, Başımda Neler Var (Büyük Grup)

Parmak Oyunu;
Bay Mikrop, Büyüyorum, Organlar, Sağlıklı Çocuk, Serçenin Kahvaltısı (Büyük Grup)
Bay Mikrop, Organlar, Saçları Lüleli, Beş Kırmızı Elma (Küçük Grup)

Tekerleme;
Üşüdüm, Pazara Gittim (Büyük Grup)
Armut, Hastayım Hasta, Soğan Sarımsak (Küçük Grup)

DENEY / GÖZLEM

- Vücudumuz maketinin incelenmesi
- Konu resimlerinin incelenmesi
- El yıkama deneyi
- Patates deneyi

MUTFAK FAALİYETLERİ

- Meyve salatası (Küçük/ Büyük grup)

Appendix D: Coding Sample from Episodes

Siz birlikte lego oynuyorsunuz değil mi, şimdi lego gibi bir oyun oynayacağız.

Elimdeki şekilleri size göstereceğim ve siz yapmaya çalışacaksınız. Size bir uyarı

önünüzde ihtiyacınız olandan daha fazla ray var

Birinci şekil bu

İdil: nasıl yapacağız

Yusuf: öğretmenim idil önüne çekiyor

Bunları da kullanabilirsiniz

İdil: ben daire yapmayı bilmiyorum ki

Yusuf: daire mi, ben biliyorum

Emre: ben yaparım

İdil: ama daire şöyle takılması gerek

Emre: yaparım ben bir dakikada

Ama birlikte yapmanız lazım çünkü yetmeyebilir raylar

Yusuf: normal yaptığımız gibi daire yapacağız, idil bilmiyormuş daire yapmayı

Emre düz bir parça takacaktı: bu olmaz, olmaz çıkarın bunu

İdil: süre var mı

Süre yok, istediğiniz kadar süreniz var

Yusuf: idil hep sen yapıyorsun ama

İdil: oldu

Oldu mu, sizce doğru mu peki

Tebrik ediyorum

Şimdi ikinci şeklimiz geliyor yapabilecek misiniz

İdil: evet

Comment [h1]: Refers to his/her own strengths or difficulties in learning and academic working skills

Comment [h2]: Refers to his/her own strengths or difficulties in learning and academic working skills

Comment [h3]: Refers to his/her own strengths or difficulties in learning and academic working skills

Comment [h4]: Explains procedures involved in a particular task

Comment [h5]: Refers to his/her own strengths or difficulties in learning and academic working skills

Comment [h6]: Compares across tasks identifying similarities and differences

Comment [h7]: Reviews progress on task

Comment [h8]: Observes or comments on task progress

Yusuf: aa çok zor

Zor değil

İdil: çok kolay

Yusuf: ben anladım nasıl yapacağımı

İdil: ben anladım

Emre: ben yapıyorum 3 parçalık—3 parçayı birleştirdi şu an—yaparken örnek şekli inceliyor

Yusuf örnek şekli inceliyor yaparken, eli bir tane düz parçaya gider gibi oldu az önce vazgeçti almaktan—bu şekilde düz parça yok

İdil: Yusuf sen yaptın mı

Emre: ben yapıyorum bile, ben yapıyorum—Yusuf'unkini inceledi bu arada

İdil: Yusuf önde gidiyor, ben de Yusuf'a yardım ediyorum—bu arada örnek şekli ve Yusuf'un yaptığını inceliyor

Emre: önemli olan yapabilmek

Yusuf: o şekil değil ya derken idil taktığı yanlış parçayı çıkarıyor

İdil: emre o değil diyor ermenin yerleştirmeye çalıştığı doğru parça için

Emre: o

Bu arada Yusuf da bitirmek üzere şeklini, örnek şekle bakarak, idil yusufun yaptığı şekille oynuyor

Emre: bitirdim bitirdim diyerek ellerini çırpıyor ve yerinde zıplıyor

Doğru mu sizce bakın bakalım

İdil &Yusuf: evet (derken örnek şekle bakıyor)

Yusuf tekrar kendi şekline dönüyor eline düz bir parça geçti baktı ve bıraktı onu, yerleştirmesi gerekli olan bir tane eğik parça aldı, yönü ters yerleştirdi: ayy deyip çıkardı

Comment [h9]: Makes a judgment about the level of difficulty of cognitive tasks or rates the tasks on the basis of preestablished criteria or previous knowledge

Comment [h10]: Makes a judgment about the level of difficulty of cognitive tasks or rates the tasks on the basis of preestablished criteria or previous knowledge

Comment [h11]: Self- commentates

Comment [h12]: Self- commentates

Comment [h13]: Self- commentates

Comment [h14]: Changes strategies as a result of previous monitoring

Comment [h15]: Self- commentates

Comment [h16]: Reviews progress on task (keeping track of procedures currently being undertaken and those that have been done so far)

Comment [h17]: Checks behaviors or performance, including detection of errors

Comment [h18]: Changes strategies as a result of previous monitoring

Comment [h19]: Checks behaviors or performance, including detection of errors

Comment [h20]: Observes or comments on task progress

Comment [h21]: Checks behaviors or performance, including detection of errors / Changes strategies as a result of previous monitoring

Comment [h22]: Checks behaviors or performance, including detection of errors / Changes strategies as a result of previous monitoring

Hangisi daha doğru, ikisi de mi doğru yoksa

Yusuf idil: ikisi de

Yusuf az önceki parçayı doğru tarafa yerleştiremedi başak eğik parça da yok etrafta:

öğretmenim parça yetmiyor, Emre'ninki daha çok

Bu parçayı kullanamaz mısın mesela

Yusuf: olmuyor ki derken parçayı eline aldı ve yerleştirdi. Mutlu bir şekilde: oldu

Emre: olmadı bak içeri giremedi derken örnek şeklin daha çok içe kıvrık olduğunu gösterdi

Yusuf: bu düz, bu yamuk birazcık

Yusuf: hmm, buldum bence, aa anladım deyip yanlışlık olan yeri gözden geçirmeye başlıyor

İdil: o oraya değil bence

Bu arada emre yusufun yaptığına bakıyor ve o da kendi şeklini değiştirmeye koyuluyor

İdil: ben de buldum yerini değiştireceğiz

İdil: bence oluyor, öğretmenim

Emre: oluyor

İdil: emre biraz yanlış yaptın sanırım, daire gibi oldu bence

Yusuf: ağaç gibi oldu

Emre: aynısı ama o

İdil: hayır, bak burada şey var burada şey var (şeklin uç kısımlarından bahsediyor), burada yok

Emre: ama bu niye böyle(kıvrık) bu niye böyle (düz) derken örnek şeklin üzerinden gösterdi

Comment [h23]: Reviews progress on task (keeping track of procedures currently being undertaken and those that have been done so far)

Comment [h24]: Reviews progress on task (keeping track of procedures currently being undertaken and those that have been done so far)

Comment [h25]: Checks behaviors or performance, including detection of errors

Comment [h26]: Reviews progress on task (keeping track of procedures currently being undertaken and those that have been done so far)

Comment [h27]: Changes or suggest strategies as a result of previous monitoring

Comment [h28]: Observes or comments on task progress

Comment [h29]: Reviews progress on task (keeping track of procedures currently being undertaken and those that have been done so far)

Comment [h30]: Rates or makes comments on currently memory retrieval

Comment [h31]: Reviews progress on task (keeping track of procedures currently being undertaken and those that have been done so far)

Comment [h32]: Reviews progress on task (keeping track of procedures currently being undertaken and those that have been done so far)

Appendix E: Average occurrence of children's metacognitive and self-regulatory abilities in 10 minutes

House for the giraffe activity										
	Group1		Group2		Group3		Group4		Group5	
	M. K.	M. R.	M. K.	M. R.	M. K.	M. R.	M. K.	M. R.	M. K.	M. R.
Child1	2.5	10	1.6	5.8	1.4	4.4	2	5	0	1
Child2	1.6	5.8	1.3	3.3	1.4	4.4	2	1	2	7
Child3	2.5	3.3	0.8	8.3	2.3	7.7	0	5	2	8
Classification activity										
	Group1		Group2		Group3		Group4		Group5	
	M. K.	M. R.	M. K.	M. R.	M. K.	M. R.	M. K.	M. R.	M. K.	M. R.
Child1	1.1	6.4	0	2.5	1.6	2.5	0.8	5.8	1	0.5
Child2	1.1	7.6	2.5	2.5	0.8	0.8	2.5	0	1	7.5
Child3	0.5	4.1	1.25	5	1.6	6.6	2.5	1.6	1.5	3
Rail Track activity										
	Group1		Group2		Group3		Group4		Group5	
	M. K.	M. R.	M. K.	M. R.	M. K.	M. R.	M. K.	M. R.	M. K.	M. R.
Child1	2.3	0.7	3	12.6	1.2	9.3	1.8	2.7	4.8	17.2
Child2	2.3	12.3	1.2	13.4	1.2	13.4	4.5	18.1	2	1.2
Child3	2.3	12.3	1.4	8.8	0.3	3.4	0.9	2.7	2	18.8
	Group6		Group7		Group8		Group9			
	M. K.	M. R.	M. K.	M. R.	M. K.	M. R.	M. K.	M. R.		
Child1	2.6	13.3	5	24.3	2.4	16.1	0	1		
Child2	1.2	8.6	3	16.4	1.2	19	2	11		
Child3	2	8.6	1.4	3.4	2.4	6.6	3	16		

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