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The Effect of Cooperative Learning Method Enhanced with Metacognitive Strategies on Students' Metacognitive Skills in Math Course *

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Abstract

The purpose of this research was to investigate the effect of cooperative learning method enhanced with metacognitive strategies on metacognitive skills of 6th grade students in mathematics education. The research was designed as a mixed method in which qualitative and quantitative methods were used together. The quantitative research was planned as a pre-test post-test control group quasiexperimental design. Document review method, one of the qualitative research techniques, was used to obtain qualitative data. The research participants were composed of 101 6th grade students. Cooperative learning method enhanced by metacognitive strategies was used in the first experimental group and only cooperative learning method with no support of metacognitive strategies was used in the second experimental group. There was no intervention for the control group. Data were collected using the "Junior Metacognitive Awareness Inventory (Jr. MAI)" developed by Sperling, Howard, Miller, and Murphy (2002) and through the written opinions of the students about implementation process. The quantitative data was analyzed by performing the dependent group t-test and analysis of variance. For the qualitative section, data was analyzed using descriptive analysis. According to the results of the data analysis, at the end of the interventions, it was seen that the levels of metacognitive skills of the first experimental group were significantly higher than of both the second experimantal group and the control group. Also, the levels of metacognitive skills of the second experimental group were higher than those of the control group. According to the results based on the analysis of students' views, it was seen that, the students in the first experimental group expressed their thoughts on the development of their metacognitive skills. In this context, it was observed that, the students' questioning the problems and their solution processes, analyzing their mistakes and their planning skills have been improved. Also, the second experimental group students stated that they did reciprocal questioning on paired worksheets and their group work skills improved.

Keywords

Cooperative learning method
Metacognition
Metacognitive strategies
Mathematics education
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Introduction

Constructivist learning approach has been largely emphasized and studied by pedagogues in the 20th century. This learning approach considers the learning process from a cognitive and social constructivist perspective (Tobias & Duffy, 2009). Cooperative learning approach is considered as one of the important applications of social constructivist learning approach (Terhart, 2003).

Cooperative learning is defined as an approach based on collaborative work among students in small groups in order to reach a common goal, while facilitating each other's' learning process (Açıkgöz, 1992; Johnson & Johnson, 1999; Slavin, 1990). Cooperative learning is a student-centered approach that students can learn actively. On the other hand, teachers have a role as facilitators rather than being instructors. The students have to develop new point of views, do planning and offer solution alternatives in order to reach their common goals. In this way, the students can develop themselves both socially and individually (Slavin, 1990).

O'Neil, Chuang, and Chung (2004) argued that cooperative learning and problem solving should be incorporated in teaching programs and learning methods in order to educate the students taking into account today's requirements. Accordingly, new methods that encourage active class participation, prevent memorizing, and contribute to students' cognitive and social skills are needed in the mathematics education instead of adopting traditional methods. As Davidson (1990) emphasized, cooperative learning is effective for communication in mathematics education, problem solving, logical thinking, and creating mathematical links.

Literature review concerning cooperative learning method and mathematics education suggests that cooperative learning is more effective in terms of increasing performance of students in mathematics compared to the traditional methods both in Turkey and other countries (Tarım & Akdeniz, 2008; Zakaria, Chin, & Daud, 2010). Moreover, studies showed that cooperative learning increased class participation and interaction between students (Andersan, 2009), and also developed positive attitude towards mathematics in students (Andersan, 2009; Zakaria et al., 2010).

However, some of the studies showed that cooperative learning did not provide significant improvement in cognitive, social, and affective skills of students (Ifamuyiwa & Akinsola, 2008; Souvignier & Kronenberger, 2007; Webb & Farivar, 1994). Davidson (1985) argued that although cooperative learning has been considered as an alternative method in mathematics education, there is not a clear difference between the levels of contribution of traditional and cooperative learning methods (as cited in Lucas, 1999). Furthermore, Webb and Farivar (1994) pointed out that students do not benefit from the cooperative learning method.

On one hand, the effects of cooperative learning on several learning outcomes have been discussed (Lucas, 1999); on the other hand, there have been different views on increasing the effectiveness of the cooperative learning method. While some researchers emphasized the importance of individual evaluations (Slavin, 1995), others introduced positive impact of cooperative learning method supported by multiple intelligence theory on student performance (Yıldırım & Tarım, 2008). However, in the recent years, several studies suggested that the effectiveness of the cooperative learning method depends on the special design of groups (Lopata, Miller, & Miller, 2003; Slavin, Hurley, & Chamberlain, 2003) and the other studies emphasized that interaction among the groups should be constructed through metacognitive skills (Jbeili, 2003, 2012; Mevarech & Kramarski, 1997).

Metacognition, which is a complicated and difficult to comprehend term, has been defined in different ways by educators and psychologists since the beginning of the 20th century (Brown, 1987; Wilson, 2001). Flavell (1979) defined metacognition as all conscious cognitive and emotional experiences that accompany intellectual development, on the other hand, Deseote and Özsoy (2009) defined metacognition as awareness about self cognitive processes. At the same time, metacognition is used as a term to cover self-awareness of students in the cognitive processes such as planning the solution of a

mathematical problem, following up, and evaluating (Fortunato, Hecht, Tittle, & Alvarez, 1991; Panaoura & Philippou, 2007).

Although different researchers make different classifications for the components of metacognition, most of the studies focus on two main components corresponding to the metacognitive knowledge and metacognitive regulation (Brown, 1987; Ifenthaler, 2012; Panaoura & Philippou, 2007; Van Der Stel & Veenman, 2008). The first component of metacognition, metacognitive knowledge, is also named as awareness about cognition or knowledge about cognition (Brown, 1987; Mevarech & Amrany, 2008; Özsoy, 2011; Panaoura, Philippou, & Christou, 2003), or metacognitive awareness (Pintrich, 2002). Metacognitive knowledge is the knowledge needed for cognitive processes and used to control them, and it is the awareness about self-thinking (Livingston, 1997; Özsoy, 2011).

Metacognitive regulation is described as the skill of the effective use of metacognitive knowledge (Özsoy, 2011), and using this skill to control and regulate cognitive processes (Schraw & Dennison, 1994). Consequently, the metacognitive activities constituting metacognitive regulation can be considered as metacognitive skills (Desoete, 2001; Desoete, Roeyers, & Buysse, 2001). Related literature focused on three main metacognitive regulation skills as planning, monitoring, and evaluation. According to Desoete (2001), planning skills are the skills that facilitate the thinking process of students related to why, when, and why should they take action. Monitoring corresponds to thinking about the steps of problem solving (Wilburne, 1997) and it is the skill of controlling a person's own problem solving processes (Biryukov, 2004). The last component of metacognitive regulation, evaluation, is about evaluating an individual's own learning processes and outcomes (Brown, 1987), and thinking about both the actions and their effectiveness during the learning processes (Wilburne, 1997). Based on the literature review, this study discussed metacognitive knowledge and regulation in the context of metacognitive skills (Veenman, Hesselink, Sleeuwaegen, Liem, & Van Haaren, 2014).

There has been an increasing interest in the studies aimed at determining the reciprocal relationship between "social interaction and metacognition" almost for the last 20 years (Eizenberg & Zaslavsky, 2003; Jbeili, 2003, 2012; Lin, 2001; Lin & Sullivan, 2008; Mevarech, 1999; O'Neil et al., 2004). According to Lin and Sullivan (2008), metacognition has a positive impact on social interaction on one hand, and some social interaction types help the development of metacognitive skills on the other hand. In this context, collaborative learning method, in which social interaction among students takes place, has been gaining importance (Jbeili, 2003). The students that participate in the groups that utilize cooperative learning method to support metacognitive skills can manage their knowledge related to when, where, and why to use the necessary strategies about their mathematics learning (Pressley & McCormick, 1987; as cited in Jbeili, 2003).

In accordance with the aforementioned information, literature review provided the knowledge about the related research that studied the reciprocal relationship between cooperative learning method facilitating social interaction between students and metacognition. The research in question mainly analyzed the problem solving processes of the students that study in small groups adapting the cooperative learning method (Cooper & Smith, 1993; Eizenberg & Zaslavsky, 2003; Sandi-Urena, Cooper, & Stevens, 2011; Steele, 2005). The research emphasized that successful problem solving necessitates cognitive and metacognitive behavior (Cooper & Smith, 1993), cooperation leads to higher level of control, and it helps the students find better solutions (Eizenberg & Zaslavsky, 2003; Sandi-Urena et al., 2011). Also, research included development and application of a model based on theories concerning cooperative learning and metacognition (Lan, 2007; Mevarech & Amrany, 2008; Mevarech & Kramarski, 1997; Mevarech, Terkieltaub, Vinberger, & Nevet, 2010; Teong, 2003).

Another group of research studied a metacognitive education for students in the cooperative learning environment, and metacognitive skills of the students were developed (Jbeili, 2003; Kramarski & Mevarech, 2003; Mevarech, 1999; Sandi-Urena, 2008; Shamir, Mevarech, & Gida, 2009). Sandi-Urena (2008) argued that reflecting mechanisms included in the interaction between the students, which are used to reflect their communication and thoughts on each other, facilitate the development of

metacognitive skills. Similarly, Shamir et al. (2009) suggested that there is a significant development in the metacognitive awareness levels of students who receive an education based on metacognitive skills.

Aforementioned research that concerned with the reciprocal interaction between the cooperative learning method and metacognition also included the effects of cooperative learning and metacognition on several variables (success, metacognitive awareness, attitude, communication, motivation, etc.). However, application of different strategies for using constructed cooperative learning techniques and developing the metacognitive skills was ruled out. When the research conducted in Turkey was analyzed, any research in mathematics field that used constructed cooperative learning techniques, described how these techniques and metacognitive strategies were used, integrated cooperative learning and metacognitive strategies, and provided detailed materials could not be found. In this context, there is a need for the research of the topic.

Development of students' higher level thinking skills to be used for their problem solving processes in the elementary level mathematics curriculum in Turkey is expected (Ministry of National Education [MEB], 2009). Furthermore, utilizing cooperative learning method in the mathematics curriculum are suggested. The study is expected to provide information about new educational activities aimed at developing the effectiveness of cooperative learning method and higher level thinking skills such as metacognition. The purpose of this research was to investigate the effect of cooperative learning method enhanced with metacognitive strategies on metacognitive skills of 6th grade students in mathematics education. In this context, the answers of the following questions were searched within the scope of research.

1. In mathematic course,

a) Is there a significant difference between metacognitive skill levels of 6th grade students before and after using the cooperative learning method enhanced with metacognitive strategies?

b) Is there a significant difference between metacognitive skill levels of 6th grade students before and after using the only cooperative learning method with no metacognitive strategies?

c) Is there a significant difference between metacognitive skill levels of 6th grade students before and after existing normal process?

2. Is there a significant difference between the metacognitive skills of the 6th grade students using cooperative learning method enhanced with metacognitive strategies, only cooperative learning method with no metacognitive strategies and existing normal process in comparisons between groups at the end of the interventions?

3. What are the main student views regarding the teaching processes in both groups using cooperative learning method enhanced with metacognitive strategies and only cooperative learning method with no metacognitive strategies?

Method

Research Model

The research was designed as a mixed method in which qualitative and quantitative methods were used together. Mixed method is a research design in which qualitative and quantitave methods, techniques and approaches are combined together for analysis purposes in a study (Johnson & Onwuegbuzie, 2004). In the research, sequential explanatory design was used as a mixed method. In sequential explanatory design, the research can start with quantitative methods, and later, qualitative data is collected in order to collect more in depth information going forward (Creswell, 2003). This study firstly applied a scale in order to collect data from a wide range of sample quantitative data. In the second phase, quantitative data was detailed with qualitative data.

The quantitative research was planned as a pre-test post-test control group quasi-experimental design. As the quasi-experimental designs cannot form the research groups articifically, they includes impartial choice of the groups. The researcher impartially choices one of the existing groups as experimental group, the other as control group, and applies the pre-test to the both groups. After using the intervention only for the experimental group, the difference between the experimental and control groups is measured by using post-tests (Creswell, 2005).

There were two experimantal groups and a control group. Cooperative learning method enhanced with metacognitive strategies was used in I. experimental group (cooperative+metacognitive) and only cooperative learning method with no enhance of metacognitive strategies was used in II. experimental group (cooperative). There was no intervention for the control group. The experimentation phase of the study lasted for five weeks (20 class hours). The attainments of mathematics learning area were started and ended at the same time for all groups during the experimentation phase. Jr. MAI was used in order to collect data on metacognitive skill level of students in experimental groups and control group during the experimentation phase.

Document review method, one of the qualitative research techniques, was used to obtain qualitative data (Yıldırım & Şimşek, 2008). Document review method is used for data collection, systematic data analysis, and evaluation (Wiersma, 2000). Written and visual materials and tools can also be integrated in the qualitative analysis in order to increase the validity of qualitative research (Yıldırım & Şimşek, 2008).

Study Group

The research participants were composed of 101 6th grade students attending an elementary school on the European side of Istanbul during the spring term of 2011-2012 academic year. Official permission was received from the governorship ve Management of Natioanl Education, before assigning the students into experimental and control groups. The first criterion in selecting the experimental groups and control group was the grades of the students in mathematics at the end of the first semester of the 2011-2012 academic year. It was found out that the average grade in mathematics was 64.01 out of 100 among six 6th grade classrooms.

One-way Analysis of Variance (ANOVA) was used to compare the groups, since there was homogenity among the classrooms under study (Levene test F=.78, p=.56>.05), assumption of normal distribution was hold, and there were six groups. As a result of the ANOVA, no significant difference was found between the classrooms in terms of the first semester mean scores in mathematics [$F_{(5\text{-}223)}$=.29; p=.92>.05]. This result indicated that first semester mean scores in mathematics were at the similar level among six classes. Accordingly, three of these classes were randomly assigned as the study groups.

Before the interventions, ANOVA has been conducted in order to find whether there has been a significant difference between the groups in terms of Jr. MAI pre-test scores. The result of this study have been presented in Table 1.

Table 1. ANOVA Results for the Jr. MAI Pre-Test Scores

Sources of Variance	Sum of Squares	df	Mean Square	F	p
Between groups	15.95	2	7.98	.04	.96
Within groups	20202.99	98	206.15		
Total	20218.95	100			

When the Table 1 is examined, results of the ANOVA conducted on the Jr. MAI pre-test scores of the study groups showed no statistically significant difference in terms of the metacognitive skills between the three groups [$F_{(2\text{-}98)}$=.04; p=.96>.05]. Additionally, the result of the Levene's Test applied to the Jr. MAI pre-test data of the study groups was F =.20 and p=.82, and thus it can be said that the group variances were homogeneous at the p>.05 significance level, i.e. groups had equal variance. Eventually, it can be said that the metacognitive skills of students in study groups were equal prior to interventions.

At the end of the analysis, from the three study groups, two were randomly assigned as the experimental groups, and one was assigned as the control group. Classes 6-E, 6-F and 6-D were determined to be I. experimental group (cooperative+metacognitive), II. experimental group (cooperative) and the control group, respectively. The characterisics of the students in the study groups were presented in Table 2.

Table 2. The Characterisics of the Students in the Study Groups

Groups	Gender				Total
	Female		Male		
	f	%	f	%	
I.experimental group (cooperative+metacognitive)	11	33.3	22	66.7	33
II. experimental group (cooperative)	12	35.3	22	64.7	34
Control group	11	32.4	23	67.6	34

As can be seen from Table 2, number of male students is more than number of female students both in experimental groups and control group. Also, the number of students in both three groups is almost the same. The analysis of the first semester mean scores in mathematics of students indicate that I. experimental group (cooperative+metacognitive) has an average score 61.89, II. experimental group (cooperative) has an average score of 65.22, while the average is 63.36 in the control group.

Different socio-economic conditions of the students in experimental and control groups could have affected the validity of the results negatively (Creswell, 2003). Therefore, the groups were selected from the students who attend the same public school. Also, some of the determinants of socio-economic conditions of participant students were analyzed using the individual file of students. It was found that the students come from families with a middle socio-economic back ground level. On the other hand, average ages of the students were also taken into consideration. While the average age of female students in I. experimental group (cooperative+metacognitive) is 11.68, the average age is 11.77 for male students. Also, the average age of female students in II. experimental group (cooperative) is 11.56, the average age is 11.83 for male students. Finally, the average age of female students in control group is 11.75, the average age is 11.63 for male students.

Explanation of threats to internal validity is very critical for quasi-experimental designs (Creswell, 2005). The researcher should make sure that the assigned groups have similar characteristics with each other in order to control the threat to internal validity caused by sampling process (Creswell, 2003, 2005). In this study, the students who have similar characteristics measured by pre-test and I. dönem matematik dersi not ortalamaları were randomly assigned into groups. Also, there is no significant difference between the groups in terms of demographic indicators such as gender composition, socio-economic back ground, and age.

Also, in order to address the ethical issues, researchers can choose to receive a voluntary participation approval from participants after providing detailed explanation about the purpose and process about the research (Smith, 1995). In this research, after the experimental groups and control group were determined, the students in the experimental groups who were chosen to participate in the awareness program were asked to approve a voluntary participation form both by themselves and by their parents. Considering the purpose and design of the study, voluntary participation was taken into account seriously.

Data Collection Instruments

Junior Metacognitive Awareness Inventory (Jr. MAI): One of the mostly used tools in the metacognition literature is the Metacognitive Awareness Inventory, which was developed by Schraw and Dennison (1994). Metacognitive Awareness Inventory developed to measure adults' metacognitive knowledge and metacognitive regulation.

Sperling et al. (2002) developed Jr. MAI (version A ve Version B) to measure elementary school students' metacognition. The first inventory (Jr. MAI, Version A) consists of 12 items for use with learners in grades 3 through 5. The second inventory (Jr. MAI, Version B) consists of the same 12 items but also included 6 additional items for use with learners in grades 6 through 8. The participants in this study consisted of 6th grade students. Thus, Jr. MAI version B was chosen to measure students' metacognitive awareness.

The Jr. MAI translated into Turkish, tested validity and reliability of Turkish version by Aydın (2007). The scale is composed of two sub-dimensions: Metacognitive knowledge and metacognitive regulation. Items 1, 2, 3, 4, 5, 12, 13, 14, and 16 are loaded on the metacognitive knowledge and items 6, 7, 8, 9, 10, 11, 15, 17, and 18 are loaded on the metacognitive regulation. The researcher calculated the reliability coefficient of the scale as α= .80. Furthermore, the Cronbach's alpha reliability coefficients of the sub-dimensions were .66 for metacognitive knowledge, .73 for metacognitive regulation (Aydın, 2007).

In order to test the validity and reliability of the scale in the Turkish culture context, exploratory factor analysis and confirmatory factor analysis were used in the study. The reliability analysis of scores and convergent, discriminant, and subgroup validity coefficients were examined (Aydın, 2007). As a result of analysis, it was seen that Jr. MAI is a reliability and valid inventory.

Jr. MAI includes 18 five point likert-scale items and it is designed as a 5-point likert scale with response categories of: Never (1), Rarely (2), Sometimes (3), Usually (4), Always (5). There were no negative statements and the possible scores of this inventory ranged from 18 to 90 which were used to identify students' level of metacognitive awareness (e.g., 18=low metacognitive awareness; 90= high metacognitive awareness). The students were allowed 20 minutes to respond the inventory. The Cronbach's alpha coefficient of the scale for this study was α= .79. Also, the Cronbach's alpha reliability coefficients of the sub-dimensions were .59 for metacognitive knowledge, .61 for metacognitive regulation.

Student compositions: Data were also collected for qualitative analyses. In this sense, students' written expressions were also used in this study, following the way adopted by Sharan (1980) in order to determine the cognitive and affective characteristics of the students at the end of the intervention. Written statements of the students in first and second experimental groups were used for qualitative data collection. At the end of the intervention, open-ended question "What do you think about the activities during the algebra learning area discussions? Please explain." was asked in order to collect information about the activities. The written statements were used to diversify qualitative data and to provide an opportunity to students in first and second groups for reflection of their learnings and positive and negative experiences. The statements were collected after the post-test in order to prevent any manipulation on activation process of metacognitive monitoring activities.

After the analysis of the written reflections of 67 students, 12 students were selected by purposeful sampling method, selecting 6 students both from I. experimental group (cooperative+metacognitive) and II. experimental group (cooperative) that can represent the views of the experimental groups. Purposeful sampling method help in depth research of the situations that have comprehensive information (Yıldırım & Şimşek, 2008). In this study, maximum diversity sampling was used as a type of purposeful sampling. The purpose behind this selection was to have a respectively small sample and to maximize the diversity of the students (Yıldırım & Şimşek, 2008). In this regard, the students in both experimental groups were ranked according to their average grades in the Jr. MAI, and two students were selected both from high, average, and low grade clusters.

Procedures

The experimental process was divided in two steps as preparation and application. The treatment for the experimental groups lasted for five weeks (20 class hours). This duration increases to 33 class hours when the time spent in the awareness increasing activities related to the method and tools, and during the pre-test and post-tests are added.

The intervention was applied in the experimental groups by the researcher herself, who is already a teacher in Istanbul. The study in the control group was carried out by the mathematics teacher of the control group. The researcher should control the time passed between pre- and post-test in the most effective way in order to prevent threats to internal validity (Creswell, 2003, 2005). In this study, the classes in experimental groups and control group were held in accordance with the attainments of algebra learning area of mathematics curricula. The meetings continued until the researcher and the teacher assigned to the control group reached an agreement on the delivery of the topics, and practice problems and activities in the the teacher's guide book to be used. In all groups, the problems incorporating attainments were started and stopped to be used simultaneously. The implementation process was coordinated with the teacher assigned to the control group during the study.

The cooperative learning method, Student Teams-Achievement Divisions (STAD) was applied to the experimental groups as teaching methods. The steps of the STAD technique has been considered during the application of the STAD method (Açıkgöz, 1992; Tarım & Akdeniz, 2008; Slavin, 1995). The steps of the technique were summarized in Table 3.

Table 3. Intervention Steps of the STAD Technique in the Experimental Groups

Process	Group	Steps	Time
Preparation process	I. Experimental group (cooperative+metacognitive)	Preparation of the materials	3 months
		Application of the pre-test	5 class hours
		Awareness program	4 class hours
	II. Experimental group (cooperative)	Assigning the students to the groups	1 class hours
		Team identity formation activities	3 class hours
Application process	I. Experimental group (cooperative+metacognitive)	Presentation of the topic	1 class hours
		Group work	2 class hours
	II. Experimental group (cooperative)	Determining students' team achievement and evaluation	1 class hours
		Group award	

Intervention Steps in I. Experimental Group (Cooperative+Metacognitive)

Preparation of the materials: In this study, 6th grade "algebra learning area" was discussed. Two aspects were taken into consideration in the choice of this area. Firstly, according to new mathematics curricula which has been gradually put into use in Turkey since 2005, aims to develop the concepts related to algebra for elementary 6-8 grades, and to teach basic skills to them (MEB, 2009). Also, according to National Council of Teachers of Mathematics (NCTM, 2000), student need to represent and analyze mathematical structures and situations by using the symbols in algebra, use mathematical models in order to represent and understand quantitative relationships, and analyze the changes in different situations in real life. Second, existing studies have shown that the students have several problems with algebra (Steele, 2005; Erbaş, Çetinkaya, & Ersoy, 2009).

In this context, firstly, attainments related to the 6th grade algebra education in the elementary level mathematics curriculum (MEB, 2009) were determined in the material preparation process. The course contect related to the attainments and materials were prepared by the researchers.

Activity worksheets, prompting card, error evaluation forms, action cards, homework guidance form, journal, group evaluation form were designd in the material preparation process. Expert opinion was also utilized in the preparation of the materials. The views of the field experts and academics that received mathematics education (2 Assoc. Prof., 2 Assist. Prof.) and mathematics and Turkish teachers were taken into account during the material preparation process, and the materials were finalized for use in the intervention after making necessary arrengements. The materials were firstly used in a class that did not participate in the study. After this trial, operability of the activities and materials, feedbacks of the students related to the materials, and the duration of the class were revised.

The first material used in the research was the "activity worksheets". The questions on the activity worksheets were created based on the questions taking place in the course, the study and the teacher's guide of the MEB (2009). Additional questions were also created in parallel with the existing questions and attainments. During the preparation of the worksheets, applications aimed at developing metacognitive skills of the students were also included (Appendix 1).

One of the materials aimed at developing metacognitive skills of the students was "prompting card". Prompting card was used so that the students students can plan their problem solving steps, evaluate these steps, and engage in reflective thinking; in summary, they can increase self awareness about their behaviors. The prompting cards ask students to estimate whether they can solve a problem or not, and build a connection between their existing knowledge and experiences. Prompting card was developed based on the scales and control lists of Fortunato, Hecht et al. (1991) and Panaoura et al. (2003) but the development of the cards also took expert views and metacognitive dimensions into consideration. Prompting card is composed of the expressions in three sections, as planning before problem solving, following up the plan during the problem solving (monitoring), and evaluating after solving the problem (Appendix 2).

Another material was "error evaluation form". The error evaluation form was aimed at informing the students about the shortcomings in the learning process and mistakes, correction of the mistakes and shortcomings by the students, and in this way developing monitoring skill, which is one of the metacognitive skills. The students were asked to fill out the error evaluation form at the end of each group work (Appendix 3).

Another material that provided an opportunity to the students to express their views was "action card". The purpose behind the design of the action cards was to make the students think in more detail about their behavior and thinking during the problem solving process. The action cards, which include cognitive and metacognitive behaviors, were based on the action cards developed by Wilson (2001); however, new expressions reflecting group interaction were added in the context of cooperative learning principles (Appendix 4).

One more material designed by the researchers was "homework guidance form". Homework guidance form was designed to help the students organize their studies by facilitating reflective thinking. The form was based on the problem solving sheet designed by Desoete et al. (2001). Homework guidance form was composed of three sections as estimation, application, and evaluation (Appendix 5).

Another material used in the study was "journal". Journal was aimed at helping students organizing their complex thoughts, synthesize their thoughts, and express these in a way that the student can understand (Appendix 6).

Moreover, "group evaluation form" was designed by the researchers in order to determine the challenges in group work, and to make provisions for protecting the structure and principles of cooperative learning (Appendix 7). MEB (2009) was used as a source when designing the group evaluation form. Each week, one student was asked to fill out the group evaluation form.

Application of the pre-test and awareness program: After the preparation of the materials, Jr. MAI was used as a pre-test both in experimental groups and control group. Awareness program was started after the pre-test. The students may need to get prepared for group work for a few weeks before cooperative learning activities (Williams, 2005). In this context, before the application, STAD technique and materials were introduced to the students, in order to make them familiar to the application techniques and materials to be used.

Assigning the students to the groups and team ıdentity formation activities: The students were assigned to the groups after the awareness program. The students should have different skill levels in order to create asking for help and offering help behaviors (Krol, Janssen, Veenman, & Van der Linden, 2004). In this regard, determining factors in the heterogenous group formation was academic ability and

gender. First semester mathematics mean scores of the students were taken into account when forming the groups for the first time. Assigning students with different academic achievement levels and different genders to each group was paid attention.

The students in the group are to sit face to face to make easier the interaction with each other. After the groups had been determined, students participated in activities for instance mirror-mirror, inverted mirror, brain storming, team slogans, team hats, meet ball, so as to develop their communication skills, constitute their group identity, enable group members to get to know each other better (Senemoğlu, Gömleksiz, & Üstündağ, 1999).

Presentation of the topic: After the preparation process of the STAD technique was completed, application process was started. Cooperative learning method enhanced with metacognitive strategies was used in I. experimental group (cooperative+metacognitive). The application process of cooperative learning method enhanced with metacognitive strategies was summarized in Table 4.

Table 4. The Application Process of Cooperative Learning Method Enhanced with Metacognitive Strategies

Step	Metacognitive Strategies	Materials
Presentation of the topic	Modeling and thinking aloud	
Group work	Self-evaluation	Error evaluation forms Group evaluation form
	Metacognitive prompting	Prompting card
	Putting action cards in line	Action cards
	Paired problem-solving and thinking aloud	Prompting card
	Choosing consciously, reaction to feedback and revising	Homework activity worksheets Activity worksheets
	Writing	
	Reflection on and reflecting learners' ideas	Prompting card
	Journal keeping	Journal
	Predicting	Homework guidance form Activity worksheets
Determining students' team achievement and evaluation Group award		

Metacognitive strategies are the techniques used to plan, monitor, control, and evaluate self metacognition processes (Flavell, 1979; Livingston, 1997; Woolfolk, 2007). On the other hand, Boekaerts and Simons (1995) argued that metacognitive strategies are the decisions made by the students before, during, and after the learning process (as cited in Toit & Kotze, 2009). Accordingly, it is necessary to arrange metacognitive strategies that can be applied in educational environments in order to develop metacognitive skills (Lin, 2001). In this study, it was considered that metacognitive strategies can be used to develop metacognitive skills (Desoete, 2001; Jager, Jansen and Reezigt, 2005; Mevarech and Amrany, 2008). So that, strategies refer to the ways that can be used by the students in order for developing their metacognitive skills.

Several strategies have been designed by the researchers to develop metacognitive skills of the students (Blakey & Spence, 1990; Costa, 1984; Darling-Hammond, Austin, Cheung, & Martin, 2003). In the study, modeling, thinking aloud, self-evaluation, metacognitive prompting, putting action cards in line, paired problem-solving, choosing consciously, reaction to feedback and revising, writing, reflection on and reflecting learners' ideas, journal keeping, and predicting strategies were used the

metacognitive strategies. Strategies that have been used in existing research and resulted in successful outcomes were studied when determining the metacognitive activities and content (Adibnia & Putt; 1998; Jbeili, 2003; Kramarski & Mevarech, 2003; Lan, 2007; Mevarech, 1999; Mevarech & Kramarski, 1997).

While the presentation of the topic in STAD technique depended on explanations by the teacher, discussion part involved the participation of the class. Presentation of the topic took almost 10-15 minutes for each new topic or problem. At this step, modeling and thinking aloud techniques were used as the metacognitive strategies.

Modeling and thinking aloud: In the modeling strategy, an important metacognitive strategy (Costa, 1984), the purpose is to make the students follow learning processes by considering the teacher as a model (Muijs & Reynolds, 2005; as cited in Toit & Kotze, 2009).

The teacher acted as a model showing how the thinking process worked during the presentation of the topic and problem solving. The teacher explained aloud what she thought when she first read the problem, how she made plan and applied it, and finally how she evaluated herself and the process. For instance, the teacher facilitated vocal reflection of statements that model thinking processes such as "I should re-read the problem statement to understand it. I should underline the key words in the problem. I was challenged in ..... parts of the problem. As necessary, the teacher established a dialouge with the students. For example, the teacher intentioanlly did not find the right solution to a problem and asked students "How can I control the accuracy of my solution? Where was the mistake? What kind of strategy can I use in order to solve the problem correctly?" In this way, the lecture was aimed at being mutually interactive rather than being a monologue.

Group work: Each group work after the presentation of the topic took almost 20 minutes. The worksheets related to the topic was distributed to the student groups. The students in the groups tried to solve the problems both individually (by developing their own strategies) and together with the groupmates (by discussing the strategies).

The teachers should help the students participate and take responsibilities in their own learning processes during the use of metacognitive strategies (Veenman et al., 2014). In this context, the mission of the teacher during group work is to control the processes of the activities, and to provide guidance to the students by asking questions to them in order to facilitate progress and thinking of the students. The teacher observed the students when they were trying to solve the problems, provided appropriate answers to their questions, and asked some open-ended questions such as "What did you think about when you first read the problem?", "What kind of plan did you make to solve the problem?", "Can you please explain how you reached this conclusion?", "What do you think about the conclusion you reached?" in order to trigger their thinking.

Figure 1. The Mission of the Teacher During Group Work

The metacognitive strategies used in the group work were explained as follows.

Self-evaluation: In order to develop self-evaluation, which is one of the strategies beneficial to metacognitive skills, the students were asked to evaluate the useful and difficult parts of what they did, what they liked and disliked, and positive and negative sides (Costa, 1984; Darling-Hammond et al., 2003). Some expressions were added to the worksheets, such as "The easiest problem in this study is..... because of.....", "The most difficult problem in this study is..... because of.....", "What is the contribution of my friend to me?"; the aim of these expressions is to get them to metacognitive monitoring themselves, and understand them importance of their teammates.

At the end of problem solving applications, error evaluation forms were circulated to develop metacognitive monitoring and evaluation processes of the students. Also, the students filled out the group evaluation form each week. The forms were reviewed by the teacher to provide feedback to the students in return.

Metacognitive prompting: It is a difficult process for the students to develop their metacognitive skills by themselves (Pintrich, 2002). That is why, prompting can be used as a supporter and indirectly prompting technique to organize problem solving processes of the students (Wirth, 2009). The main goal of this strategy is to focus the students' attention on specific aspects of her/his own problem solving process and to develop process monitoring and controlling skills of them. The students were directed to ask questions in order to comprehend every aspect of their own problem solving processes. Prompting cards including questions that the students are expected to ask themselves were given to the students. One copy of the prompting cards was hang on the clipboard in the class and emphasized by the teacher during the problem solving process. The teacher encouraged the students to understand all aspects of their problem solving processes and ask questions both to themselves and their friends.

Figure 2. The Students When They Were Studing with Promting Card.

Putting action cards in line: According to Wilson (2001) action cards, on which cognitive and metacognitive action statement each associated with one of the metacognitive skills expressions are written, trigger self-questioning of the students. In this study, the purpose of putting the cards in line is, to get the students to remember their problem solving process, also develop skills of controlling and evaluating self-learning process. In this context, the students were asked to choose and put in line the action cards based on their solving process. Then, the students were expected to put their action cards in line while solving a problem with their friends. The students were asked to explain what kind of differences exist between arrengement of the cards, and what they learned from this activity to each other.

Paired problem-solving and thinking aloud: Paired problem-solving facilitates abstract thinking. Moreover, it helps the students learn how to ask questions, determine the deficiencies in their knowledge, and understand others' thoughts (Darling-Hammond et al., 2003). So that, it provides sustainability of thinking (Blakey & Spence, 1990; Hargrove, 2013). In this context, paired problem-solving and thinking aloud strategies were used to increase awareness of students by following each others' thinking processes, to provide new point of views to the students, to develop the students' skill of using an explanatory language when putting their views into words, and to develop their communication and empathy skills.

A worksheet including questions in similar difficulty levels was provided to the students, who worked in pairs, during the strategy implementation process. The student that is listening asked the questions on the worksheet to the problem solver if he/she wanted to ask. The problem solver solved the problem by answering the questions and explained the solution aloud. The student that is listening to the explanations offered help if the problem solver struggled in problem solving. In case a consent cannot be reached, help of other group members was asked and discussed.

Figure 3. The Students When They Were Studing With Paired Problem-Solving Strategy

Choosing consciously, *reaction to feedback and revising*: According to Costa (1984), students should consider the results of their decisions in any decision making process. In this way, the students can comprehend the relationship between their choice, actions, and results. At the same time, giving feedback to the students provide an opportunity for the students to learn from their mistakes (Toit & Kotze, 2009). In this sense, this study used making conscious choices strategy to make the students realize how they made their choices. Also, feedback was provided to the students in order to help them realize their mistakes in different stages and correct them.

While applying the choosing consciously strategy, problems, which are similar to the ones in homework sheets, were assigned to the students. The purpose is to help the self-questioning process of the students about their decisions. Then, the students were also asked to solve a certain number of these problems.

Writing: In mathematics education, writing down the relationship between concepts by the students' own words is very important for the development of metacognitive skills of the students (Steele, 2005). In the light of this information, writing strategy was used to teach the students organizing their thoughts, making them clear, and express them. Writing can be considered "thinking aloud" on the paper (Pugalee, 2004). That is why, during the awareness program, it was emphasized that students are expected to write everything in their minds on the materials. The students were asked to write everything on the worksheets related to what they did and thought during problem solving processes. Writing activities like keeping journal, error evaluation forms, both in and out of class, and homeworks were assigned to the students. Journal, error evaluation form and activity worksheets were restructured based on literature in order to improve the writing experience of students.

Reflection on and reflecting learners' ideas: Reflection can be explained as questioning one's own actions during an activity, then rethinking about these, and as a result organizing one's general knowledge (Rogers, 2001). In this context, the students in the groups were asked to reflect on their own and learnes' ideas in order to develop metacognitive awareness.

There are some studies showing that language facilitates metacognitive development (Costa, 1984; Hartman, 2001). In the light of this information, making explanations with the help of reflection of thoughts on others method has been used during all problem solving processes. The students were encouraged to think aloud when they were studying, and to guide each other with the help of guidance cards.

Figure 4. The Students When They Were Studing with Reflecting Learners' Ideas Strategy

Journal keeping: According to Hargrove (2013), journals can increase the effects of educational programs and serve as reminders. In this sense, journal keeping strategy was used to help the students recall what they learn during the classes, think about their own applications and facilitate their metacognitive developments with the help of self-evaluation processes. The students were asked to keep a mathematic journal on every mathematic class day.

Predicting: When a student makes a prediction and founds out that prediction was wrong, a cognitive imbalance arises and leads to motivation for learning (Settlage & Southerland, 2007). In the light of this information, the homework guidance form was used to develop prediction skills of the students and increase their motivation. Expressions related to prediction skills were utilized both in homework guidance forms and worksheets.

Determining students' team achievement and evaluation: The team achievement scores were evaluated by individual improvement scores as suggested by Slavin (1995). The students were tested each week using individual tests that cover discussed subjects. In order to evaluate the tests, beginning main scores of the students were recorded. Beginning main scores was considered as the students' scores on the first mathematics test in the second semester. In this way, individual improvement scores of the students were determined by comparing their test results and main scores. If the student does better than main score, he/she can contribute to the group progress. Individual improvement score was found by taking difference between test score and main score (Slavin, 1995).

Group award: After the main and improvement scores were found out, group score was determined by taking average of the individual improvement scores of the students in each group. A certificate was given to the most successful groups of the week based on group scores. At the end of topic, a general evaluation test that covered all subjects was used. After covering all subjects, the study was completed by conducting the post-tests.

Intervention Steps in II. Experimental Group (Cooperative)

Only STAD technique was used, without appliying metacognitive questioning or strategy teaching in II. experimental group (cooperative). The steps of the STAD technique was carried out simultaneously with I. experimental group (cooperative+metacognitive) technique. Worksheets including the same problems with I. experimental group's (cooperative+metacognitive) problems were used as materials in the STAD application process. However, these worksheets did not cover expressions aimed at developing metacognitive skills. After the pre-test, awareness program was implemented aimed towards the STAD technique. Upon the completion of awareness program, students were assigned into groups. After determining the groups, activities such as mirror-mirror, inverted mirror, brain storming, team slogans, team hats, meet ball, were used for team bonding purposes. The teacher explained sample problems after lecturing on outline of the topic. Then, the students were provided with activity worksheets and group study period was started. During the group study, students were guided for working cooperatively. The students worked together interacting with

each other. At the end of group work, the lectures were finalized after summarizing information learned throughout the day. Each week, the students took tests composed of questions about that week's lectures after teacher presentations and group work. Individual tests are identical with the tests used in I experimental group (cooperative+metacognitive). The same steps as those in the I. experimental group (cooperative+metacognitive) were followed in terms of beginning main scores, individual improvement scores and group scores. Successful groups were rewarded.

Figure 5. The Students When They Were Studing with Cooperation

Intervention Steps in the Control Group

No information was provided to the teacher of the control group. Any different teaching plan was not created for the control group, normal processes recommended in the teacher's guidebook were used. The lectures in control group were conducted in parallel with those in control group thanks to coordination among the groups regarding lecturing method, selection of activities in guide book, and practice problems to be used. However, some operations were carried out in order to describe the teaching process in the control group and determine whether it was different from the process in the experimental groups. The problems used in the experimental groups were given to the control group teacher, who was asked to present the activities that he/she did while solving these problems (Appendix 8). Furthermore, the control group teacher was observed while teaching, and an observation form was used (Appendix 9). This observation form was prepared by the researchers taking into account the cooperative learning method and metacognitive strategies employed in the experimental groups. At the end of the observations, it was determined that the control group teacher displayed only 13% (the average of 9 observations) of the items given in the observation form. Considering the problem-solving activities presented in written by the control group teacher and other findings obtained during the observations, it can be said that the lessons in the control group were teacher-centered in general. The selected practice problems were solved by teacher, asking questions to students from time to time. At the end of each class, students were asked if they have any questions. The confusions about the topics that were not comprehended completely were clarifies by the explanations of teacher or a student in the class. It was seen that the teaching process in the control group did not involve the methods and strategies carried out in the experimental groups.

Also, the presence of an interaction between the control and experimental groups might affect the internal validity of an experimental study (Creswell, 2005). Thus, the control group was chosen from a different term in the present study.

Analysis of Data

First of all, because the groups size is smaller than 50, Shapiro-Wilk test has been used in analyzing whether the groups display a normal distribution or not (Büyüköztürk, 2012; Tabachnick & Fidell, 2000). According to this test, if the $p > .05$, then the data has normal distribution and they can be analyzed with the parametric tests (Köklü, Büyüköztürk, & Çokluk Bökeoğlu, 2010).

Afterwards, the "dependent group t-test" was used in paired comparisons within groups themselves and "ANOVA" was used in comparisons between groups depending on the types of data. If a significant difference is found as a result of ANOVA, comparisons were conducted using Sheffe test depending on variance homogenity in order to understand the main reason of the difference. The significance level was accepted as 0.05 in all the statistical operations. Also, if a statistically significant difference is found between the groups, magnitudes of influence was calculated in order to undertand if the difference has practical implications as well. For determining the effect size, Cohen's *d* values were calculated in the dependent group t-test where the difference between the means of the two groups was analyzed, whereas Cohen's *f* values were calculated through analysis of variance (Cohen, 1988; Özsoy & Özsoy, 2013). Cohen (1988) indicated that a *d* value under .20 could be interpreted as a weak effect size, if it is .50 then the level of influence is medium; and if it is .80 and higher then the level of influence is large (strong) effect. Also, Cohen's *f* value was considered to have a weak effect size with .10, a medium effect size with .25 and a large (strong) effect size with .40 (Cohen, 1988).

Writing opinions of students were subjected to a descriptive analysis. In descriptive analysis, findings are summarized and interpreted based on pre-determined themes. The goal of this analysis is to present findings in an organized and interpreted way (Yıldırım & Şimşek, 2008). In this respect, the documents including student views were analyzed line-by-line from the perspective of metacognitive skills. While condicting the descriptive analysis, a theme, named as "the student / his or her knowledge about the process and skills to control it", was created. This theme was formed based on the conceptual framework of the study, but it was also found to be consistent with the theoretical structure. Afterwards, the papers submitted by students were evaluated based on the theme. The student views were classified as positive and negative within the scope of "the student / his or her knowledge about the process and skills to control it" theme. Then, the discussion part explained how the findings were further examined by making connections with student views.

In order to address the internal validity of the study, the results and how the researcher reached these conclusions were explained in detail. Each statement of students was carefully studied. It was ensured that the theme is compatible with conceptual framework in order to make results confirm. The results were compared to each other and interpreted carefully; in this way, data was presented with a critical thinking process. Direct quotes were used in the findings part in order to explain the process of drawing conclusins and making inferences. When doing this, the real names of students were replaced with symbolic names.

Results

This section provides the findings obtained from the Jr. MAI pre-test/post-test administered to students in the experimental groups and control group. However, Shapiro-Wilk test were conducted to establish whether the results had normal distribution and Levene's Test applied to establish whether the group variances had homogeneous prior to analysis of the tests. The results of the Shapiro-Wilks tests have been presented in Table 5.

Table 5. Shapiro-Wilk Normality Test Results for Jr. MAI

	Groups	**Pre-test**		**Post-test**	
		Shapiro-Wilks	**p**	**Shapiro-Wilks**	**p**
Jr. MAI	I. Experimental group (cooperative+metacognitive)	.94	.09	.98	.71
	II. Experimental group (cooperative)	.94	.10	.97	.53
	Control group	.96	.37	.96	.41

When the Table 5 is examined, the results of the Shapiro-Wilk Test conducted on the results of the Jr. MAI pre-test administered to the experimental groups and control group are as follows, respectively: (w= .94, p= .09> .05), (w= .94, p= .10> .05) and (w= .96, p= .37> .05); and the results of the Shapiro-Wilk Test conducted on the results of the post-test are as follows, respectively: (w= .98, p= .71>.05), (w= .97, p= .53> .05) and (w= .96, p= .41> .05). Because it was seen that the tests had normal distribution on the basis of these results, it was decided to use the t-test and ANOVA in other analyses.

Results Pertaining to the First Sub-Problem

The three questions that are considered under the first sub-problem of the research are as follows:

a) At the end of the interventions in I. experimental group (cooperative+metacognitive), based on the research question "Is there a significant difference between metacognitive skill levels of 6th grade students before and after using the cooperative learning method enhanced with metacognitive strategies?", the Jr. MAI pre- and post-test results were compared with each other using dependent t-test and the findings were presented in Table 6 along with descriptive statistics.

Table 6. I. Dependent Group T-Test Results of I. Experimental Group (cooperative+metacognitive) According to Jr. MAI Pre-Test and Post-Test Scores

Group	Assessment	N	$\bar{x}$	Min	Max	sd	df	t	p
I. Experimental group	Pre-test	33	61.03	27	83	14.99	32	5.85	.00
(cooperative+metacognitive)	Post-test	33	76.67	61	89	6.71			

According to the Table 6, the means of post-test scores of I. experimental group (cooperative+metacognitive) were higher than the means of pre-test scores. Results of the dependent group t-test conducted on the Jr. MAI pre-test and post-test scores of the I. experimental group (cooperative+metacognitive) showed significant difference at a statistical level of significance of .05 [$t_{(32)}$=5.85, p< .05]. According to the results, at the end of the interventions, it was seen that the Jr. MAI post-test scores were significantly higher than of pre-test scores. Consequently, it can be said that metacognitive skill of the students was developed as a result of the cooperative learning method enhanced with metacognitive strategies. Considering the calculated value that shows the effect size (Cohen's *d*= 1.35> .80) it can be said that the cooperative learning method enhanced with metacognitive strategies had a considerable large effect on the metacognitive skills of the students (Cohen, 1988).

b) At the end of the interventions in II. experimental group (cooperative), based on the research question "Is there a significant difference between metacognitive skill levels of 6th grade students before and after using the only cooperative learning method with no metacognitive strategies?", the Jr. MAI pre and post-test results were compared with each other using dependent t-test and the findings were presented in Table 7 along with descriptive statistics.

Table 7. Dependent Group T-Test Results of II. Experimental Group (cooperative) According to Jr. MAI Pre-Test and Post-Test Scores

Group	Assessment	N	$\bar{x}$	Min	Max	sd	df	t	p
II. Experimental group	Pre-test	34	61.62	32	85	14.45	33	2.54	.02
(cooperative)	Post-test	34	69.26	51	86	9.35			

As can be seen from Table 7, the means of post-test scores of II. experimental group (cooperative) were higher than the means of pre-test scores. Results of the dependent group t-test conducted on the Jr. MAI pre-test and post-test scores of the II. experimental group (cooperative) showed significant difference at a statistical level of significance of .05 [$t_{(33)}$=2.54, p< .05]. Accordingly, cooperative learning method can be said to be a method contributing to the development of metacognitive skills of the students. Effect size value was found to be Cohen's *d* .63. In this regard, the cooperative learning method has a medium effect on the development of metacognitive skills (Cohen, 1988).

c) At the end of the interventions in control group, based on the research question "Is there a significant difference between metacognitive skill levels of 6th grade students before and after existing normal process ", the Jr. MAI pre- and post-test results were compared with each other using dependent t-test and the findings were presented in Table 8 along with descriptive statistics.

Table 8. Dependent Group T-Test Results of Control Group According to Jr. MAI Pre-Test and Post-Test Scores

Group	Assessment	N	$\bar{x}$	Min	Max	sd	df	t	p
Control group	Pre-test	34	34	62.00	31	84	33	.02	.98
	Post-test	34	34	62.06	38	80			

Also, when Table 8 is analyzed, the means of pre-test and post-test scores of the control group are almost at the same level. Results of the dependent group t-test conducted on the Jr. MAI pre-test and post-test scores of the control group showed no significant difference at a statistical level of significance of .05 [$t_{(33)}$= 0.02, p> .05]. In line with this finding, the existing learning process applied for the control group cannot be said to be effective on the development of metacognitive skills of the students.

Results Pertaining to the Second Sub-Problem

At the end of the interventions, ANOVA has been conducted in order to find whether there has been a significant difference between the groups in terms of Jr. MAI post-test scores. The results of this study have been presented in Table 9.

Table 9. ANOVA Results for the Jr. MAI Post-Test Scores

Sources of Variance	Sum of Squares	df	Mean Square	F	p
Between groups	3573.47	2	1786.74	23.21	.00
Within groups	7543.83	98	76.98		
Total	11117.31	100			

As seen Table 9, Jr. MAI post-test scores of the experimental groups and control group showed a significant difference in terms of the metacognitive skills between the three groups [$F_{(2\text{-}98)}$= 23.21, p= .00< .05]. The value showing the effect size for this difference was calculated to be Cohen's *f*= .95, which was interpreted as a large effect size (Cohen, 1988; Özsoy & Özsoy, 2013).

Additionally, the result of the Levene's Test applied to the Jr. MAI post-test data of the experimental groups and control group was (F=2.08, p= .13), and thus it can be said that the group variances were homogeneous at the p>.05 significance level, i.e. groups had equal variance. To identify significantly which specific groups differed, Scheffe test has been conducted. The results of this study have been presented in Table 10.

Table 10. Scheffe Test Results for the Jr. MAI Post-Test Scores

Grup(I)	Grup(J)	Mean difference (I-J)	p
I. Experimental group (cooperative+metacognitive)	II. experimental group	7.40	.00
	Control group	14.61	.00
II. Experimental group (cooperative)	I. experimental group	-7.40	.00
	Control group	7.20	.00
Control group	I. experimental group	-14.61	.00
	II. experimental group	-7.20	.00

According to the results of the Scheffe test, at the end of the interventions, it was seen that the levels of metacognitive skills of the I. experimental group (metacognitive+cooperative) were significantly higher than of both the II. experimental group (cooperative) and the control group (p= .00<

.05). The results also showed that students in II. experimental group (cooperative) significantly outperformed their counterparts in control group in metacognitive skills (p= .00< .05).

Two important factors in the development of metacognitive skills of the students are following up their own learning processes and evaluating themselves in the context of learning goals. Putting an emphasis on these two factors while implementing the cooperative learning methods might have been effective on the difference between the metacognitive skills in the groups. Although using only the cooperative learning method without enhancing it with metacognitive strategies was effective in the development of metacognitive skills compared with the control group, this method did not become sufficient by itself. In order to increase the effectiveness of this method, metacognitive strategies are thought to be a supporting element.

Results Pertaining to the Third Sub-Problem

Student views about the cooperative learning method enhanced with metacognitive strategies and cooperative learning method applications were presented below. To begin with, the views of students in the I. experimental group (cooperative+metacognition) were described and presented.

When the views of the students in the context of "the student / his or her knowledge about the process and skills to control it" were evaluated based on the student's experiences during the cooperative learning method enhanced with metacognitive strategies, it was seen that the main focus was the error evaluation forms. The students stated that they saw the mistakes of their ways, questioned why they did the mistakes, took advice from their friends aimed at correcting the mistakes, and also gave advice to their friends by using the error evaluation forms. In this regard, Ela said that "Our teacher gave us the error evaluation forms. I fill in the form when I make mistake when solving the problems. If I do not make any mistake, we evaluate my advice to my friends. When I see my mistakes on the form, I can solve another problem more successfully". Moreover, Ali stated that "We also have the error evaluation forms. Before, I was not even aware of my mistakes. But after the forms, I could correct my mistakes. Before, I did not even think about what I did. But now, I evaluate what I am doing."

According to views of the students, the awareness of the students was increased by the help of the error evaluation form activities. Furthermore, the students helped each other in order to correct their mistakes as they studied in cooperation. It can be inferred that cooperative learning method enhanced with metacognitive strategies positively affects the development of metacognitive monitoring skills of the students.

On the other hand, the students expressed that they questioned problems and themselves with the help of the activities during the lessons. The inquiry of "Is the problem easy or difficult for you?" in the prompting card or the inquiries in the activity worksheets aimed at finding out the most difficult and easiest problems can be said to be effective in developing metacognitive evaluation skills of the students. In this regard, Elif said that "When my friend asks me whether the problem is easy or difficult, I read the problem again. If I solved a similar problem before, it seems like an easy problem to me. I have not thought like this before". Also, Efe stated that "We chose the problems that we wanted to solve when our teacher proposed many different problem alternatives to us. I read all the problems and evaluated them, and chose the easiest ones. But then, I solved others as well since I was curious about them. I read the problems a few times and asked myself which one to choose".

The students expressed that prompting cards help them in solving the problems, as an indicator of the effects of metacognitive prompting strategy. The students stated that their friends asking questions on the prompting cards helped them solve the problems step by step, they also started asking questions themselves even if there was not any prompting card, in this way they could solve the problems more easily, and their performance in mathematics increased. It can be concluded that metacognitive skills of the students have developed by the help of questioning among the students facilitated by the prompting cards. In this respect, Elif expressed that "We read the questions on the prompting cards one by one. Once Samet, then me. The questions remained in my mind. From now on, I can ask these questions myself even if there is no prompting card. In this way, I can solve problems more effectively."

The students also stated that they became aware of their own behaviors during their problem solving processes thanks to the putting action cards in line activity. The putting action cards in line activity promoted thinking processes of the students. In this regard, Omer said that "Before, our behaviors were not written down on a paper. But now, I think of my own actions when I see the action cards. It is similar to solving the problems again." And, Buse stated that "I wished I had thought of different things when I was putting the action cards in line."

The students stated that they can relax and feel happy by keeping a journal that they write down their thoughts and emotions and repeat their learnings. Keeping a journal activity was aimed at developing writing skills of the students. At the same time, journals can be said to be a kind of experience that help the students emotionally relax, and develop their metacognitive skills by providing an opportunity to express their thoughts in a systematic way. In this sense, Ela said that "I would never imagine writing down what happened during the mathematics class on my diary. I think of my actions during the class, and write down everything in sequence. Sometimes I need to look at my notes from the class, in this way I have to repeat what I learned in the class".

One of the activities that were pointed out in the students' compositions is the prediction of time activity, which took place in the study worksheets and homework guidance form. The students expressed that they enjoyed estimating how much time would take their problem solving process, tried to be faster and to use more practical methods, understood the importance of time, and felt satisfied when they could solve the problem faster than their prediction. The students also emphasized that they continued applying self-evaluation processes when doing their homework by the help of homework guidance forms. It can be said that the *Predicting* strategy used in the cooperative working groups has been effective in developing problem solving skills of the students and their attitudes toward mathematics. In this regard, Buse said that "I do my homework in a different way and explain everything. As I explain everything, my knowledge about the letters has increased a lot. My favorite is keeping time. Finish my job earlier makes me very happy, because my prediction is proved to be right". Moreover, Efe stated that "My mother asked about the homework guidance form and I replied with saying that I always ask questions. Even if I cannot finish the form quickly, the important part is writing down my actions by proper explanations. Otherwise, my friend would not understand my form. That is why, I write everything down in details".

It can be inferred that cooperative learning method enhanced with metacognitive strategies and applied during the experimental process helped the students in perceiving mathematics more thoroughly, understanding the topics in depth and in different aspects, and making sense of the logic behind the topics. Most importantly, these knowledge and skills were gained as a result of self-questioning or asking questions among the students that were facilitated in the motivating atmosphere of cooperative working environment.

Along with the positive feedbacks, the students also mentioned the difficulties they encountered with during the group works. They stated that some of their group mates did not meet their responsibilities such as writing down detailed solutions to the problems on the worksheets, keeping journal, paying attention to the error evaluation forms, and doing the homework thoroughly. However, the same students also stated that they warned their friends in case of failing to meet the requirements, and solved the issues among themselves. For instance, Ela said that "Some of our friends did not fill out the error evaluation forms truly. Also he/she did not explain the solutions to the problems in detail on the worksheets. We warned him/her for the overall success of our group. Everyone warned each other in the group".

On the other hand, the views of the students in the II. experimental group (cooperative) were found to be quite limited when evaluated in the context of "the student / his or her knowledge about the process and skills to control it". According to positive wiev of students, the students expressed that they did reciprocal questioning on paired worksheets, and explained the reasons in depth when their classmate did not understand the reasoning behind the explanations. In this sense, Inci said that "We

both explained how we are going to solve the problems; because, after one of us solves the problems, the other one should also solve them". Furthermore, Melih stated that "Even if it is only one person in the group that did not understand, we explained everything in detail without getting bored. Everyone in the group taught each other".

When a student could not solve a problem, s/he explained the group work process and her/his questions to teammates. While Hale, a student, expressed that "If any of us does not understand the topic, other help her/him.", Sıla stated "I have done my best in order to ensure that not oly myself, but also all my teammates become successful in exams. We have tried to solve every practice problem as a group. When I tried to explain the process to my teammates, I also learned the topic better.". On the other hand, Cem said "I did not pass any question if I am struggled; instead, I asked to my friends".

Since there is group evaluation in cooperative learning, students has expressed that they worked with their friends and became more successful in group study. In this respect, Ahmet said "As long as my group is successful, I am successful. That is why, everybody worked hard. There was no free-ride". Inci stated "Now we are a connected group. We should be good at the exams, my success would not be enough by itself. We have shared our own knowledge with each other". Cem expressed that "I think the exams are fair. Because I was successful if my grades got better. Not only the hard-working students were successful. Everybody had a chance to improve their group's results".

Within the II. experimental group (cooperative), students stated negative results in terms of fulfilling personal responsibilities within the group. They explained that there were some students who were disruptive to the group process; however, they overcame this hurdle by communicating with each other and with the teacher. While Hale stated that "Some students did not participate in the activities as much as they could. When my teammate was not willing to participate, I felt sad and gave him a warning", Ahmet said "But some teammates did not complete the assignments. I was really upset with this. We have always warned these irresponsible individuals". Some students expressed their concerns about potential negative effects of cooperative learning method on their grades. In this regard, Buse said "I was concerned about a possible drop in my grade, because there are some students with low grades in the group". Also, students emphasized that they have warned their counterparts in case they behaved disrespectfully. Melih stated that "There were some disagreements occassionally. We have warned the ones who increased tone of their voice in discussions. We have decided that everyone should be respectful to each other".

The views of the students were found to be mostly focused on group work, communication, and mathematics rather than the theme scope. In this case, it can be said that although the cooperative learning method can be effective in developing social and affective skills, it should be supported with enriched activities in order to develop metacognitive skills as well.

Conclusion, Discussion and Implications

The development of metacognitive skills, which are prerequisite for meaningful learning in mathematics (Brown, 1987), depend on having metacognitive experiences (Biryukov, 2004). In this context, according to the first sub-problem, at the end of the interventions, a statistically significant difference was found between the average scores of the Jr. MAI pre-test/post-test of both the I. and II. experimental groups students. This difference is in favour of the post-test. It was also determined that the effect sizes for the I. and the II. experimental groups were large and medium respectively. This finding is in parallel with the findings of the previous experimental studies (Dignath, Büttner, & Langfeldt, 2008; Özsoy & Ataman, 2009). In their meta-analysis study, Dignath et al. (2008) indicated that teaching through metacognitive strategies had a large effect size in the development of megacognitive skills. Özsoy and Ataman (2009) found that teaching megacognitive strategies in mathematics lessons resulted in positive development with a 'large' effect size on metacognitive skills.

However, no statistically significant differences were found among the Jr. MAI pre-test/post-test score averages of the students in the control group. Using methods and strategies that supported

students to behave actively and ask questions are thought be the reason behind this result. However, it can also be said that the application in control group did not contribute to the development of the students' metacognitive skills at all. In this sense, Jbeili (2012) stated that conventional method of teaching struggles on the face of evolving expectations from knowledge and skills. That is why, it was emphasized that it is important for the students to understand their own learning methods and evaluate learning processes in effective mathematics education.

In this study according to the second and third sub-problems, at the end of the interventions, statistically significant difference was found among the Jr. MAI post-test score averages of the experimental groups and control group. According to the results of the data analysis, it was seen that metacognitive skills of the I. experimental group (cooperative+metacognitive) were are significantly higher than of both the II. experimantal group (cooperative) and the control group.

Lopata et al. (2003) stated that only 23% of students properly adapt and realize cooperative learning. In this regard, the activities in the cooperative learning method were enhanced with metacognitive strategies in this study. According to the results, using metacognitive strategies together with the cooperative learning method has a positive influence on the development of students' metacognitive skills. Being involved in discussions that reflect the students' thoughts, thinking aloud, and prompting strategies can be said to facilitate the development of the students' metacognitive skills such as planning, monitoring, and evaluation. This result is in parallel with the existing research that studied the effects of cooperatively environments on metacognitive skills (Cooper & Smith, 1993; Eizenberg & Zaslavsky, 2003; Hartman, 2001; Jbeili, 2012; Lan, 2007; Larkin, 2006; Sandi-Urena, 2008; Sandi-Urena et al., 2011; Steele, 2005; Teong, 2003). The results also support the study conducted by Jbeili (2012) and Lan (2007) that emphasized the facilitator role of metacognitive questions and discussions incorporated in cooperative groups in the development of the students' metacognitive skills. Moreover, Hartman (2001) and Steele (2005) explained that metacognitive skills of students in the cooperative groups are developed by explaining solutions to the problem and then confirming them, while expressing thoughts aloud. Also, Sandi-Urena et al. (2011) and Sandi-Urena (2008) emphasized that social interaction and reflective thinking applications contribute to increase metacognitive skills.

The reflections from the students, such as "I solve the problems by putting more thought on them with the help of prompting cards. I consider my solution process in more detail since I explain it to my classmate." and "I learned more when I was discussing my mistakes with my classmate. I evaluated easy and difficult questions before choosing them. I asked to myself why the question was a difficult one. I also asked to myself whether I solved a similar problem before or not." confirm the results of existing studies. This result of the study comply with Eizenberg and Zaslavsky's (2003) statement that cooperation and metacognitive skills can be reciprocally developed. Research by Teong (2003) and Cooper and Smith (1993) are also in parallel with Eizenberg and Zaslavsky's (2003) findings, so that self-awareness of students, who work in cooperation, about their own cognitive processes is higher. Similarly, according to Larkin (2006), cooperative learning is effective on the development of children's metacognitive skills. In his study about the development of metacognitive skills in a cooperative learning environment, Larkin (2006) explained the effect of social interaction on metacognition saying that "Asking questions to self can be started after asking questions to others".

In this study, it was seen that materials like prompting card, error evaluation forms, action cards, homework guidance form, and journal, which are aimed at developing metacognitive skills, have been effective in the higher level of development of metacognitive skills of the students participated in cooperative learning method groups enhanced with metacognitive strategies compared to that of students in groups that only cooperative learning method was used. Existing studies also confirm this finding (Cooper & Smith, 1993; Davis, 2003; Hargrove, 2013; Lin, 2001; Wilson, 2001). Cooper and Smith (1993) stated that the students that were guided with the help of certain roles and paired worksheets planned and monitored their work in cooperation. Moreover, Davis (2003) and Lin (2001) explained that prompting facilitate the development of metacognitive skills by providing an opportunity for the students to plan and track their own learnings, and also, the prompting can be used to prompt self-

explanation. Hargrove (2013) emphasized that journal is a tool for the use of the students in order to reflect and evaluate their ideas. Also, Hargrove (2013) found that journals can help an individual restructure his/her knowledge. In his study about a similar strategy as putting action cards in line activity, Wilson (2001) showed that putting action cards in line activity provide opportunities for students to comprehend their thoughts, discuss about them, and control them.

The questions taking place on worksheets and homework guidance forms and aimed at employing predicting strategy can also be considered as an important factor in the development of metacognitive skills. Making prediction was found to be a critical metacognitive skill for problem solving processes in many researches (Desoete, 2001; Meijer, Veenman, & van Hout-Wolters, 2006).

Modeling strategy that was applied in the I. experimental group (cooperative+metacognitive) is also thought to be one of the factors contributing to the development of metacognitive skills. In this study, the teacher acted as a role model for the students by thinking aloud during the course, asking question to herself, and making in depth evaluations. The statements of the students such as "I asked questions to myself just as my teacher did" and "I acted similar to my teacher when I was working with my classmate. I kept asking questions and requested explanations from my friend", and findings of Hacker and Dunlosky (2003) support the aforementioned conclusion. Hacker and Dunlosky (2003) emphasized that creating an environment that encourages students to ask questions oneself and facilitates discussion is important. According to Hacker and Dunlosky (2003), a teacher that asks effective questions can help students solve problems and activate their thinking processes and metacognitive skills. This study suggested that the role of teacher is effective on making contributions to the development of metacognitive skills. The findings of Adibnia and Putt (1998) support this finding. Adibnia and Putt (1998) modeled the process of metacognitive thinking and consciousness and explained that teaching conducted with metacognitive strategies can lead to metacognitive activities for students.

Also in this study, statistically significant difference was found among the Jr. MAI post-test score averages of the II. experimental (cooperative) and control group. This difference is in favour of the II. experimental group (cooperative). This result of the study consistent with the results of studies explaining that high level thinking skills of students such as reasoning and ratiocination are developed if the students are engaged in cooperative learning methods (Artz & Newman, 1990; Jbeili, 2012; Johnson & Johnson, 1999, Slavin, 1995). Artz and Newman (1990) explained that cooperative learning method support the students to increase their thinking and reasoning skills. Jbeli (2012) stated that skill levels of the students in mathematics were developed when they were taught with cooperative learning method. However, the level of development in the groups adapting only cooperative learning method was found to be less than the level of development in the groups that cooperative learning method is enhanced with metacognitive strategies. Johnson and Johnson (1999) emphasized that cooperative learning method encourages cognitive thinking and new ideas more compared to competitive and individual teaching methods. According to Slavin (1995), high level cognitive skills can be developed with the help of academic dilemmas and cognitive imbalances arising from being involved in cooperation process.

In the light of the findings of this study, cooperative learning method enhanced with metacognitive strategies can be said to be an important factor in the development of the students' metacognitive skills. For this reason, metacognition can be used as a useful tool to develop thinking skills of students in mathematics, which is also emphasized in the vision of in the elementary level mathematics curriculum. Culaste (2011) stated that new experiences about monitoring and evaluation should be offered to students in order to help them develop their metacognitive skills. According to Jbeli (2012), activities such as prompting metacognitive questions facilitate incorporation of cooperative learning method in a more efficient way. In this regard, it is suggested that learning environments supporting the development of metacognitive skills should be incorporated in cooperative learning processes in elementary level.

Teacher was found to be an important determinant in the implementation of cooperative learning method enhanced with metacognitive strategies. Accordingly, skills and knowledge of the teachers are critical for the employment of cooperative learning method and metacognitive strategies in mathematics education. For this reason, in-service training can be implemented aimed towards teachers. It would be helpful to provide environments that can include cooperative learning method enhanced with metacognitive strategies rather than providing only theoretical information in these in-service training. In this way, the teachers can have experiences with the help of different activities. Also, incorporating theoretical and applied information about metacognitive and cooperative learning into education faculty can be effective in training prospective teachers in a more equipped way.

There exists some studies explaining the advantages and disadvantages of using the metacognitive strategies by themselves as they are employed in this study (Hargrove, 2013; Panaoura & Philippou, 2007; Pugalee, 2004; Steele, 2005). Experiences during problem solving process can be stated as they are in thinking aloud strategy, however, it takes more time in reality compared to the writing strategy (Panaoura & Philippou, 2007). Writing strategy is easier to implement in large groups (Pugalee, 2004; Steele, 2005). It is important to match students with their same-age peers in paired problem-solving strategy. This strategy is advantegous in terms of the student's efforts to understand her/his peer's thinking process and compare it with their own process (Hargrove, 2013). In this study, üstbilişsel stratejiler were used in a complementary way and by integrating them with cooperative learning method. Future reseach can focus further on understanding the effects of metacognitive strategies on the development of metacognitive skills, and on identifying advantages and disadvantages of these strategies.

One of the main challenges in studies on megacognition is the measurement of metacognition (Deseote & Özsoy, 2009; Panaoura & Philippou, 2007). Though different methods are employed to measure metacognition, each method is criticized (Whitebread et al., 2009; Wilson, 2001) and has its advantages and disadvantages (Panaoura et al., 2003). Self-report methods are often used for evaluating metacognition (Kramarski & Mevarech, 2003; Sperling et al., 2002). Open-ended surveys might provide rich qualitative data despite being time-consuming. There are also criticisms about their validity and reliability, as is the case in the observation technique (Nisbett & Wilson, 1977). Multiple-choice surveys are useful for measuring metacognitive processes fast and providing objective data. However, the disadvantage about surveys is that especially young students verbal ability is incompletely developed (Whitebread et al., 2009). As for the writing technique, it is used in mathematics lessons both for developing metacognitive behaviour in problem-solving processes and for collecting data (Pugalee, 2004; Steele, 2005). In the present study, multiple-choice scale and writing technique were used to collect data for measuring the metacognitive skills of students. It was assumed that the limitations of both techniques might be reduced by using them together. It is also recommended to use multi-dimensional scales for measuring metacognitive skills in future studies due to the advantages and disadvantages of one single method (Özsoy & Ataman, 2009).

For the internal validity of experimental studies, it is advised that researchers carry out the same activities in control and experimental groups during the process (except for the independent variable that is manipulated in the experimental group) (Creswell, 2005). In the present study, it was hypothesized that the students in the experimental groups and control group were in equal conditions in terms of the learning environment. Also, the lessons were taught based on the same acquisition and same problems in both groups. However, they were taught by different teachers in the experimental groups and control group. In order to prevent this situation from posing a threat about the internal validity of the study, teacher interviews, coordinated studies, written teacher opinions about the problem-solving activities, and observation form were employed, which are explained in detail under the title of "Intervention Steps in the Control Group". It was determined that a teacher-centered learning process was carried out in the control group unlike the methods and strategies employed in the experimental groups. Similarly, a teacher observation form was used in a previous study by Özsoy and Ataman (2009) in order to describe the process in control and experimental groups. For future studies,

it can be recommended to use more than one control group for finding out the effectiveness of the methods and strategies in more detail.

This study is limited with the algebra learning area in 6th grade mathematics course. Further experimental research can be conducted in different Learning Areas and levels of grades by using cooperative learning method enhanced with metacognitive strategies. Additional studies about the how cooperative learning method enhanced with metacognitive strategies effect different variables such as self-efficacy, attitude, logical thinking, and critical thinking can be conducted. Interaction among students that are involved in cooperative learning methods enhanced with metacognitive strategies can be analyzed in detail with the help of qualitative studies. In this study, STAD, which is one of the cooperative learning techniques, was used. Further research can be conducted to understand the effects of supporting cooperative learning techniques with metacognitive strategies on the variables like academic performance, metacognitive skills, and attitude.

Effectiveness of the cooperative learning method, which is frequently emphasized in the current Middle School Mathematics Curriculum (MEB, 2013), can be increased by enhancing it with metacognitive strategies. However, it was observed that the programs used in Turkey do not pay much attention to including metacognitive skills. In this context, incorporating the activities and educational attainments that develop metacognitive skills into program enhancement studies can be useful. Integrating metacognitive strategies such as metacognitive prompting, which was also used in this study, with learning methods and course content can contribute to the construction of the program.

In order to apply cooperative learning method and metacognitive strategies, physical environment of classrooms should be arranged in a way that facilitates interaction between the students. Based on the findings of the study, it can be said that modification of desk order only for mathematics education may lead to a problematic process. In order to prevent this problematic situation, classroom environments that can facilitate employment of methodological approaches should be provided to teachers by considering the physical dimensions of learning environments.

Preparation of cooperative activities that match with every specific subject can be seen as a tiresome process for teachers even though it is aimed at developing the students' metacognitive skills. However, as emphasized by Gerver and Sgroi (2003), a teacher, who is willing to implement an approach that will make students active agents in their education, can construct his/her plan aimed at this purpose. To that end, coordination among teachers is suggested. As Gerver and Sgroi (2003) also suggested, if every teacher can develop several activities throughout an academic year, an archive of the activities with experimented and proven effectiveness can be achieved at the end of the year, and can be ready to use for the next year after eliminating the deficiencies. In this direction, an archive of materials that can be created by teachers by designing activities that can develop metacognitive skills in cooperative learning environments can be useful.

References

Açıkgöz, K. Ü. (1992). *İşbirlikli öğrenme: Kuram, araştırma, uygulama*. Malatya: Uğurel Matbaası.

Adibnia, A., & Putt, I. J. (1998). Teaching problem solving to year 6 students, a new approach. *Mathematics Education Research Journal*, *10*(3), 42-58.

Andersen, T. (2009). *Using cooperative learning in a sixth grade math classroom (Action research projects)*. Lincoln: Universty of Nebraska.

Artz, A. F., & Newman, C. M. (1990). Cooperative learning. *Mathematics Teacher*, *83*, 448-449.

Aydın, U. (2007). *Structural equation modeling study: The metacognition knowledge model for geometry* (Unpublished master's thesis). Middle East Technical University, Department of Secondary Science and Mathematics Education, Ankara.

Biryukov, P. (2004). Metacognitive aspects of solving combinatorics problems. *International Journal for Mathematics Teaching and Learning*, 1-19. Retrieved from http://www.cimt.org.uk/journal/biryukov.pdf

Blakey, E., & Spence, S. (1990). Thinking for the future. *Emergency Librarian*, *17*(5), 11-13.

Brown, A. L. (1987). Metacognition, executive control, self-regulation, and other even more mysterious mechanisms. In F. E. Weinert, & R. H. Kluwe (Eds.), *Metacognition, motivation and understanding* (pp. 65-116). Hillsdale, Nj: Lawrence Erlbaum Associates.

Büyüköztürk, Ş. (2012). *Sosyal bilimler için veri analizi el kitabı*. Ankara: PegemA Yayıncılık.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

Cooper, T., & Smith, R. (1993, July 9-13). *Relating social-interaction roles and metacognitive functioning in mathematics problem solving*. Paper presented at the Contexts in Mathematics Education: Proceedings of the Sixteenth Annual Conference of the Mathematics Education Research Group of Australasia (Merga), Brisbane.

Costa, A. L. (1984). Mediating the metacognitive. *Educational Leadership*, *11*, 57-62.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, CA: Sage.

Creswell, J. W. (2005). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (2nd ed.). New Jersey: Pearson Education, Inc.

Culaste, I. C. (2011). Cognitive skills of mathematical problem solving of grade 6 children. *International Journal of Innovative Interdisciplinary Research*, *1*, 120-125.

Darling-Hammond, L., Austin, K., Cheung, M., & Martin, D. (2003). *Thinking about thinking: Metacognition*. Retrieved from http: // www.learner.org/Courses/LEarningclassroom/Support/09_Metag.Pdf

Davidson, N. (1990). Small-group cooperative learning in mathematics. In N. J. Cooney (Ed.), *Teaching and learning mathematics in the 1990s: 1990 yearbook* (pp. 52-61). Reston, Va: Nctm.

Davis, E. A. (2003). Prompting middle school science students for reflection: Generic and directed prompts. *The Journal of the Learning Sciences*, *12*(1), 91-142.

Deseote, A., & Özsoy, G. (2009). Introduction: Metacognition, more than the lognes monster?. *International Electronic Journal of Elementary Education*, *2*(1), 1-6.

Desoete, A. (2001). *Off-line metacognition in children with mathematics learning disabilities* (Unpublished doctoral dissertation). Universiteit Gent.

Desoete, A., Roeyers, H., & Buysse, A. (2001). Metacognition and mathematical problem solving in grade 3. *Journal of Learning Disability*, *34*(5), 435-449.

Dignath, C., Büttner, G., & Langfeldt, H. P. (2008). How can primary school students learn self-regulated learning strategies most effectively? A meta-analysis on self-regulation training programmes. *Educational Research Review*, *3*, 101-129.

Eizenberg, M. M., & Zaslavsky, O. (2003). Cooperative problem solving in combinatorics: The inter-relations between control processes and successful solutions. *Journal of Mathematical Behavior*, *22*, 389-403.

Erbaş, A. K., Çetinkaya, B., & Ersoy, Y. (2009). Student difficulties and misconceptions in solving simple linear equations. *Education and Science*, *34*(152), 44-59.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive developmental inquiry. *American Psychologist*, *34*(10), 906-911.

Fortunato, I., Hecht, D., Tittle, C., & Alvarez, L. (1991). Metacognition and problem solving. *Arithmetic Teacher*, *39*(4), 38-40.

Gerver, R. K., & Sgroi, R. J. (2003). Creating and using guided-discovery lessons. *Mathematics Teacher*, *96*(1), 6-13.

Hacker, D. J., & Dunlosky, J. (2003). Not all metacognition is created equal. *New Directions for Teaching and Learning*, *95*, 73-79.

Hargrove, R. A. (2013). Assessing the long-term impact of a metacognitive approach to creative skill development. *International Journal of Technology and Design Education*, *23*(3), 489-517. doi:10.1007/s10798-011-9200-6

Hartman, H. J. (2001). Developing students' metacognitive knowledge and strategies. In H. J. Hartman (Ed.), *Metacognition in learning and instruction: Theory, research, and practice* (pp. 33-68). London-The Netherlands: Kluwer Academic Publishers. Chapter 8 Dordrecht.

Ifamuyiwa, S. A., & Akinsola, M. K. (2008). Improving senior secondary school students' attitude towards mathematics through self and cooperative-ınstructional strategie. *International Journal of Mathematical Education in Science and Technology*, *39*(5), 569-585.

Ifenthaler, D. (2012). Determining the effectiveness of prompts for self-regulated learning in problem-solving scenarios. *Educational Technology & Society*, *15*(1), 38-52.

Jager, B., Jansen, M., & Reezigt, G. (2005). The development of metacognition in primary school learning environments. *School Effectiveness and School Improvement*, *16*, 179-196.

Jbeili, I. (2012). The effect of cooperative learning with metacognitive scaffolding on mathematics conceptual understanding and procedural fluency. *International Journal for Research in Education (IJRE)*, *32*, 45-71.

Jbeili, I. M. A. (2003). *The effects of metacognitive scaffolding and cooperative learning on mathematics performance and mathematical reasoning among fifth-grade students in Jordan* (Unpublished doctoral dissertation). University Sains Malaysia.

Johnson, D. W., & Johnson, R. T. (1999). *Learning together and alone: Cooperative, competitive and individualistic learning*. Boston: Allyn & Bacon.

Johnson, R. B., & Onwuegbuzıe, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher*, *33*(7), 14-26.

Köklü, N., Büyüköztürk, Ş., & Çokluk Bökeoğlu, Ö. (2010). *Sosyal bilimler için istatistik*. Ankara: PegemA Yayınları.

Kramarski, B., & Mevarech, Z. R. (2003). Enhancing mathematical reasoning in the classroom: The effects of cooperative learning and metacognitive training. *American Educational Research Journal*, *40*(1), 281-310.

Krol, K., Janssen, J., Veenman, S., & Van Der Linden, J. (2004). Effects of a cooperative learning program on the elaborations of students working in dyads. *Educational Research and Evaluation*, *10*(3), 205-237.

Lan, H. G. (2007). A cooperative learning programme to enhance mathematical problem solving performance among secondary three students. *The Mathematics Educator*, *10*(1), 59-80.

Larkin, S. (2006). Collaborative group work and individual development of metacognition in the early years. *Research in Science Education*, *36*, 7-27.

Lin, X. (2001). Designing metacognitive activities. *Educational Technology Research and Development*, *49*(2), 23-40.

Lin, X., & Sullivan, F. R. (2008). Computer context for supporting metacognitive learning. In J. Voogt, & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (Vol. 1, pp. 281-298). New York: Springer.

Livingston, J. A. (1997). *Metacognition an overview*. Retrieved from http://gse.buffalo.edu/Fas/Shuell/Cep564/Metacog.Htm

Lopata, C., Miller, D., & Miller, R. (2003). A survey of actual and preferred use of cooperative learning among exemplar teachers. *The Journal of Educational Research*, *96*, 232-239.

Lucas, C. A. (1999). *A study of effects of cooperative learning on the academic achievement and self-efficacy of college algebra students* (Unpublished doctoral dissertation). University of Kansas, Faculty of The Graduate School Department of Teaching and Leadership, Lawrence.

Meijer, J., Veenman, M. V. J., & van Hout-Wolters, B. H. A. M. (2006). Metacognitive activities in text-studying and problem-solving: Development of a taxonomy. *Educational Research and Evaluation*, *12*(3), 209-237.

Mevarech, Z. R. (1999). Effects of metacognitive training embedded in cooperative settings on mathematical problem solving. *The Journal of Educational Research*, *92*, 195-205.

Mevarech, Z. R., & Amrany, C. (2008). Immediate and delayed effects of meta-cognitive instruction on regulation of cognition and mathematics achievement. *Metacognition Learning*, *3*(2), 147-157.

Mevarech, Z. R., & Kramarski, B. (1997). Improve: A multidimensional method for teaching mathematics in heterogeneous classrooms. *American Educational Research Journal*, *34*(2), 365-394.

Mevarech, Z. R., Terkieltaub, S., Vinberger, T., & Nevet, V. (2010). The effects of meta-cognitive instruction on third and sixth graders solving word problems. *Zdm*, *42*(2), 195-203.

Minisrty of Natioanl Education. (2009). *İlköğretim matematik dersi 6-8. sınıflar öğretim programı ve kılavuzu*. Ankara: MEB Yayınları.

Minisrty of Natioanl Education. (2013). *Ortaokul matematik dersi (5-6-7-8. sınıflar) öğretim programı*. Ankara: MEB Yayınları.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Nation Council of Teachers of Mathematics.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we know: Verbal reports on mental processes. *Psychological Review*, *84*, 231-259.

O'Neil, H. F., Chuang, S., & Chung, G. K. W. K. (2004). *Issues in the computer-based assessment of collaborative problem solving (CSE report 620)*. Los Angeles: University of California.

Özsoy, G. (2011). An investigation of the relationship between metacognition and mathematics achievement. *Asia Pacific Educ. Rev.*, *12*, 227-235.

Özsoy, G., & Ataman, A. (2009). The effect of metacognitive strategy training on problem solving achievement. *International Electronic Journal of Elementary Education*, *1*(2), 67-82.

Özsoy, S., & Özsoy, G. (2013). Effect size reporting in educational research. *Elementary Education Online*, *12*(2), 334-346.

Panaoura, A., & Philippou, G. (2007). The development of students′ metacognitive ability in mathematics. *Cognitive Development*, *22*(2), 149-164.

Panaoura, A., Philippou, G., & Christou, C. (2003, March). *Young pupils' metacognitive ability in mathematics*. Paper presented at the Third Conference of the European Society for Research in Mathematics Education, Italy.

Pintrich, P. R. (2002). The role of metacognitive knowledge in learning, teaching and assessing. *Theory into Practice*, *41*(4), 219-225.

Pugalee, D. K. (2004). A comparison of verbal and written descriptions of students' problem solving processes. *Educational Studies in Mathematics*, *55*, 27-47.

Rogers, R. (2001). Reflection in higher education: A concept analysis. *Innovative Higher Education*, *26*, 37-57.

Sandi-Urena, S. S. (2008). *Design and validation of a multimethod assessment of metacognition and study of the effectiveness of metacognitive ınterventions* (Unpublished doctoral dissertation). Graduate School of Clemson University, Usa.

Sandi-Urena, S., Cooper, M. M., & Stevens, R. H. (2011). Enhancement of metacognition use and awareness by means of a collaborative metacognitive intervention. *International Journal of Science Education*, *33*, 323-340.

Schraw, G., & Sperling-Dennison, R. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology*, *19*, 460-470.

Senemoğlu, N., Gömleksiz, M., & Üstündağ, T. (1999). *Öğrenmenin oluşumu*. Burdur: Burdur Eğitim Fakültesi Yayınları.

Settlage, J., & Southerland, S. A. (2007). Teaching science through inquiry. *In Teaching Science to Every Child*, 87-93.

Shamir, A., Mevarech, Z. R., & Gida, C. (2009). The assessment of meta-cognition in different individualized vs. peer assisted learning. *Metacognition Learning*, *4*, 47-61.

Sharan, S. (1980). Cooperative learning in small groups: Recent methods and efeects on achievement, attitudes and ethnic relations. *Review of Educational Research*, *50*(2), 241-271.

Slavin, R. E. (1990). Research on cooperative learning: Consensus and controversy. *Educational Leadership*, *47*(4), 52-54.

Slavin, R. E. (1995). *Cooperative learning: Theory, research, and practice*. Boston: Allyn & Bacon.

Slavin, R. E., Hurley, E. A., & Chamberlain, A. (2003). Cooperative learning and achievement: Theory and research. In W. M. Reynolds, & G. E. Miller (Eds.), *Handbook of psychology: Educational psychology* (Vol. 7, pp. 177-198). New York: Wiley.

Smith, M. W. (1995). Ethics in focus groups: A few concerns. *Qualitative Health Research*, *5*, 478-486.

Souvignier, E., & Kronenberger, J. (2007). Cooperative learning in third graders' jigsaw groups for mathematics and science with and without questioning training. *British Journal of Educational Psychology*, *77*, 755-771.

Sperling, R. A., Howard, B. C., Miller, L. A., & Murphy, C. (2002). Measures of children's knowledge and regulation of cognition. *Contemporary Educational Psychology*, *27*, 51-79.

Steele, D. (2005). Using writing to access students' schemata knowledge for algebraic thinking. *School Science and Mathematics*, *105*(3), 142-154.

Tabachnick, B. G., & Fidell, L. S. (2000). *Using multivariate statistics*. Boston: Allyn & Bacon.

Tarım, K., & Akdeniz, F. (2008). The effects of cooperative learning on Turkish elementary students' mathematics achievement and attitude towards mathematics using tai and stad methods. *Educ Stud Math*, *67*, 77-91.

Teong, S. K. (2003). The effect of metacognitive training on mathematical word-problem solving. *Journal of Computer Assisted Learning*, *19*(1), 46-55.

Terhart, E. (2003). Constructivism and teaching: A new paradigm in general didactics? *Journal Curriculum Studies*, *35*(1), 25-44.

Tobias, S., & Duffy, T. M. (2009). The success or failure of constructivist ınstruction. In S. Tobias, & T. M. Duffy (Eds.), *Constructivist instruction: Success or failure?* (pp. 3-10). New York: Routledge.

Toit, S., & Kotze, G. (2009). Metacognitive strategies in the teaching and learning of mathematics. *Pythagoras*, *70*, 57-67.

Van Der Stel, M., & Veenman, M. V. J. (2008). Relation between intellectual ability and metacognitive skillfulness as predictors of learning performance of young students performing tasks in different domains. *Learning and Individual Differences*, *18*, 128-134.

Veenman, M. V. J., Hesselink, R. D., Sleeuwaegen, S., Liem, S. I. E., & Van Haaren, M. G. P. (2014). Assessing developmental differences inmetacognitive skills with computer logfiles: Gender by age interactions. *Psychological Topics*, *23*(1), 99-113.

Webb, N., & Farivar, S. (1994). Promoting helping behavior in cooperative small groups in middle school mathematics. *American Educational Research Journal*, *31*, 369-396.

Whitebread, D., Coltman, P., Pasternak, D. P., Sangster, C., Grau, V., Bingham, S., … & Demetriou, D. (2009). The development of two observational tools for assessing metacognition and self-regulated learning in young children. *Metacognition and Learning*, *4*(1), 63-85.

Wiersma, W. (2000). *Research methods in education: An introduction*. Needham Heights, Ma: Allyn & Bacon A Pearson Education Company.

Wilburne, J. M. (1997). *The effect of teaching metacognition strategies to preservice elementary school teachers on their mathematical problem solving achievement and attitude* (Unpublished doctoral dissertation). Temple University Graduate Board, Philadelphia.

Williams, D. (2005). *The impact of cooperative learning in comparison to traditional instruction on the understanding of multiplication in third grade students* (Unpublished doctoral dissertation). Capella University.

Wilson, J. (2001). *Methodological difficulties of assessing metacognition: A new approach*. Retrieved from ERIC databases (ED460143).

Wirth, J. (2009). Prompting self-regulated learning through prompts. *Zeitschrift für Pädagogische Psychologie*, *23*(2), 91-94.

Woolfolk, A. (2007). *Educational psychology* (10th ed.). Boston, MA: Allyn & Bacon.

Yıldırım, A., & Şimşek, H. (2008). *Sosyal bilimlerde nitel araştırma yöntemleri*. Ankara: Seçkin Yayıncılık.

Yıldırım, K., & Tarım, K. (2008). Çoklu zekâ kuramı destekli kubaşık öğrenme yönteminin ilköğretim beşinci sınıf matematik dersinde akademik başarı ve hatırda tutma düzeyine etkisi. *İlköğretim Online*, *7*(1), 174-187.

Zakaria, E., Chin, L. C., & Daud, Y. (2010). The effects of cooperative learning on students' mathematics achievement and attitude towards mathematics. *Journal of Social Sciences*, *6*(2), 272-275.

Appendix 1. Activity Worksheets

ÇALIŞMA KAĞIDI

Aşağıdaki tabloyu doldurunuz.

Cebirsel ifade	Terimler	Terim sayısı	Katsayılar	Katsayılar toplamı
8+3a	8, 3a	2	8, 3	8+3 =11
2n-7m+12	2n, -7m, 12	3	2, -7, 12	12+2=14 - 7= 7
5xy	5	1	5	5
3ab+4k	3ab, 4k	2	3, 4	3+4 = 7
7y+9f-3r	9y, 9f, -3r	3	7, 9-3	9+7=16-3 = 13
6hfgb+5	6hfgb, 5	2	6, 5	6+5 = 11

toplam çıkarm

Problemler kolay gibi gözüküyor.

Problemleri kaç dakikada çözebileceğini tahmin et v e tahminini yaz..6. çok olduğunu gördüm

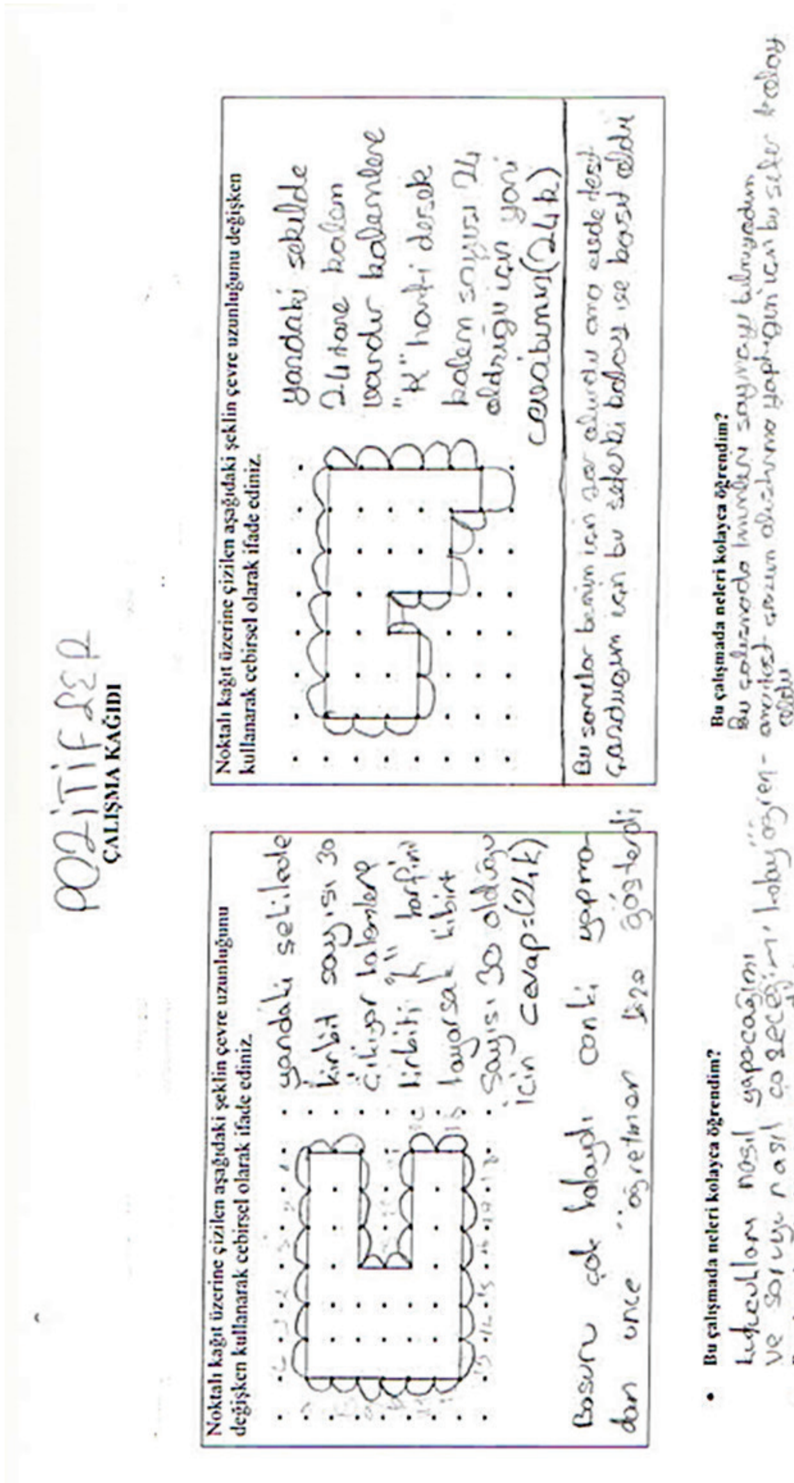
1. Problemleri çözmeye başlamadan önce saat:09:30 6 dakikada bitiriyim sandım
2. Problemlerin çözümü bittiğinde saat:09:35

Bu çalışmadaki en kolay problem: 3'üncü
Çünkü, Sadece bir terim var.

Bu çalışmadaki en zor problem: 5inci ile 2 inci
Çünkü, Sorudaki problemleri biraz düzündüm. Eksi benim kafamı karıştırdı.

Yanlış yaptığım soru var mı? Niçin yanlış yaptım?
Yanlış yaptığım soru yok. Çünkü problemleri tekrar tekrar dikkatli okudum. Ayrıntıları gözden kaçırmadım. Terim bne dikkat ettim

Buna benzer sorularda hata yapmamak için ne yapmalıyım?
Buna benzer sorularda hata yapmamak için problemleri dikkatli okuyup, ayrıntıları gözden kaçırmamalıyım.


ÇALIŞMA KAĞIDI
Noktalı kağıt üzerine çizilen aşağıdaki şeklin çevre uzunluğunu değişken kullanarak cebirsel olarak ifade ediniz.
Noktalı kağıt üzerine çizilen aşağıdaki şeklin çevre uzunluğunu değişken kullanarak cebirsel olarak ifade ediniz.
Bu çalışmada neleri kolayca öğrendim?
Bu çalışmada zorlandığım bölümler neler?
Arkadaşımın bana katkıları neler?
Bu çalışmada neleri kolayca öğrendim?
Bu çalışmada zorlandığım bölümler neler?
Arkadaşımın bana katkıları neler?

Appendix 2. Prompting Card

YÖNLENDİRME KARTI
PROBLEMİ ÇÖZMEDEN ÖNCE; 1. Problemi birkaç kez anlayana kadar yüksek sesle oku. Anlamadığın ifadeyi arkadaşına sor. 2. Problemden ne anladığını kendi cümlelerinle açıklayarak yaz. 3. Problem senin için zor mu kolay mı? 4. Problemin niçin zor veya kolay olduğunu arkadaşına açıkla. 5. Problemi çözmek için ihtiyacın olan ön bilgileri açıkla. 6. Daha önce benzer bir problem çözüp çözmediğini hatırlamaya çalış. Hatırlıyorsan önceki problemle hangi açıdan (nasıl) benzerlik taşıyor arkadaşına açıkla.
PROBLEMİ ÇÖZERKEN; 7. Problemi çözmek için hangi yolları kullanabilirsin?(tahmin etme ve test etme, şekil veya şema çizme, örüntü arama …) 8. Verilen bilgileri düzenle, önemli bilgileri not et. 9. Problemi çözerken yapacağın her işlemi adım adım yaz. 10. Her adımı bitirdikten sonra doğru olup olmadığını kontrol et. 11. Yanlış yaptığın adım varsa, yanlışını açıkla, adımını veya problemi tekrar yap. 12. Arkadaşların bu problemi çözerken ne tür hatalar yapabilir?
PROBLEM ÇÖZMEYİ BİTİRDİKTEN SONRA; 13. İşlemlerin ve cevabın doğru mu? Doğruluğunu kanıtla. 14. Çözüm yolunu gözden geçir ve problemi çözmek için farklı bir yol düşün. 15. Zorlandığın veya geri dönüp tekrar etmen gereken yerler var mı? 16. Problemden öğrendiklerini özetle.

Appendix 3. Error Evaluation Form

HATALARIMI DEĞERLENDİRİYORUM

➢ Yanlış yaptığım adım var mı? Evet yaklaşık var

➢ Varsa nerede yanlış yaptım?

Parantezli cebirsel ifadeleri yazarken, önce parantezin içine mi, önündeki sayıyı kat olarak mı okuyacağımı karıştırıyordum.

➢ Niçin yanlış yaptım?

Daha dikkatli cebirsel ifade yazmadığım için yanlış yaptım.

➢ Buna benzer sorularda hata yapmamak için ne yapmalıyım?

Arkadaşım bana, "daha önce çözdüğün soruları düşün" deyince, öğretmenimin yaptıklarını hatırladım. "Önce ne yapmalıyım?" diye düşündüm. Yani, öğretmenimizi dikkatli dinlemeliyiz. Bir de, arkadaşımın sorularını dikkate almalıyım.

➢ Hatalarımı düzeltmemde arkadaşım katkıları neler?

Beni hatalarımda uyardı ve yanlışlarımı düzeltmemi sağladı. O yönlendirme kartını okudu, ben de yaptım. Yönlendirme kartı beni biraz yavaşlattı ama böylece doğru olduğundan daha kesin emin oluyorum

➢ Çalışmanın sonunda arkadaşıma tavsiyelerim:

- Probleni anlayana kadar oku.
- Cevapları gözden geçir
- Soruyu biraz daha odaklan
- Adımlara dikkat et

Appendix 4. Activity Worksheet which Used "Putting Action Cards in Line" Strategy

ÇALIŞMA KAĞIDI

Selin ile Yaren'in yaşları toplamı 20 dir. Selin'in yaşı "f" olduğuna göre Yaren'in yaşını veren cebirsel ifadeyi yazınız.

1) Problemi okuduktan sonra ne anladığını kendi cümlelerinle açıklayarak yaz.	Selin'in ve Yarenin yaşlarının toplamı 20'dir
2) Problemi çözebilir misin, tahmin et? a) Problemi doğru çözeceğime kesinlikle eminim. b) Problemi doğru çözerim. c) Doğru çözebilirim ama hata olabilir. d) Problemi yanlış çözerim. e) Problemi yanlış çözeceğimden kesinlikle eminim.	a) Problemi doğru çözeceğime kesinlikle eminim.
3) Problemi adım adım açıklayarak çöz.	Selinin yaşı: f 20-f = YAREN'İN YAŞI Selin ve YAREN'İN YAŞLARININ TOPLAMI
4) Problemi nasıl çözdüğünü gösteren davranış kartlarını sırayla yaz.	1) Sahip olduğum bilgileri düşündüm. 2) Önceden buna benzer bir problem çözüp çözemediğimi hatırlamayı denedim. 3) Daha önce yaptığım ve bana faydası olan şeyleri düşündüm. 11) Problemi çözmek için bir plan yaptım. 20) Hesapladımı saydım. 24) Yapabileceğimi düşündüm. 31) Çözümü adım adım yaptım. 40) Çıkardım, 34) Arkadaşımla sonucu karşılaştırdım 39) Arkadaşımın sorgulamasıyla yaptıklarımı sürekli kontrol ettim.
5) Arkadaşların bu problemi çözerken ne tür hatalar yapabilir?	Aslında arkadaşımın yanlış yapacağını (bu soruda) düşünmüyorum. Artı ve çıkarma yerine toplama yapabilir, bir de 20-f yerine f-20 yapabilir.

Appendix 5. Homework Guidance Form

ÖDEV YÖNLENDİRME FORMU

EV ÖDEVİLERİNİ YAPARKEN;

- Problemi kaç dakikada çözebileceğini tahmin et ve tahminini yaz……
- Problemi çözmeye başlamadan önce saat:……..
- Problem çözümü bittiğinde saat:……..

Bu problemi doğru bir şekilde çözebilir misin?

a) Problemi doğru çözebileceğimden kesinlikle eminim.

b) Problemi doğru çözebilirim.

c) Problemi doğru çözemeyebilirim.

d) Problemi doğru çözemeyeceğimden kesinlikle eminim.

Problemi çözerken;

- Problemi dikkatli bir şekilde anlayana kadar oku.
- Uygun yolu seç.
- Problemi çözmek için gerekli olan önemli bilgileri belirle
- Problemi açıklayarak çöz.

Soruyu çözdün ve bir cevabın var. Cevabının doğru olduğundan emin misin?

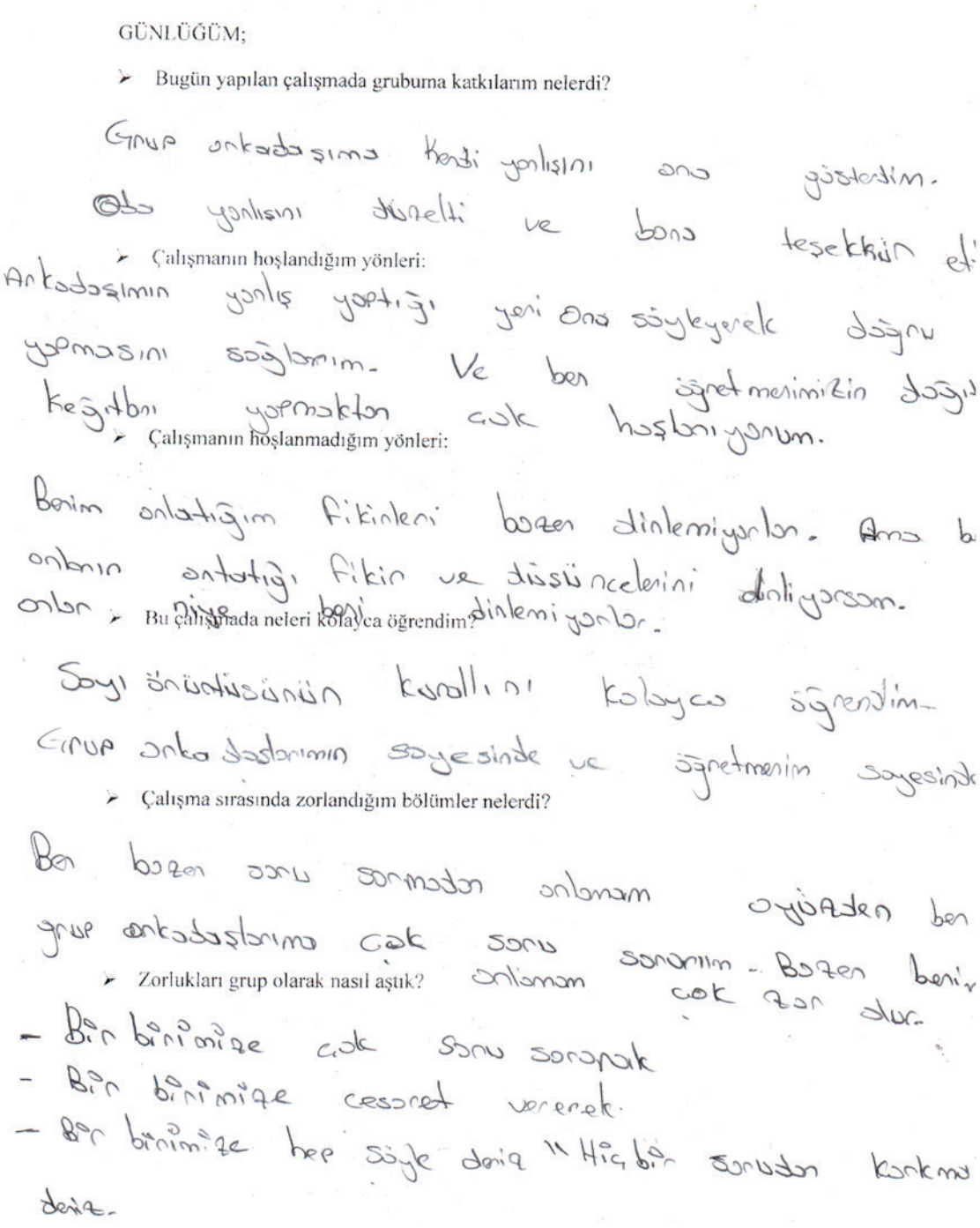
a. Problemi doğru çözdüm, kesinlikle eminim.

b. Problemi doğru çözdüğümden emin değilim.

c. Problemi doğru çözmedim, kesinlikle eminim.

d. Problemi doğru çözmediğimden emin değilim.

Appendix 6. Journal



GÜNLÜĞÜM;

- Bugün yapılan çalışmada gruburna katkılarım nelerdi?

Grup arkadaşıma kendi yanlışını ona gösterdim. Onu yanlışını düzeltti ve bana teşekkür etti.

- Çalışmanın hoşlandığım yönleri:

Arkadaşımın yanlış yaptığı yeri ona söyleyerek doğru yapmasını sağlarım. Ve ben öğretmenimizin doğru kağıtları yapmaktan çok hoşlanıyorum.

- Çalışmanın hoşlanmadığım yönleri:

Benim anlatığım fikirleri bazen dinlemiyorlar. Ama ben onların anlattığı fikir ve düşüncelerini dinliyorsam. onlar bana dinlemiyorlar.

- Bu çalışmada neleri kolayca öğrendim?

Sayı örüntüsünün kurallını kolayca öğrendim. Grup arkadaşlarımın sayesinde ve öğretmenim sayesinde

- Çalışma sırasında zorlandığım bölümler nelerdi?

Ben bazen soru sormadan anlamam oyüzden ben grup arkadaşlarıma çok soru sorarım. Bazen benim anlamam çok zor olur.

- Zorlukları grup olarak nasıl aştık?

- Bir birimize çok soru sorarak
- Bir birimize cesaret vererek.
- Bir birimize hep söyle dedik "Hiçbir sorudan korkma" dedik.

Appendix 7. Group Evaluation Form

GRUP DEĞERLENDİRME FORMU

Grubun adı: Zeki Dostlar **Sınıf:** 6/E

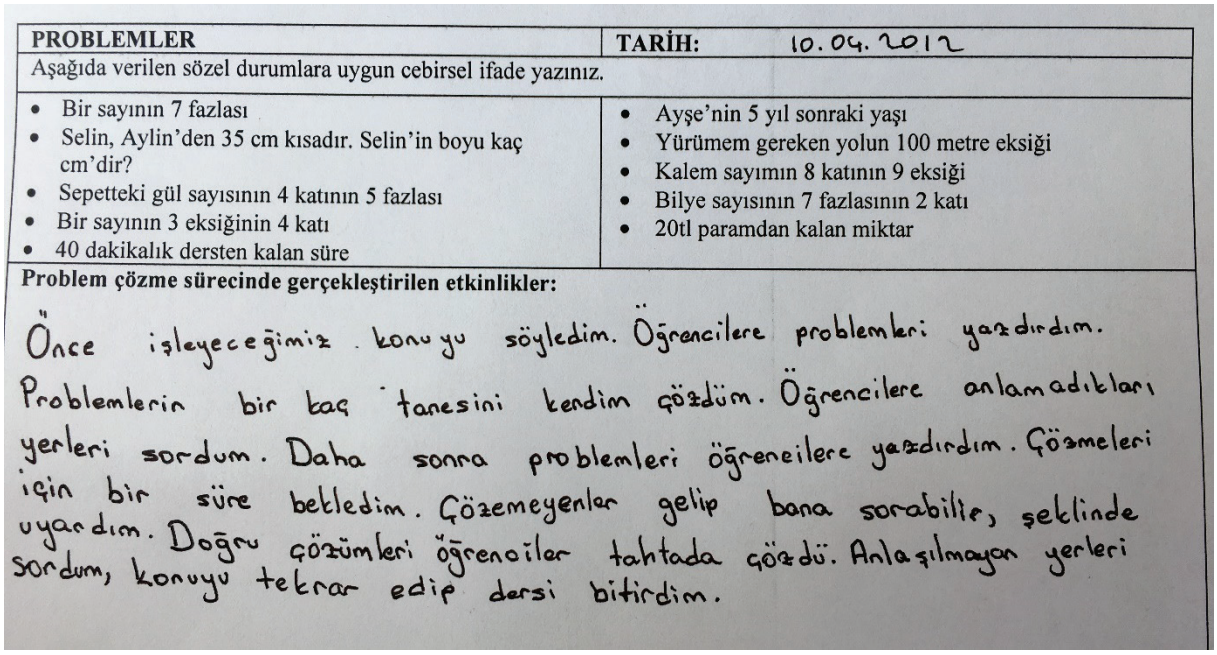
ÖLÇÜTLER	0	1	2	3	4	5
1. Grup üyelerinin birbirlerinin düşüncelerini dinlemesi						✓
2. Grup üyelerinin birbirlerine saygı göstermesi					✓	
3. Grubun kendi içindeki çatışmaları grup içinde çözmesi				✓		
4. Grup üyelerinin görüşlerini rahatlıkla ifade etmesi						✓
5. Grup üyelerinin bireysel sorumluluklarını yerine getirmesi						✓
6. Grup üyelerinin bilgileri birbirleri ile paylaşması						✓
7. Grup üyelerinin birbirlerine güvenmesi						✓
8. Grup üyelerinin ihtiyaç duyduklarında birbirinden yardım istemesi						✓
9. Grup üyelerinin birbirlerine destek olması						✓
10. Grup üyelerinin birbirlerini cesaretlendirmesi					✓	
11. Grup üyelerinin birbirlerini takdir etmesi					✓	
12. Grup üyelerinin birbirlerinin duygularını anlaması				✓		
13. Grup üyelerinin birbirinin hakkını koruması					✓	
14. Grup üyelerinin birlikte çalışmaktan hoşlanması						✓
15. Grubun verimli bir şekilde çalışması						✓
Toplam puan						

Grup olarak en iyi olduğumuz bölüm: Cebirsel İfadeler, grubun adı, Grubun işareti Grubun sloganı, birbirimize saygı göstermemiz, birbirimizi her zaman dinlemeniz, Grubun içindeki cinsellik, derse katılım, konu dışına.

Grup olarak karşılaştığımız en büyük problem: Yok, çok iyi bir grubuz hiç bir kavgamız yok grubun içinde, çok saygılıyız.

Grup olarak daha iyi olabilmek için şunları yapmalıyız: Çok çalışmalı, grup arkadaşlarımıza yardım etmeli birbirimizi dinlemeli ve konulara önem göstermeli

Appendix 8. Problem Solving Activity Plan for Control Group



PROBLEMLER	TARİH: 10.04.2012
Aşağıda verilen sözel durumlara uygun cebirsel ifade yazınız.	
• Bir sayının 7 fazlası • Selin, Aylin'den 35 cm kısadır. Selin'in boyu kaç cm'dir? • Sepetteki gül sayısının 4 katının 5 fazlası • Bir sayının 3 eksiğinin 4 katı • 40 dakikalık dersten kalan süre	• Ayşe'nin 5 yıl sonraki yaşı • Yürümem gereken yolun 100 metre eksiği • Kalem sayımın 8 katının 9 eksiği • Bilye sayısının 7 fazlasının 2 katı • 20tl paramdan kalan miktar
Problem çözme sürecinde gerçekleştirilen etkinlikler:	
Önce işleyeceğimiz konuyu söyledim. Öğrencilere problemleri yazdırdım. Problemlerin bir kaç tanesini kendim çözdüm. Öğrencilere anlamadıkları yerleri sordum. Daha sonra problemleri öğreneilere yazdırdım. Çözmeleri için bir süre bekledim. Çözemeyenler gelip bana sorabilir, şeklinde uyardım. Doğru çözümleri öğrenciler tahtada çözdü. Anlaşılmayan yerleri sordum, konuyu tekrar edip dersi bitirdim.	

Appendix 9. Teacher Observation Form for Control Group

	KONTROL GRUBU DERS İŞLEME SÜRECİNİ DEĞERLENDİRMEYE YÖNELİK GÖZLEM FORMU Gözlemci:…… Tarih:…… Saat:……..	Evet	Hayır
Sınıf ortamı	Öğrenciler gruplar halinde oturtuldu.		
	Öğrenciler, birbirleriyle etkileşimlerini kolaylaştıracak şekilde karşılıklı oturtuldu.		
Konu sunumu	Öğretmen,		
	Konu sunumunda veya problem çözerken düşünme sürecinin nasıl işlediğini gösteren model sundu.		
	Sesli düşünme stratejisiyle düşünme sürecini yansıttı.		
	Öğrencilere çalışma kağıtlarını dağıttı.		
Problem çözme süreci ve değerlendirme	Öğrenciler bireysel olarak çalıştı.		
	Öğrenciler grup arkadaşlarıyla çalıştı ve tartıştı.		
	Öğrenciler problemlerle uğraşırken gözlendi ve süreç ilerlerken onlardan gelen sorular yönlendirici bir şekilde cevaplandı.		
	Öğretmen,		
	Öğrencilerin üstbilişsel düşünmelerini tetiklemek amacıyla açık uçlu sorular yöneltti.		
	Öğrencileri, problem çözme süreçlerini anlamaları için hem kendi kendilerine hem arkadaşlarına soru sorma konusunda yönlendirdi.		
	Öğrencilere yanlışlarının farkına varmaları ve düzeltmeleri amacıyla dönütler verdi.		
	Ev ödevinde öğrencilerden verilen problemler içinden seçtikleri belirli sayıda problemi çözmeleri ve seçme nedenini açıklamalarını istedi.		
	Öğrencilerin çiftli problem çözmelerini, sesli düşünmelerini ve yansıtma yapmalarını sağladı.		
	Problem çözme etkinlikleri sonrasında, öğrencilerin öz-değerlendirme ve üstbilişsel izleme yapmalarını geliştirmek amacıyla düşünme süreçlerini değerlendirmelerini sağladı.		
	Öğrencilerden mümkün olduğunca zihinlerinden geçen her şeyi çalışma kağıtlarına yazmalarını istedi.		
	Öğrencilerden matematik günlüğü yazmalarını istedi.		
	Öğrencilerin tahmin becerilerinin gelişmesini sağlayan uygulamalar yaptı.		
	Bireysel ilerleme puanı ve grup puanını belirledi.		
	Diğer tespitler:		