Eurasian Journal of Educational Research 80 (2019) 89-112

Eurasian Journal of Educational Research
www.ejer.com.tr

Effect of Cooperative Learning Supported by Reflective Thinking Activities on Students' Critical Thinking Skills*

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ARTICLE INFO

Article History:
Received: 11 Nov. 2018
Received in revised form: 17 Mar. 2019
Accepted: 23 Mar. 2019
DOI: 10.14689/ejer.2019.80.5

Keywords
Mathematics education, higher order thinking skills, jigsaw technic, middle school.

ABSTRACT

Purpose: It is assumed that cooperative work and critical thinking skills will come into prominence in 2020. In this context, the aim of this study is to examine the effect of cooperative learning supported by reflective thinking activities on seventh grade students' critical thinking skills during mathematics course.
Method: In this study, a quasi-experimental model with pretest-posttest control group was applied. In the experimental group, cooperative learning method supported by reflective thinking activities was applied. In the control group, mathematics teaching was carried out in accordance with the curriculum of the mathematics course. The study group was composed of 70 seventh grade students. Cornell Critical Thinking Test, Level X was used as the data collection tool. Dependent and independent samples t-tests were used in data analysis, and ANCOVA was applied to determine the difference between the post-tests scores of the groups.
Findings: In the study, when the pre-test scores of the experimental and control groups were checked, a significant difference was found between the corrected CCT-X post-test mean scores. This difference was found to be in favor of the experimental group. Based on this finding, cooperative learning supported by reflective thinking activities can be said to have a positive effect on students' critical thinking skills.
Implications for Research and Practice: In future research, the effects of different reflective thinking strategies on critical thinking skills can be examined in cooperative learning environment, and their advantages and disadvantages can be discussed. Student's critical thinking skills can be analyzed by qualitative methods.

* This study was partly presented at the 5th International Eurasian Educational Research Congress in Antalya, 02-05 May, 2018.
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Introduction

Today, individuals are expected to have strong interpersonal skills (Organisation for Economic Co-operation and Development [OECD), 2017). In today's conditions, cooperative learning (CL) plays a role in helping individuals acquire the desired skills. The CL can be defined as a learning method in which students with a common purpose work together in small groups, where each group member is responsible for the learning of other members (Johnson, Johnson & Smith, 2014). CL is one of the most important applications in mathematics education (Parveen, Yousuf & Mustafa, 2017). According to the research results, CL has a positive effect on students' mathematics achievement (Asha & Al Hawi, 2016; Cumhur & Elmas-Baydar, 2017; Parveen et al., 2017), communication and social skills (Pandya, 2017), mathematical understanding, and logical inference skills (Asha & Al Hawi, 2016). CL has many benefits in the field of mathematics education.

It can be said that the skills expected from the students have changed according to today's conditions in CL and problem solving process in mathematics education. In this context, the OECD (2017) has combined its ability to monitore and reflect with cooperative problem-solving competencies. Dewey (1933) emphasizes the importance of cooperation in the reflection process. Therefore, reflective thinking (RT) is a concept that needs to be addressed in the CL process.

Reflection is the ability of the student to present a subject or a problem state, and to present his / her own thoughts, attitudes, knowledge and abilities (Schön, 1987). Dewey (1933) states that learning consists of reflections on experiences. RT is an important thinking skill in terms of mathematics education (Kramarski, Weiss & Sharon, 2013; McNaught, 2010). Mathematical learning process requires to build up interrelation between concepts, strategy selection and reflection (Kramarski et al., 2013). The results of the research show that RT supports meaningful learning in mathematics (Inoue & Buczynski, 2011; McNaught, 2010) and provides students to reach correct and logical solutions (Agustan, Juniati & Siswono, 2016).

In addition to the importance of RT in mathematics education, some strategies are important in the process of providing students to reflect. One of the strategies used in the development of RT skills is "Writing". Writing is an effective tool for students to express, explore, organize, and reflect ideas about mathematical content and process (Freeman, Higgins & Horney, 2016; Inoue & Buczynski, 2011; Suhaimi, Shahrill, Tengah & Abbas, 2016). With "Journal writing", which is one of the writing activities, students can reflect on their experiences, points they are strong or weak, important points of an event, how they deal with a power situation, and their feelings (Farrah, 2012; Guce, 2017, 2018; Mitchell & Coltrinari, 2001). Students are able to discuss with their group members and evaluate their own activities with the "Group discussion" strategy that transforms reflective activities into a social activity (Aldahmash, Alshmrani & Almufti, 2017; Kohen & Kramarski, 2012). Students focus on their own thinking processes, processes, activities through questions that guide peer interaction and reflection in the "Reflective dialogue" strategy (Kohen & Kramarski, 2012; Wille, 2017). Furthermore, if a student is guided to be present in the "Self-evaluation", he/she asks himself/herself questions, is trying to understand how he/she learns, and can think about these solutions by being aware of his/her strengths and weaknesses. (Agustan et al., 2016). The students evaluate their mental processes and reflect on their thoughts audibly at the end of the evaluation with "Thinking aloud" strategy (Taggart & Wilson, 2005).

When the literature is examined, it is seen that there are studies in which different strategies are applied in order to improve RT skills of students in the field of mathematics education (Agustan et al., 2016; Freeman et al., 2016; Guce, 2017; Kramarski et al., 2013; McNaught, 2010; Suhaimi et al., 2016). However, in mathematics education in Turkey, there is a limited number of studies on improving the skills of RT (Kizilkaya, 2009). Therefore, in Turkey, studies on the RT skills are inadequate, it is necessary and important for the literature to carry out studies in which RT activities are applied in mathematics education.

One of the concepts related to both CL and TR is critical thinking. Critical thinking is reflective and logical thinking, focused on deciding what to do and what to believe (Ennis, 1996). In addition, critical thinking is the judgmental problem-solving process aimed at improving knowledge (Tiruneh, Verburgh & Elen, 2014). Critical thinking related to mathematical skills such as problem solving, questioning, analysis is an important part of mathematics education (Palinussa, 2013; Sumarna, Wahyudin & Herman, 2017; Su, Ricci & Mnatsakanian, 2016). Due to the nature of critical thinking, critical thinking requires reflection and sociability (Choy & Oo, 2012).

In the studies, it has been reported that CL is a method that develops students' critical thinking skills (Garcha & Kumar, 2015; Loes & Pascarella, 2017; Quines, 2017; Tiruneh et al., 2014; Silva et al., 2016). Critical thinking is also associated with RT (Ghanizadeh, 2017). In this context, a reflective thinker also has critical thinking skills (Evin-Gencel & Guzel-Candan, 2014; Tican & Taspinar, 2015). Studies show that students' activities to improve their skills of RT have positive effects on critical thinking skills (Aryani, Rais & Wirawan, 2017; Farrah, 2012). Considering research carried out in Turkey, few studies have been found to examine reflective and critical thinking levels of pre-service teachers and examine the effect of RT activities on critical thinking skills, (Demir, 2015; Evin-Gencel & Guzel-Candan, 2014; Tican & Taspinar, 2015)

With the adoption of the constructivist approach in Turkey, skills such as cooperation, reflective thinking, and critical thinking are included in mathematics curriculum. However, according to results in PISA 2015, Turkey ranks last among OECD countries in cooperative problem-solving skills (OECD, 2017). Therefore, in order to reach the objectives of the mathematics curriculum, it is necessary to conduct more comprehensive and different activities related to CL in the field of mathematics education. It is thought that the present research will contribute to the literature in terms of presenting the RT activities that can be applied in CL environments.

In today's world, changes continue without slowing down. It is assumed that cooperative work and critical thinking skills will come into prominence in 2020 in the knowledge of the World Economic Form (Gray, 2016). However, effectiveness of CL on learning outcomes is discussed. A number of studies have shown that CL does not bring significant cognitive, social, and affective gains for students (Berkun & Ada, 2017; Souvignier & Kronenberger, 2007). In this context, research has been conducted to examine CL under different forms. In some studies, CL was supported by multiple intelligence (Isik & Tarim, 2009), metacognitive strategies (Mevarech & Amrany, 2008), inquiry strategy (Souvignier & Kronenberger, 2007) or problem-solving strategies (Yazlik & Erdogan, 2016). In these previous studies, unstructured CL techniques were used, and the cooperative group structures were not discussed in detail. In this context, it can be said that more research is needed on the effectiveness of CL.

In recent years, it can be seen that CL and RT are the concepts discussed together. RT skills are combined with cooperative problem-solving competencies (OECD, 2017). In studies, it was stated that as a result of students' reflections in CL environments, their skills such as problem solving, questioning, linking old and new information, making plans and strategies, and self-regulation skills were developed (Applefield, Huber & Moallem, 2000; Bransford, Brown & Cocking, 2000; Gagnon & Collay, 2006; King, Goodson & Rohani, 2013; Lan, 2007; Kramarski & Kohen, 2017). In the studies that analyzed the interrelationship of CL and RT skills mentioned above, the importance of reflection in CL environments was emphasized while the cooperative group structure was not explained in detail. In these studies, the use of structured CL techniques and the integration and implementation of different strategies to improve skills of RT have been ignored. Despite CL and work together to address the RT concept abroad, the number of research carried out in this field in Turkey (Guvenc, 2011) is quite limited. It is considered important to investigate the outcomes of CL's support in the teaching environment with RT strategies.

Considering the research conducted in Turkey in the field of mathematics education; It will be seen that the number of studies on CL, RT and critical thinking concepts is quite low. This research is specific for the use of a structured CL technique, for describing the use of different RT strategies in the CL environment, and for the detailed presentation of the materials used in the implementation of strategies. This study differs from previous studies in terms of CL structure of previous studies, and in terms of integrating RT strategies. Therefore, this study is thought to provide a different perspective on the effectiveness of CL. In accordance with the stated reasons, the aim of this study is to examine the effect of CL supported by RT activities on seventh grade students' critical thinking skills during mathematics course.

Method

Research Design

In this study, a quasi-experimental model with pretest-posttest control group was applied. In the quasi-experimental model, due to the difficulty of artificially forming groups, paired groups are randomly assigned as experimental groups (Fraenkel & Wallen, 2006). In this study, there is an experiment and a control group. In the experimental group, CL method supported by RT activities was applied. In the control group, no special teaching method was applied. An appropriate mathematics instruction was conducted in accordance with the current mathematics curriculum.

Study Group

This study was carried out during the academic year 2016-2017, with a total of 70 students in the seventh grade in a secondary school located in Turkey's Eastern Anatolia province. A random method was adopted to determine the experimental and control groups. There were 36 students in the experimental group and 34 in the control group. While 21 of the students in the experimental group were females (58%) and 15 of them were males (42%), 20 of the students in the control group were females (59%) and 14 of them were males (41%). The number of female students in both groups was higher than that of male students. It can be stated that the number of students in two study groups is quite close to each other.

Data Collection Tool

Cornell Critical Thinking Test, Level X (CCT-X) was used as the data collection tool. This test was developed by Ennis and Millman (1985) and adapted to Turkish by Mecit (2006). CCT-X, which is one of the most widely used tests for measuring critical thinking skills at elementary level all over the world, is a three-choice multiple-choice measurement tool consisting of 72 items in total. In the test with the "Yes, No, Maybe" options, each question has only one correct answer. A maximum of 72 points can be obtained from the test. The general Cronbach Alpha coefficient of the scale was calculated as .75 by Mecit (2006), and it was calculated as .77 in this study.

Procedures

The experimental phase of the study lasted 25 class hours. Considering the awareness program and the pretest-posttest implementation periods for the recognition of strategies and materials, this study was completed within a total of 35 class hours. The intervention in the experimental and control groups were carried out by the researcher. The same problems were studied in the groups and the studies in the groups were started and completed in parallel time periods.

The research stages were carried out by determining the strategies of RT and material preparation, pilot application, awareness program, and implementation of RT activities in CL groups. In the process of designing RT activities, firstly literature review in the field of CL, RT, and mathematics education was done.

Strategies that are found successful in previous studies are examined (Colley, Bilics & Lerch, 2012; Kramarski et al., 2013; Lan, 2007; Taggart & Wilson, 2005). In the present study, writing, journal writing, group discussion, reflective dialogue, self-evaluation and thinking aloud strategies, which are frequently used in mathematics education, directing students to thinking, discussing and questioning, developing problem solving skills were used.

After the determination of the strategies, materials were designed by the researcher in order to construct the implementation of these strategies. It was aimed to successfully manage the CL process and group dynamics through structured materials. The results of successful research were examined in the editing of RT materials (Brockbank & McGill, 2006; Kohen & Kramarski, 2012; Lan, 2007; Mevarech & Kramarski, 2014; Michalsky & Kramarski; 2015; Mitchell & Coltrinari, 2001; Taggart & Wilson, 2005; Wilson & Jan, 1993). In this direction, journal, group discussion form, reflective dialogue form, self-evaluation form materials, which would be used in the implementation process of RT activities were designed. In order to discuss RT strategies and materials, opinions of the experts and mathematics teachers who took mathematics education were taken, and necessary arrangements were made. The RT strategies, activities and materials applied in the experimental group are described below.

Writing. In the awareness program, students were told that they had to write everything they had learned and everything passed through their minds. During the experimental implementation process, students were directed to write on the study papers about each situation they thought and did during the activities. Materials such as journal, group discussion form and self-evaluation form, which were developed to provide reflection of students inside and outside the classroom, were structured. Thus, it was aimed to develop critical thinking skills of students with writing activities in CL environment. Writing strategy is a general strategy used throughout the entire experimental implementation.

Journal writing. Journal writing strategy was used in order to make students remember what they had learned in the course, to review their experiences and to make reflections by self-evaluation. When writing the jornal, steps to be followed were based on the work of Mitchell and Coltrinari (2001) and "journal" material was designed (Appendix, 1). At the end of each math course, journals written at home were examined by the teacher, and the students were provided with feedback.

Group discussion. With this strategy, it was aimed to create new thoughts with the interaction of the community and to reflect these thoughts in the learning process. It is important for group discussions to be carried out with well-structured activities and the questions that lead students to the reflection process. In this context, students were directed to make reflective discussions as a group, to answer questions of what and why. The "group discussion form" (Appendix, 2) was prepared based on research using questions that led students to reflective inquires (Kohen & Kramarski, 2012; Lan, 2007; Mevarech & Kramarski, 2014). At the end of the discussions, students were asked to write their common ideas as a group on the group discussion form.

Reflective dialogue. With this strategy, students were required to review and question what they have learned as a result of their dialogue with their peers. In the study, a structured "reflective dialogue form" including CL principles was developed based on the study of Brockbank and McGill (2006) (Appendix, 3). Reflective dialogue form was used as a guide to ask students task-oriented questions. Paired students asked questions in the form to each other and answered them aloud.

Self-evaluation. With self-evaluation strategy, it was aimed to improve students' ability to criticize the learning process with a critical approach, to raise awareness of deficiencies and mistakes, to correct them if there are deficiencies and errors, and to improve their monitoring skills. In this direction, "self-evaluation form" (Appendix, 4) was developed based on CL principles and type of reflective prompt (generic, judgment or modification) that Michalsky and Kramarski (2015) stated in their research.

Thinking aloud. In this study, students were asked to think aloud during reflective dialogue process or during group discussions with their friends. Students were directed to interact with their friends openly for their explanations.

The contents of the activity worksheets were based on the seventh grade ratio and proportion sub-learning area attainments. The study included 19 eighth grade students, who were not included in the scope of the study group, who had the previous year's ratio and proportion sub-learning attainments. Pilot training was conducted with these students during 15 class hours. Students were given RT materials, the meaning of questions and expressions, and how to use the materials were explained. Students were informed about the Jigsaw-I technique and the strategies they would use. Students actively participated in the RT strategies and used materials. After the pilot implementation, the statements were revised in terms of functionality, student feedback, and clarity of the materials and activities.

Following the application of the pretest, six hours of awareness program was conducted in the experimental group. In the awareness program, firstly information about the implementation of CL, the Jigsaw-I technique, teacher and student roles were presented. Next, the strategies and materials to be implemented were explained in detail. In this context, information about the purpose and duration of the study was given and the questions of the students were answered by introducing the materials.

Following the awareness program, CL method, which was supported by RT activities, was applied in the experimental group. Throughout the experimental process, the teacher played a guiding role in the research. In the study, Jigsaw-I technique, one of the CL techniques, was applied by taking into consideration the steps mentioned in the literatüre (Aronson & Patnoe, 1997; Souvignier &

Kronenberger, 2007; Un-Acikgoz, 2011). The application stages of the Jigsaw-I technique and the strategies and materials used in these stages were announced.

Creation of main groups. In the first phase, students were divided into heterogeneous groups taking into account the gender and the average of the previous year's mathematics course. Each group was assigned a letter (A, B, C, D, E, F), consisting of six groups of six students. The group names of these main groups were determined by asking the students. Ratio and proportion sub-learning attainments were grouped according to the number of group members. The teacher asked the group members to share headings from each group. Students in the group were coded according to the topics they took (eg, students in group A, A1, A2, A3, A4, A5, A6). The subjects were distributed to all students in the same coded group with the same topic (For example, students with A1, B1, C1, D1, E1, F1 studied the same subject). The students were given worksheets on the subject and were asked to get prepared for the topic. The students were asked to write their journal at home.

Expertise. In the following process, in each group, groups of experts formed by gathering the same subject and having the same code were determined. Students in the expert groups were allowed to work together with their friends on their specialization topics. First of all, students in expert groups worked in the CL environment without an RT strategy. Then, the process was supported by RT strategies to enable students to collaborate, interact and reflect. With the reflective dialogue strategy, students were able to answer the questions in a reflective dialogue form. Thus, students were directed to share their thoughts, to reflect their ideas and to help each other.

Also, students were asked to work with group discussion strategy. Students discussed the questions in the group discussion form by thinking aloud, and they wrote and prepared a joint report on the topic to be told to their friends in the main groups. Thus, all groups were taught in the same way according to a common report and missing learning was prevented. In the next course hour, students were asked to complete self-evaluation form to evaluate their own learning. At the end of each mathematics course, students were asked to write their journals at home.

Consolidation. In the expert groups, students working on their subjects returned to their main groups and told their group members in order. At this stage, students asked questions to their fellow students about the topic, and they discussed by thinking aloud. At the end of each topic, students working with the group discussion strategy completed the group discussion form and the individual self-evaluation form. Also, at the end of each math course, students wrote their journals at home.

Completion and evaluation. At this stage, a different sub-topic was presented to each of the main groups in order to integrate learning. After the group presentations, whole topic was summarized by the teacher. In the group presentations, the first three successful groups were given a certificate of achievement.

In the control group; mathematics teaching was conducted under the guidance of current mathematics curriculum. Students in the control group solved the same problems with the experimental group. The teacher gave a presentation with the guidance of the mathematics curriculum. During the course, the same problems used in the experimental group were solved by the teacher, or the teacher directed these problems to the students by question-answer method. At the end of the course, students were asked questions, concepts or problems they could not solve, in order to complete the missing learning of the students. Difficulties were solved on the board by the teacher or another student. At the end of the topic, topic summary was made by the teacher or by the students. Therefore, it can be said that the control group had a different learning environment than the experimental group.

Data Analysis

In the data analysis, the Shapiro-Wilks test was applied to analyze the normal distribution. When analyzing the data, independent group t-test and dependent group t-test were used, depending on the data type. Covariance analysis (ANCOVA) was performed to examine the difference between the posttest scores of the groups. The Bonferroni test was used to determine the source of the difference between the adjusted scores. The significance level was taken as p <.05 in the research process.

Results

In this section, the findings obtained from the CCT-X pre and posttest scores of the experimental and control groups were presented. In the analysis of the tests, normal distribution of scores was analyzed by the Shapiro-Wilks test. The results were presented in Table 1.

Table 1

Shapiro-Wilks Normality Results Regarding CCT-X

Group	Pre-test		Post- test	
	Shapiro-Wilks	p	Shapiro-Wilks	p
Experimental	.96	.22	.97	.33
Control	.97	.59	.98	.79

In Table 1, Shapiro-Wilk Test normality results, CCT-X pre-test scores (w= .96, p= .22> .05) and CCT-X post-test scores (w= .97, p=. 33> .05) were given. Shapiro-Wilk Test normality results of the control group were presented for the pre-test scores of CCT-X; (w= .97, p= .59> .05) and for CCT-X post-test scores; (w= .98, p= .79> .05). Based on these findings, it was determined that the test scores showed normal distribution. Before RT activities in the experimental group, CCT-X pre-test scores of the study groups were analyzed by independent group t-test, and the results were shown in Table 2.

Table 2

Independent Group T-Test Results for Comparing CCT-X Pre-Test Scores

Group	N	$\bar{x}$	sd	df	t	p
Experimental	36	27.36	8.13	68	.02	.98
Control	34	27.32	6.05			

When Table 2 was analyzed, there was no statistically significant difference between the CCT-X pre-test scores of the experimental and control groups [$t_{(68)}$= .02, p> .05]. In the light of these findings, it can be said that critical thinking skills of the students in the experimental and control groups were equal before the experimental procedures. In the study, CCT-X pre- and post-test scores were analyzed with dependent group t-test after CL process supported by RT activities in the experimental group, and the results were given in Table 3.

Table 3

Dependent Group T-Test Results for the CCT-X Pre- and Post-Test Scores of Experimental Group

Test	N	$\bar{x}$	sd	df	t	p
Pre-test	36	27.36	8.13	35	-6.05	.00
Post-test	36	33.97	7.79			

According to Table 3, the CCT-X post-test mean scores of the experimental group was higher than the pre-test mean scores. As a result of the dependent group t-test analysis for the CCT-X pre- and post-test scores, there was a statistically significant difference [$t_{(35)}$=-6.05, p< .05]. The resulting significant difference was in favor of the post-test. After the teaching practices in the control group, the CCT-X pre- and post-test scores were analyzed by the dependent group t-test, and the results were presented in Table 4.

Table 4

Dependent Group T-Test Results for the CCT-X Pre- and Post-Test Scores of Control Group

Test	N	$\bar{x}$	sd	df	t	p
Pre-test	34	27.32	6.05	33	-1.44	.16
Post-test	34	28.41	6.47			

When Table 4 was examined, it was found that the CCT-X pre-test and post-test mean scores of the control group were quite close to each other. According to the results of the dependent group t-test for the CCT-X pre- and post-test scores of the control group, no statistically significant difference was found [$t_{(33)}$= -1.44, p> .05].

ANCOVA was applied to determine whether the CCT-X post-test mean scores differed for the experimental and control groups after the initial CCT-X pre-test scores were controlled. Before applying ANCOVA, ANCOVA assumptions were examined. The first assumption was the normal distribution of the data with the Shapiro-Wilks test. The findings of these data were given in Table 1. As can be seen from Table 1, it was found that CCT-X pre-test and post-test scores had a normal distribution. In order to control the hypothesis of linear relationship between linearity, dependent variable (CCT-X post-test scores) and covariate (CCT-X pre-test scores), the overall distribution of scores was examined by scatter plot for each of the groups. For each group, a linear relationship was found between the dependent variable and the covariate. Then, the assumption of homogeneity of regression slopes, which was one of the main assumptions of ANCOVA, was investigated. These results are shown in Table 5.

Table 5

Regression Slope for CCT-X

Source	Sum of squares	df	Mean square	F	p
Corrected model	2252.15	3	750.72	27.65	.00
Intercept	531.65	1	531.65	19.58	.00
Group	103.97	1	103.97	3.83	.06
Pre-test	1641.93	1	1641.93	60.48	.00
Group*Pre-test	23.04	1	23.04	.85	.36
Error	1791.69	66	27.15		
Total	72497.00	70			
Corrected total	4043.84	69			

As can be seen from Table 5, it was determined that covariate and post-test scores did not show a statistically significant interaction [$F_{(1,66)}$= .85, p= .36> .05]. Based on this finding, it was seen that the assumption of homogeneity of the regression slopes was ensured. In addition, in order to examine the assumption of homogeneity of variances, Levene's Test was applied and it was determined that the variances between the groups were homogeneous (F=2.03, p= .16> .05). According to the findings, ANCOVA assumptions were obtained. Based on these results, to control the pre-test scores of the groups, ANCOVA was applied to determine whether there was a significant difference between the corrected post-test scores. These results are presented in Table 6.

Table 6

ANCOVA Results for Corrected CCT-X Post-Test Scores

Source of variance	Sum of squares	df	Mean square	F	p
Pre-test (Reg.)	1688.48	1	1688.48	62.34	.00
Group	535.58	1	535.58	19.77	.00
Error	1814.73	67	27.09		
Total	72497.00	70			

According to Table 6, the CCT-X pre-test scores of the experimental and control groups were checked and a significant difference was found between the corrected CCT-X post-test mean scores [$F_{(1,67)}$=19.77, p <.05]. This difference was found to be in favor of the experimental group. When the Bonferroni test results for the corrected CCT-X post-test mean scores were examined, critical thinking skills of students in the experimental group ($\bar{x}$= 33.96) were found to be higher than those of the students in the control group ($\bar{x}$= 28.43).

Discussion, Conclusion and Recommendations

According to the findings of the study, there was no statistically significant difference between the CCT-X pre-test mean scores of the students in the experimental and control groups. Based on this finding, it can be said that critical thinking skills of the students in the study groups were equal before the experimental applications in the experimental group.

In the study, after the experimental implementations, it was concluded that the CCT-X post-test mean score of the experimental group was significantly higher than the pre-test mean score. However, no significant difference was found between the CCT-X pre-test and post-test mean scores of the control group. Based on this finding, it can be said that the mathematics courses carried out in the control group did not contribute to the development of students' critical thinking skills. Based on the findings of the research, in addition to stressing that students have critical thinking skills in mathematics curriculum (Ministry of National Education [MoNE], 2018), it can be said that structured activities for the development of these skills should be applied in classroom environments.

Applefield et al. (2000) stated that, in the context of social constructivist vision, creating knowledge and skills required in students is based on interpersonal interaction. In cooperative environments based on social constructivism, students who have discussions and reflect on their learning develop their critical perspectives. Research findings of Palinussa (2013) also support this result. Palinussa (2013) stated that students' critical thinking skills were influenced by classroom learning environment. Therefore, it is stated that it is insufficient to emphasize these skills in the curricula only in order to ensure that students are developed as critical thinkers. The need for a supportive atmosphere for the development of skills in the classroom is also indicated. Chukwuyenum (2013) showing a similar result to Palinussa (2013) emphasizes that critical thinking skills should be taught by reflecting in social interaction and by integrating them into mathematics course.

Another important finding in the research; when the pre-test scores of the experimental and control groups were checked, is that a significant difference was found between the corrected CCT-X post-test mean scores. This difference was found to be in favor of the experimental group. Based on this finding, CL supported by RT activities can be said to have a positive effect on students' critical thinking skills.

It supports Colley et al. (2012) who reported that reflective learning environments are created on the basis of educating individuals who think critically. This finding of the research is consistent with the results of the research examining the effects of providing cooperative environments on critical thinking skills (Adams, 2013; Gagnon & Collay, 2006; Gillies, 2006; Gorlewski & Greene, 2011; Guce, 2017; Lucena & San Jose, 2016; Mitchell & Coltrinari, 2001; Parsons & Stephenson, 2005; Silva et al., 2016; Webb & Farivar, 1994). Webb and Farivar (1994) reported that students' inadequately developed communication skills could adversely affect their use of CL, while Gillies (2006) emphasized that students who benefit most from CL are benefited from guiding support areas. It was determined that critical perspectives of the students who analyzed peers and gave feedback to each other, analyzed their thoughts, interacted with their peers, and made statements to their peers in CL groups were developed during the study. In a number of studies; it was stated that classroom discussion, CL, journal writing, dialogue, and reflection were influential factors in the development of critical thinking skills of teaching environments (Adams,2013; Gorlewski & Greene, 2011; Guce, 2017; Mitchell & Coltrinari, 2001). Gagnon and Collay (2006) stated that students have criticized the meaning they have formed together and their own thinking process by both group reflection and by making individual projections in CL groups. Considering the research findings in the literature, it is observed that students who develop interactive thinking and reflections in CL groups develop their critical thinking skills.

In the study, it was thought that writing and journal writing strategies were effective in the development of critical thinking skills of students in the CL group supported by RT activities more than the students in the control group. Previous studies have supported this conclusion. In the studies, it was stated that students explain their reasoning, correctness of solutions, thinking processes by writing and they made reflections about mathematics learning process in mathematics courses (Freeman et al., 2016; Inoue & Buczynski, 2011). Suhaimi et al. (2016) stated that students who write journal in mathematics courses organize their thoughts, thus journal writing improves communication and critical thinking skills of the students. In addition, it can be said that supporting CL with group discussion strategy is one of the factors that improve students' critical thinking skills. King et al. (2013) and Gibson (2008) have obtained findings that support this view in their studies. They reported that well organized and managed group discussions developed students' critical thinking skills in their studies.

It can be said that reflective dialogue strategy used in this research contributed to the development of students' critical thinking skills. In research supporting this view, it was determined that students questioned their knowledge and focused on thinking about the activities they reflected critically on the learning process as a result of peer dialogues (Brockbank & McGill, 2006; Kohen & Kramarski, 2012; Wille, 2017). In addition, it is emphasized in researches that verbal language skills about explaining and asking questions (Souvignier & Kronenberger, 2007) and how to communicate in CL groups should be taught (Gillies, 2006). With the reflective dialogue strategy, it can be said that questioning and reasonable thinking skills developed within the scope of critical thinking,

In the study, critical thinking skills can be said to develop in a positive way as a result of self-evaluation. Previous research findings support this view (Mevarech & Kramarski, 2014; Michalsky & Kramarski, 2015; Wilson & Jan, 1993). At the end of the learning activities with self-evaluation strategy, students can learn to think critically (Michalsky & Kramarski, 2015; Wilson & Jan, 1993).

Used in research; writing, journal writing, reflective dialogue, group discussion, self-evaluation, and thinking aloud strategies were used alone in previous research (Agustan et al., 2016; Aldahmash et al., 2017; Guce, 2017, 2018; Kohen & Kramarski, 2012; Lan, 2007; Quines, 2017; Tican & Taspinar, 2015). In this study, integrating the use of RT strategies in a structured CL environment can be seen as one of the strengths of the research. In future research, the effects of different RT strategies on critical thinking skills can be examined in CL environment, their advantages and disadvantages can be discussed.

In mathematics curriculum (MoNE, 2018), students are expected to have high-level thinking skills. However, it can be said that strategies, activities and materials for developing these skills are not sufficiently involved in the curriculum. PISA results also show that students in Turkey are quite inadequate in cooperative problem-solving skills (OECD, 2017). Therefore, RT activities can be used as a useful tool for supporting CL and developing critical thinking skills.

First of all, teachers who will apply CL and RT activities in a classroom should have high-level thinking skills such as reflective thinking and critical thinking. Gagnon and Collay (2006) state that teachers should structure and manage the processes of projecting about their cooperative experiences. In teacher training programs, it is suggested that pre-service teachers should implement their experiences with CL and RT activities.

This research was limited to the seventh grade level. However, the independent applicability of the RT strategies and materials used in the CL process are considered to be one of the strengths of the research. In future research, the effects of CL supported by RT activities on mathematical achievement, metacognitive skills, self-efficacy beliefs, attitude, et al. can be determined. Experimental research can be carried out in different subject areas and at different grade levels by using CL supported by RT activities. Students' critical thinking skills can be analyzed by qualitative methods and more detailed data can be gained.

In subsequent studies, supporting different CL techniques with RT activities can be investigated in terms of academic achievement, self-regulation, metacognitive skills and attitudes. In the classroom environment, student interaction processes can be analyzed in detail through qualitative research. It is also important that the physical state of the class is designed to allow student interaction for the implementation of CL and RT activities. In this context, not only for mathematics courses but only for all courses, it is suggested that the physical structure of the class should be arranged in such a way that teachers can easily apply methodological approaches.

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Yansıtıcı Düşünme Etkinlikleriyle Desteklenen İşbirlikli Öğrenmenin Öğrencilerin Eleştirel Düşünme Becerileri Üzerine Etkisi

Atıf:

Erdogan, F. (2019). Effect of cooperative learning supported by reflective thinking activities on students' critical thinking skills. *Eurasian Journal of Educational Research, 80*, 89-112, DOI: 10.14689/ejer.2019.80.5

Özet

Problem Durumu: Dünya Ekonomik Forumu'nun bilgilendirmesinde 2020 yılında bireyin sahip olması gereken beceriler kapsamında işbirlikli çalışma ve eleştirel düşünme becerisinin ön plana çıkacağı varsayılmaktadır. Ayrıca, OECD izleme ve yansıtma becerisini işbirlikli problem çözme yetkinlikleri ile birleştirmiştir. Dolayısıyla, son yıllarda, işbirlikli öğrenme (İÖ) ve yansıtıcı düşünmenin (YD) birlikte ele alınan kavramlar olduğu görülmektedir. Araştırmalarda, öğrencilerin İÖ ortamlarında yansıtmalar yapmaları sonucunda, problem çözme, sorgulama, eski ve yeni bilgileri ilişkilendirme, plan yapma, stratejiler geliştirme ve öz-düzenleme becerilerinin geliştiği belirtilmektedir. Daha önce yapılan, İÖ ve YD becerilerinin karşılıklı ilişkisini analiz eden araştırmalarda, İÖ ortamlarında yansıtmanın önemi vurgulanırken, işbirlikli grup yapısı ayrıntılı açıklanmamıştır. Bu araştırmalarda, yapılandırılmış İÖ teknikleri kullanımı ve YD becerisini geliştirmeye yönelik farklı stratejilerin İÖ tekniklerine entegre edilerek uygulanması göz ardı edilmiştir. Yurtdışında İÖ ve YD kavramlarını birlikte ele alan çalışmalar yapılmasına rağmen Türkiye'de araştırmaların oldukça sınırlı olduğu belirlenmiştir. Öğretim ortamlarında İÖ'nün YD stratejileriyle desteklenmesi sonucu elde edilen çıktıların araştırılması önemli görülmektedir. Türkiye'de yapılan araştırmalara bakıldığında matematik eğitimi alanında İÖ, YD ve eleştirel düşünme kavramlarını inceleyen oldukça az sayıda araştırma olduğu saptanmıştır. Mevcut araştırma, yapılandırılmış bir İÖ tekniğinin kullanılması, İÖ ortamında farklı YD stratejilerin kullanımının betimlenmesi ve stratejilerin uygulanması sürecinde kullanılan materyallerin ayrıntılı sunulması, İÖ yapısına uygun YD stratejilerinin bütünleştirilmesi açısından daha önce yapılan araştırmalardan farklılaşmaktadır. Dolayısıyla, bu araştırmanın İÖ'nün etkililiği üzerine farklı bir bakış açısı sunacağı düşünülmektedir.

Araştırmanın Amacı: Bu araştırmanın amacı, matematik dersinde YD etkinlikleriyle desteklenen İÖ'nün yedinci sınıf öğrencilerinin eleştirel düşünme becerileri üzerindeki etkisini incelemektir.

Yöntem: Araştırmada nicel araştırma yaklaşımlarından ön test-son test kontrol gruplu yarı deneysel model uygulanmıştır. Bu araştırmada bir deney ve bir kontrol grubu yer almaktadır. Deney grubunda YD etkinlikleriyle desteklenen İÖ yöntemi uygulanmıştır. Mevcut araştırmada, matematik eğitimi alanında sıklıkla

kullanılan, öğrencileri düşünmeye, tartışmaya ve sorgulamaya yönelten, problem çözme becerisini geliştirdiği vurgulanan, İÖ ve grupla çalışma yapısına uygun olduğu görülen yazma, günlük yazma, yansıtıcı diyalog, grup tartışması, öz-değerlendirme ve sesli düşünme stratejileri kullanılmıştır. Bu doğrultuda YD etkinliklerini uygulama sürecinde kullanılacak olan günlük, grup tartışma formu, yansıtıcı diyalog formu, öz-değerlendirme formu materyalleri tasarlanmıştır. Kontrol grubuna ise özel bir öğretim yöntemi uygulanmamış, mevcut matematik dersi öğretim programına uygun bir matematik öğretimi gerçekleştirilmiştir.

Araştırma, 2016–2017 eğitim öğretim yılında Türkiye'nin Doğu Anadolu bölgesinde yer alan bir ilde bulunan bir ortaokulun yedinci sınıflarında öğrenim gören toplam 70 öğrenci ile yürütülmüştür. Araştırmada veri toplama aracı olarak Cornell Koşullu Sorgulama Testi-Form X (CCT-X) kullanılmıştır. Veriler çözümlenirken, veri türüne bağlı olarak, bağımsız grup t-testi ve bağımlı grup t-testi kullanılmıştır. Grupların son test puanları arasındaki farkı incelemek amacıyla tek faktörlü kovaryans analizi (ANCOVA) uygulanmıştır.

Bulgular: Araştırmada, deney ve kontrol gruplarının CCT-X ön test puanları arasında istatistiksel açıdan anlamlı bir farklılık olmadığı görülmüştür [$t_{(68)}$= .02, p> .05]. Deney grubunun CCT-X son test ortalamasının ön test ortalamasına göre yüksek olduğu belirlenmiştir. Deney grubunun CCT-X ön ve son test puanları için yapılan bağımlı grup t-testi analizi sonucunda istatistiksel olarak anlamlı bir farklılık olduğu saptanmıştır [$t_{(35)}$= -6.05, p< .05]. Ancak, kontrol grubunun CCT-X ön ve son test puanlarına yönelik uygulanan bağımlı grup t-testi sonucuna göre istatistiksel açıdan anlamlı bir farklılık bulunamamıştır [$t_{(33)}$= -1.44, p> .05]. Deney ve kontrol gruplarının CCT-X ön test puanları kontrol edilirken, düzeltilmiş CCT-X son test ortalama puanları arasında anlamlı bir farklılık tespit edilmiştir. Bu farklılığın deney grubu lehine olduğu belirlenmiştir.

Sonuç ve Öneriler: Araştırmada, deney ve kontrol grubundaki öğrencilerin CCT-X ön test puan ortalamaları arasında istatistiksel olarak anlamlı bir farklılık tespit edilmemiştir. Deneysel uygulamalar sonrasında, deney grubunun CCT-X son test puan ortalamasının, ön test puan ortalamasına göre anlamlı derecede yüksek olduğu sonucuna ulaşılmıştır. Ancak, kontrol grubuna ait CCT-X ön test ve son test puan ortalamaları arasında anlamlı bir farklılık tespit edilmemiştir. Araştırmada elde edilen diğer bir önemli bulgu olarak, deney ve kontrol gruplarının ön test puanları kontrol edilirken düzeltilmiş CCT-X son test ortalama puanları arasında anlamlı bir farklılık bulunmuştur [$F_{(1,67)}$= 19.77, p< .05]. Bu farklılığın deney grubu lehine olduğu belirlenmiştir. Bu bulguya dayanarak, YD etkinlikleriyle desteklenen İÖ'nün öğrencilerin eleştirel düşünme becerileri üzerinde pozitif etkisinin olduğu söylenebilir.

Bu araştırmada, YD stratejilerinin yapılandırılmış İÖ ortamında, bütünleştirilerek kullanılması araştırmanın güçlü yönlerinden biri olarak görülebilir. Yapılacak araştırmalarda, İÖ ortamlarında farklı YD stratejileri karşılaştırılarak eleştirel düşünme becerileri üzerindeki etkileri incelenebilir, avantaj ve dezavantajları irdelenebilir. YD etkinlikleri İÖ'nün desteklenmesi ve eleştirel düşünme becerilerinin geliştirilmesi için faydalı bir araç olarak kullanılabilir. İÖ sürecinde kullanılan YD stratejilerinin ve materyallerin konudan bağımsız uygulanabilirliği araştırmanın güçlü yönlerinden bir diğeri olarak görülmektedir. YD etkinlikleriyle desteklenen İÖ kullanılarak farklı konu alanlarında ve farklı sınıf düzeylerinde deneysel araştırmalar yapılabilir. Yapılacak araştırmalarda, farklı İÖ tekniklerinin YD etkinlikleriyle desteklenmesinin akademik başarı, öz-düzenleme, üstbilişsel beceri ve tutum gibi değişkenler üzerindeki etkisi araştırılabilir. Sınıf ortamında öğrenci etkileşim süreçleri nitel araştırmalarla ayrıntılı olarak incelenebilir. Ayrıca, sınıfların fiziksel yapısının öğretmenlere metodolojik yaklaşımları kolaylıkla uygulayacakları şekilde düzenlenmesi önerilmektedir.

Anahtar Kelimeler: Matematik eğitimi, üst düzey düşünme becerileri, birleştirme tekniği, ortaokul.

Appendix

Appendix 1.

Journal

Dimensions	Expression in the journal
Descriptive	1) What was done in the lesson today?
Metacognitive	2) What are your feelings, beliefs, attitudes about the activities in the lesson?
Analytical	3) Why were the activities and practices in the class made?
Evaluator	4) What aspects did you find successful / unsuccessful in the activities? 5) What were the chapters in which you were successful or forced in group work?
Reconstructor	6) What kind of change can be made about the activities? Why? 7) What would you like to have in future activities? 8) What are your recommendations to your group friends to make the activities more successful?

Appendix 2.

Group Discussion Form

- What did you learn at the end of the activities? Please summarize.
- Is the subject fully understood? What are unclear points?
- What are the similarities and differences between the subjects learned and the previous subjects?
- Is it necessary to change the activities? Why? If yes, what is the change?
- What were the problem-solving strategies used throughout the activities?
- Do you have a different strategy proposal? If so, what are these strategies?
- What were the hard points during the events? Why?
- What have you been doing to deal with the points you are struggling with?

Appendix 3.

Reflective Dialogue Form

Question type	Question statement
Task-oriented	• What is the purpose of this activity? • Could you describe your role in this activity? • Can you tell me about your friend's duties at this activity?
Process-oriented	• How did you complete the objectives of this activity? • What is the most interesting situation in this activity? • Do you list the situations in which you are successful? • Can you list situations in which you have difficulty with this activity? • What was your friend's help with at this activity? • How did you help your friend in this activity? • If you didn't complete this activity, what were the things that prevented you? • What can help you to perform better at this activity? • What do you feel about this activity? • What is your advice to a friend?

Appendix 4.

Self-Evaluation Form

- I'm the best at the activity.............
- The worst things in the activity...............
- The most important knowledge / skills I gained at the activity.............
- My friend's contributions / damages ....
- What do you think can be done differently during the activity process?