The Effect of Cooperative Learning Method on Academic Achievement, Attitude and Critical Thinking Disposition in the 7th Grade Mathematics Lesson*

Ayşegül SARIKAYA[1], Eray EĞMİR[2]

Article History:
Received 04.06.2023
Received in revised form 28.07.2023
Accepted
Available online 01.10.2023

This study aims to determine the contribution of using the cooperative learning method in the 7th-grade mathematics course on students' academic achievement in mathematics, attitudes towards mathematics, and critical thinking dispositions. This study was conducted with 40 students in a Mediterranean region of Turkey district in the 2020-2021 academic year. The study was conducted with a quasi-experimental design and cooperative teaching methods (Student Teams-Achievement Divisions and Team-Game-Tournament technique) were applied in the experimental group, and the activities in the Ministry of National Education middle school mathematics curriculum were applied in the control group. The data collection tools used in the study were the "Achievement Test" developed by the researchers, the "Attitude Towards Mathematics Scale", and the "Critical Thinking Disposition Scale." The study revealed that the academic achievement of the students in both groups increased significantly (with a significant effect of the teaching method). Attitude towards mathematics scores decreased significantly in the experimental group (with a moderate effect of the teaching method) and increased insignificantly in the control group. Critical thinking disposition scores decreased insignificantly in the experimental group (with a moderate effect of the teaching method) and increased significantly in the control group. In conclusion, the cooperative learning was more effective in increasing the students' academic achievement than the current curriculum. However, the method was not effective in increasing the mean scores of the students' attitude towards mathematics and critical thinking dispositions compared to the current curriculum

Keywords: Cooperative learning method, attitude towards mathematics, critical thinking

INTRODUCTION

In today's world, countries must keep up with the times by adapting to innovations in science and technology. To fall behind this rapid and continuous change means to risk being behind the times. Adapting to development and innovations mean giving importance to education. Countries with high-quality education systems regard education as a value which shapes the future, and educators attach significance to the development of affective characteristics in students as well as academic achievement. Developed nations with established educational systems and curriculums have focused their existing resources on education, developed their curriculums by considering local demographics and cultural norms, and emphasized practice and student-centeredness (OECD, 2018). Mathematics instruction has always been an essential and critical part of education systems (Özerbaş & Safi, 2022).

Mathematics covers information which facilitates the work of individuals in all areas of their daily lives, at all levels of education and training. Mathematics as a universal language is a significant area for individuals, society, scientific research and technological developments in the constantly developing world (Baykul, 2014). In parallel with the developments in science and technology in today's world, the curriculums used in mathematics instruction have changed their philosophical basis and are intended to increase mathematical literacy competencies, to enable people to use mathematics in their everyday life, to interpret the cause-and-effect relationships of the events encountered, and to raise awareness that mathematics is a joint contributor to all sciences (MoNE, 2018). In addition, within the scope of mathematics teaching, they are designed to provide students with associative skills, and curriculums were developed by taking twenty-first-century skills such as critical thinking, problem-solving, creativity and collaboration into account (Özerbaş & Safi, 2022).

An examination of the common goals used in implementing the educational strategies of countries with developed mathematics instruction suggests that teaching mathematics by its functionality in everyday life and the use of more effective techniques are very significant (Eurydice, 2011: 93; NCTM, 2007; Yenilmez & Duman, 2008). It will therefore be beneficial to develop and use teaching methods and techniques which will effectively increase the quality of mathematics teaching (Karalı, 2017). Since a

* This study is derived from the master's thesis of the first author under the supervision of the second author.

[1] Master Degree Graduate, Afyon Kocatepe University, Department of Curriculum and Instruction, aysegul_bektas_682@hotmail.com, 0000-0002-3687-5322.

[2] Assoc. Prof. Dr., Afyon Kocatepe University, Department of Curriculum and Instruction, eegmir@aku.edu.tr, 0000-0003-3054-1011.

significant number of students see mathematics as a set of rules to memorize and have difficulty associating it with everyday life, the need for methods such as cooperative learning which ensure the efficient perception and comprehension of mathematics and continuity in knowledge emerges (Artut & Tarım, 2004). Using social and thinking skills-oriented teaching methods in which students actively learn and which develop teachers' cooperative learning competencies will increase the efficiency and permanence in mathematics teaching (Orcan, 2013: 2).

Several studies have shown that more positive results are obtained in academic achievement in mathematics teaching by using cooperative techniques (Akbuğa, 2009; Gelici, 2011; Koç, 2015; Karalı, 2017). Since cooperative learning is a teaching method applied in small groups of individuals with different abilities, it provides the opportunity to develop the ability to comprehend both information and social skills. It positively affects students' attitudes and approaches toward mathematics by improving their affective skills (İflazoğlu, 1999; Gök, 2006; Ural, 2007; Philips, 2010; Zakaria, Chin & Daud, 2010; Arısoy, 2011; Gelici, 2011; Torchia, 2012; Susanto, Bharata & Dahlan, 2018; Hossain & Ariffin, 2018).

In the Turkish education system, educators think that the effective use of cooperative learning methods and techniques in educational processes will support the development of students' attitudes towards mathematics and contribute to their academic achievement. Therefore, educators must practise student-centered teaching methods which increase comprehension and continuity in education and contribute to the development of social skills as well as academic achievement (Aladağ, 2005; Göktaş, 2017; Akkaya, 2018).

Cooperative learning is a teaching method in which students work in groups towards a specific goal, and the success and reward belong to the group. It is a form of learning in which students with different skills in the group transfer their knowledge to each other and find solutions to a common problem together (Büyükkaragöz, 1997: 103). In cooperative learning, all students participate in the learning process and even the most passive student is involved in active learning by participating. Since it is student-centered, all of the students in a group can express their thoughts effectively. In addition to facilitating teaching, this method also facilitates knowledge retention and contributes to critical thinking. In this learning method, each student in the group is obliged to support the learning of the other students (Millis, 2010: 5-7).

The Student Teams-Achievement Divisions technique (ST-AD) was developed by Slavin (1980) and is applied in five stages (cited in Bilgin, 2006; Bilgin, Aktaş & Çetin, 2014). In the first stage, the teacher presents the relevant topic to the students in the class in the lecture and discussion style. In the second stage, the students are divided into groups of four or five to represent the whole class in terms of academic achievement, gender or ethnicity (Johnson & Johnson, 1989). The most important task of the team is to prepare group members to succeed in the exams. In the third stage, the students are given individual exams at regular intervals. They are not allowed to help each other in these exams. The exams contain questions in parallel with the worksheets for the teams. If a student has performed better than in previous exams, he/she can receive individual progress points. Here, the student is competing with him/herself; there is no competition with other students. Receiving a score above the previous base score will cause the student to receive individual achievement points, thus contributing to the team score. To motivate the group, students are rewarded according to pre-determined criteria (Açıkgöz, 1992: 27-34). At the end of the exams, the teacher creates a student score sheet to announce the group members' scores. Point sheets are used to show both the highest-performing team and the students who contributed the most to the team.

As a development of the ST-AD, the Team-Game-Tournament technique (TGT) was established by De Vries and Slavin (1978); in this technique, after the activities, students in different teams with similar final success scores compete with each other (cited in Slavin, 1982: 9; Artz & Newman, 1993: 3). There are four main elements in the TGT technique: (Slavin, 1995). The first two stages are similar to the ST-AD technique. Games consist of questions and a test created to measure the level of knowledge gained by team members from classroom briefings and group activities. During the game, three students who are members of different teams sit around a table and try to answer one of the numbered questions by

drawing. If the answer is wrong, a student is given one more opportunity to respond and if another wrong answer is given, the other students are given the right to respond. Tournaments express activities consisting of different games and are put into practice at the end of teamwork, after the teacher's presentation and at the end of the units covered. Tournament tables are homogeneous. To achieve this, high-performing students are distributed at one table, followed by high-performing students at another table (Koç, 2015: 27).

Research Purpose and Significance

The current study was designed to investigate the contributions of cooperative learning methods to the academic achievement, attitudes toward mathematics, and critical thinking tendencies of seventh-grade students within the scope of the data analysis subject in a mathematics lesson and to develop solutions in line with the results. Many studies such as ABIDE (Monitoring and Evaluation of Academic Skills), LGS (Transition to High Schools System), PISA (Program for International Student Assessment), TIMSS (Trends in International Mathematics and Science Study) and PIRLS (Progress in International Reading Skills Study) conducted at the national level show that students' proficiency in high-level mathematical literacy skills is not sufficient in Turkey (MoNE, 2017; 2019; 2020). Mathematics is a science that should be given importance so that students can succeed in it in many science branches. Mathematics teaching carried out through cooperative teaching activities is vital in bringing different ideas together, improving communication and instilling problem-solving habits at every stage of life and developing mathematical skills (Çırakoğlu, 2009: 23).

Considering students' failures in mathematics courses and their attitudes towards mathematics, there is evidently an inadequacy in the curriculum in schools. Because the teachers cannot deal with the students one by one, the number of students in classrooms is high and the subjects are not adequately explained due to a lack of time all contribute to this situation. It is necessary to implement teaching methods to increase students' interest in mathematics and positively affect their success and attitudes. It therefore becomes a necessity for educators to teach mathematics with more exciting methods. For this reason, teachers have turned to new teaching methods. One of the most important of these new methods is the cooperative learning method (Ünlü, 2008: 19).

The teaching techniques studied within the scope of the cooperative learning method enable meaningful learning by putting the student at the center and providing efficiency in education. Accordingly, countries need to improve their international level of mathematics (Açıkgöz, 2011). With cooperative learning, students develop critical thinking tendencies as they share information in addition to their academic knowledge. The fact that students learn different solution methods by discussing them with each other also contributes to the positive development of their attitudes towards mathematics (Gelici, 2011: 18).

In the cooperative learning method, the student is at the center and is actively involved in the study, and the teacher only acts as a guide. Therefore, the active participation of all students in the lesson is ensured. The teacher can intervene more quickly when s/he observes that a student has difficulty understanding the subject. The involvement of all students makes passive learners more dynamic. Since students with problems need to attend the lesson, in-class problems are reduced (Karaca, 2005: 63). From this point of view, it is thought that the development and use of methods and techniques which will contribute to improving the quality of mathematics teaching will be beneficial (Karalı, 2017).

Research Problem

This study investigated whether the cooperative learning method affected students' academic achievement, attitudes towards mathematics and critical thinking tendencies in the teaching process of the data analysis sub-learning area in the seventh-grade mathematics lesson, and sought answers to the following questions;

- What is the level of the effect of the cooperative learning method on students' academic achievement in the data analysis sub-learning area of the seventh-grade mathematics lesson?

- What is the level of the effect of the cooperative learning method on students' attitudes towards mathematics in the data analysis sub-learning area of the seventh-grade mathematics lesson?
- What is the level of the effect of the cooperative learning method on students' critical thinking dispositions in the data analysis sub-learning area of the seventh-grade mathematics lesson?

METHOD

Research Design

This research was a quasi-experimental study in which measurements were made before and after the experiment. In experimental research models, data are generated under the observation of the researcher to determine any cause-and-effect relationships. In the model, no special effort is made to equalize the elements through unbiased selection, but the necessary action is taken to ensure that the group members work in harmony with each other (Karasar, 2014: 97). The independent variables of the research were the ST-AD and TGT cooperative learning techniques. The dependent variables were mathematics achievement, attitude towards mathematics and critical thinking disposition. As a result of the research, it is hoped to show the effect of the independent variable on the dependent variables.

Research Working Group

In the study, a criterion sampling model was used to determine the participants. Reviewing and analyzing all instances which satisfy a pre-set threshold of relevance is the process of criterion sampling. (Patton, 2002: 238). It is the study of all situations which meet a predetermined set of criteria. The researcher creates the criterion, or a previously prepared criteria list can be used (Marshall & Rossman, 2014). The criteria for determining the sample for this study were defined as follows: the experimental and control groups in the study consisted of 40 students attending a children's club who were studying in five different secondary schools in in a Mediterranean region of Turkey in the first semester of the 2020-2021 academic year.

Instruments

Achievement Test in Data Analysis Learning Area

To develop an achievement test to be used by the researchers as a measurement instrument before and after the application, the seventh-grade mathematics curriculum was first examined, the learning outcomes related to the learning area were determined and a specification table was prepared accordingly. The questions asked in the PISA and TIMSS exams and the questions asked in the achievement comprehension exams prepared by the MoNE were examined, and an Achievement Test consisting of questions related to the targeted learning outcomes of the data analysis sub-learning area was prepared. The draft achievement test was reviewed by three mathematics teachers and three mathematics field experts. Necessary adjustments were then made in compliance with the feedback received, and the final version of the Data Analysis Achievement Test consisting of 32 questions was created.

The achievement test was applied as a pilot study to 70 eighth-grade students who had taken the mathematics course in accordance with the learning outcomes of the related subject in the previous year. Based on the data obtained in the pilot study, the Kuder Richardson (KR-20) test was used to determine item difficulty and the discrimination values and reliability values of the test. The results showed that the item difficulty value was 0.62, and the item discrimination value was 0.48. The fact that the coefficients obtained were above 0.40 indicated that the test items were usable. The KR-20 reliability coefficient was 0.883, and the fact that it was close to 1 indicates that the reliability value was sufficient (Atılgan, Kan & Doğan, 2014).

After the pilot application, the achievement test was applied to the students of both groups as a pre-test, and the KR-20 value was found to be 0.91. After the application to the participants, the achievement test was again applied as a post-test to the students of both groups; the KR-20 value was found to be 0.87.

To test the reliability of the achievement test, the researchers also conducted a test-retest reliability study and administered the test twice at a specific interval. The higher the test-retest reliability, the less the scores obtained from both tests will be affected by factors other than the test. As a result of the test-retest reliability study, the Pearson Product Moment Correlation Coefficient was calculated as 0.98. This showed the level of compatibility between the scores obtained from the test application at different times and that the test could make stable measurements (Atılgan et al., 2014).

Attitude toward Mathematics scale

The study used the Attitude Towards Mathematics Scale developed by Önal (2013). This scale was composed of 22 items and four sub-dimensions to measure middle-school students' attitudes towards mathematics. These dimensions were determined as interest, anxiety, study and necessity. A sample item from each sub-dimension is presented below:

'*I would be happy to use mathematical concepts in other lessons.*' (Interest sub-dimension)

'*I think my friends are better at math than me.*' (Anxiety sub-dimension)

'*I repeat the topic before the math exams.*' (Study sub-dimension)

'*I do not use mathematics in any area of my social life.*' (Necessity sub-dimension)

The items in the scale were prepared as a five-point Likert type. Factor analysis was performed to find the internal consistency of the whole scale and the Cronbach's Alpha value was found to be 0.90 (Önal, 2013). The Cronbach's Alpha values of the internal consistency of the entire scale were found to be 0.83 and 0.68 respectively in the tests conducted before and after the implementation. The fact that the values obtained were close to 1 indicates the scale's reliability (Can, 2018: 388-391).

Critical Thinking Disposition Scale

The Critical Thinking Disposition Scale, adapted into Turkish by Kılıç and Şen (2014), was used in the study. The scale consists of 25 items and three sub-dimensions. These sub-dimensions are participation (ten items), cognitive maturity (eight items) and innovativeness (seven items). A sample item from each sub-dimension is presented below:

'*While solving problems, I am confident that I can reach a logical conclusion.*' (Participation sub-dimension)

'*Even if reaching the truth makes me uncomfortable, I strive for it.*' (Cognitive maturity sub-dimension)

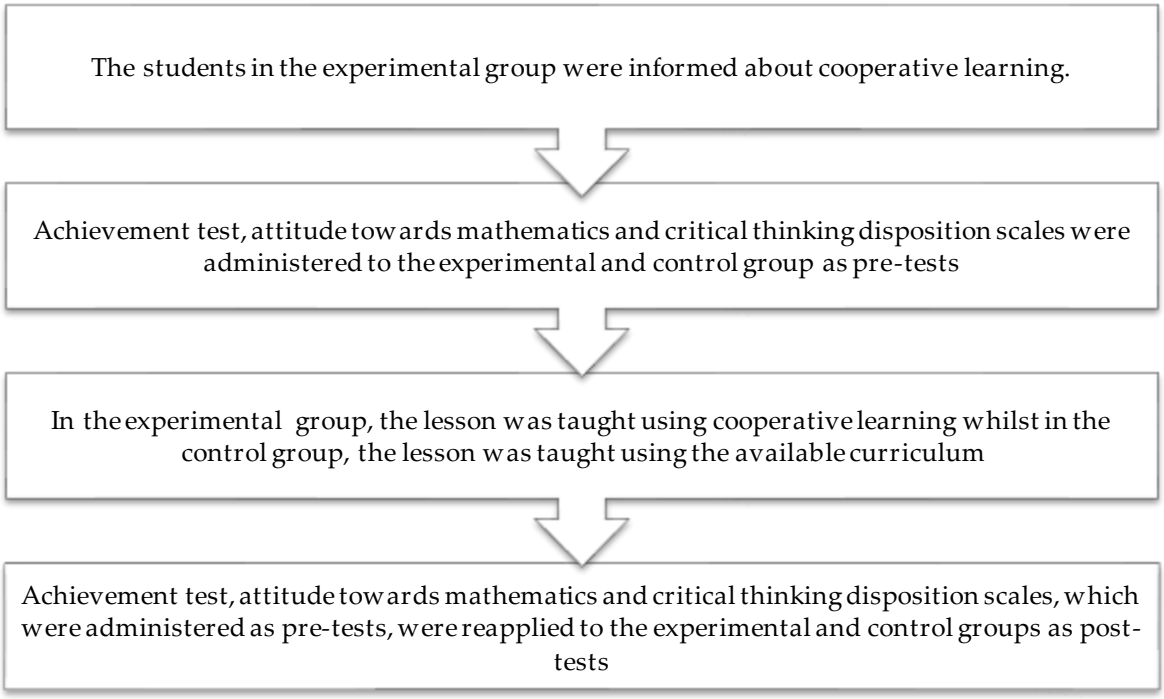
'*I try to find more than one solution to problems.*' (Innovativeness sub-dimension)

The items in the scale were again prepared as a five-point Likert type. The internal consistency Cronbach's Alpha value for the whole scale was 0.91 (Kılıç & Şen, 2014). The internal consistency Cronbach's Alpha value of the whole scale was found to be 0.88 in both the pre-and the post-application tests. The fact that this value was close to 1 indicates high reliability (Can, 2018).

The Learning and Teaching Procedure in the Experimental and Control Groups

In the study, the following procedures were applied to the experimental and control group students to obtain the required data.

Figure 1. The Procedure of the Application



Before the application, the students in the experimental group were informed about cooperative learning. The researchers tried to introduce the practices which the participants would do with similar applications. It was ensured that the students working together actively participated in the applications. Subsequently, achievement test, attitudes towards mathematics and critical thinking disposition scales were administered to the experimental and control groups as pre-tests. In the experimental group, the lesson was taught using a lesson plan created by the researchers in accordance with the cooperative learning techniques ST-AD and TGT. In contrast, in the control group, the lesson was taught using a lesson plan created by the researchers in accordance with the available curriculum. The study took place over a total of four weeks. After the applications, the achievement test, attitudes towards mathematics and critical thinking disposition scales, which were administered as pre-tests, were reapplied to the experimental and control group as post-tests. The applications to the two groups were completed at the same time, in parallel with each other.

In the application of ST-AD technique, first, the method was introduced to the experimental group students, who were divided into five teams, each with four members. The students were divided into heterogeneous groups based on their academic achievements and year-end grades. After the teacher's lecture presentation, sample questions were solved and activities prepared for the students were carried out. Worksheets related to these activities were distributed to the students, who were asked to solve them within the rules of the cooperative learning method. At the end of each subject studied, individual outcome assessment exam papers were distributed to the students, and it was evaluated whether the required achievement had been made on the subject. Individual progress scores were determined by comparing the initial scores of each student in the group (or the average of previous exams) with the scores which they received from the achievement assessment exams (the difference between them). The team scores were determined by taking the average of the students' individual progress scores divided by four.

In the application of the TGT technique, after the activity was completed, the teacher assigned members from different teams with the same academic success to homogeneous groups to represent their teams in tournaments. In these homogeneous teams, members with the same success level competed among themselves. At the end of the tournament, all students wrote their names and returned their points and

playing cards to the teacher, who then gave scores. At the end of the tournament, the teacher determined the first team according to the scoring.

Data analysis

The data obtained from the study groups were analyzed with the help of package programs in the computer environment within the scope of the problems addressed in the research. To determine whether there was a statistically significant difference between the mean scores of the experimental and control group students, the first of the assumptions that must be met in order to apply parametric tests such as an independent samples t-test and to obtain beneficial results is that the data whose means are compared must be normally distributed. The p-value found according to the normality test result of the pre- and post-achievement tests applied to the experimental and control groups showed that normality was ensured ($p>0.05$). To evaluate the result properly, the Kolmogorov-Smirnov test is recommended if the number of data items is above 50, and the Shapiro-Wilk test is recommended if the number of data points is below 50 (Can, 2018: 89). The skewness and kurtosis coefficients were found to be -1.30 and -0.568 in the experimental group and -0.689 and -0.694 in the control group. The fact that these values were between -1.96 and +1.96 indicates that the distribution can be considered normal (Can, 2018).

The second assumption to be met is that each set of data must be independent of the other. The third assumption requires that the variances of the groups be equal. Levene's test was performed to determine the similarity of the variances of the groups, and the p-value was found to be 0.751. A p-value greater than 0.05 indicates no significant difference between the variances (Can, 2018: 116-121).

As a result of the comparing the achievements, attitude towards the mathematics course pre-tests, attitude towards the mathematics course attainment scores, and critical thinking tendency attainment scores of the experimental and control group students, normality was ensured. Hence, it was determined that it was appropriate to use the independent samples t-test, one of the parametric tests, to compare the scores of the two groups.

When the pre- and post-tests of attitude towards the mathematics course and critical thinking disposition of the experimental and control group students were compared, it was seen that the data series formed by the differences of the data whose means were compared had normal distribution characteristics. It was therefore determined that it was appropriate to use the paired samples t-test due to the normality in the distribution of differences between measurements in the comparison of the pre-test and post-test scores.

When the achievement test scores and critical thinking disposition pre-test scores of the students of both groups were compared, it was seen that the data did not have normal distribution characteristics. Accordingly, it was determined that the Mann-Whitney U test, which is an alternative used when there are abnormalities in the distribution of independent samples t-test data, was appropriate for the comparison of achievement scores and critical thinking disposition pre-test scores.

When the pre-tests and post-tests of the experimental and control group students' achievement tests were compared, it was seen that the data series formed by the differences of the data whose means were compared did not have a normal distribution. It was therefore determined that it was appropriate to use the Wilcoxon Signed Ranks Test, which is an alternative to the paired samples t-test when there are anomalies in the distribution of differences between measurements in the comparison of pre-test and post-test scores.

RESULTS

Findings regarding the Achievement Test

To address the question *What is the difference between the maths achievement scores of the experimental and control group students before the application?*, an independent samples t-test was applied and the means and statistical values of the scores obtained by the students from the mathematics achievement test are given in Table 1.

Table 1. Experimental and Control Groups' Pre-Test Achievement Scores t-Test Results

Group	*N*	*Mean*	*SD*	*df*	*t*	*p*
Experimental	20	63.28	23.62	38	-0.105	0.917
Control	20	64.06	23.59			

As seen in Table 1, in the pre-test applied to determine the mathematics achievement levels of the experimental and control group students before the application, the mean mathematics achievement scores of the students in the experimental group were x=63.28 and those of the students in the control group were x=64.06. A t-test was conducted to determine whether the difference in the scores between the two groups was significant or not, and t(38) = -0.105 was obtained. The fact that the p=0.917 value is greater than the significance (0.05) value shows no significant difference when the mathematics achievement of the students of the two groups is compared.

The Wilcoxon Signed Ranks test was applied to determine the address the question *What is the difference between the achievement scores of the students in the experimental group in the pre-test and post-test applications?* and the statistical values obtained are shown in Table 2.

Table 2. Wilcoxon Signed Ranks Test Results of the Experimental Group Achievement Scores Before and After the Application

Post-test- Pre-test	*N*	*Mean Rank*	*Rank Sum*	*z*	*P*
Negative ranks	17	9	153	-3.653	0.00*
Positive ranks	0	0	0		
No difference	3				

*p<.05

As a result of the Wilcoxon Signed Ranks test, a significant difference was found between the achievement post-test and the achievement pre-test (z=-3.653, p<0.05). The fact that the score differences before and after the application were in favor of negative ranks indicates that the application made a significant contribution to increasing achievement. Although the Wilcoxon test indicated that the difference between the mean scores before and after the intervention was significant, the magnitude of the difference was not clear. The effect size therefore had to be found in addition to the statistical significance level (Can, 2018). Dividing the z value found as a result of the Wilcoxon test by the square root of the number of data shows the effect size (Connolly, 2007):

$d = z / \sqrt{n}$

$d = -3.653 / \sqrt{20} = -0.82$ (effect size value)

According to Can (2018: 141), a d value greater than 1 indicates a very large effect, 0.80 indicates a large effect, 0.5 indicates a medium effect and 0.2 indicates a small effect. In the study, an effect size of 0.82 was found. This value shows that the cooperative teaching approach had a significant effect on the achievement of the experimental group students.

The Wilcoxon Signed Ranks test was applied to address the question *What level of difference is observed when the pre-test and post-test mathematics achievement score means of the students in the control group are compared?* The values found as a result of the statistical analysis are shown in Table 3.

Table 3. Wilcoxon Signed Ranks Test Results for the Control Group Pre-Test and Post-Test Achievement Scores

Post-test- Pre-test	*N*	*Mean Rank*	*Rank Sum*	*z*	*p*
Negative ranks	16	8.78	140.50	-2.444	0.01*
Positive ranks	2	15.25	31		
No difference	2	2			

*Based on negative ranks

The Wilcoxon Signed Ranks test showed a significant difference between achievement post-test and achievement pre-test mean scores (z=-2.44, p< 0.05). The fact that the difference in scores is more in the direction of negative ranks shows that the application significantly contributed to increasing achievement. The value of the effect size found after the analysis was 0.57. This result showed that the current teaching approach contributed positively to the achievement of the students in the control group, but this effect was moderate.

The Mann-Whitney U test was applied to address the question *What is the difference between the maths achievement test scores of the students in the experimental and control groups?* and the values found are given in Table 4.

Table 4. Mann-Whitney U Test Results for the Experimental and Control Group Mathematics Achievement Test Scores

Group	*N*	*Mean Ranks*	*Rank Sum*	*U*	*p*
Experimental	20	8.60	444	166	0.33
Control	20	5.47	376		

In Table 4, the Mann-Whitney U test result shows the students' achievement scores in both groups. The achievement scores were obtained by subtracting the pre-test scores from the post-test scores in mathematics achievement. When the achievement scores of both groups were compared (U=166, p>0.05), a statistically significant difference was found (Can, 2018: 130).

Findings Regarding Attitudes towards Mathematics

To address the question *What is the difference between the attitude towards mathematics lesson scores of the students in the experimental and control groups before the application?*, the independent samples t-test was applied, and the means and statistical values of the scores obtained by the two groups of students from the attitude towards mathematics scale are shown in Table 5.

Table 5. Results of the Experimental and Control Groups' Attitude towards Mathematics Pre-test Scores

Group	*N*	*Mean*	*SD*	*df*	*t*	*P*
Experimental	20	81.40	12.80	38	-0.158	0.87*
Control	20	82.00	11.17			

p<.05

As presented in Table 5, in the pre-test applied to determine the attitude score levels of the students in the experimental and control groups before the application, the mean scores of the students in the experimental group were $\bar{x}$ =81.40 and those of the students in the control group were $\bar{x}$=82.00. To determine whether the difference between the scores was significant, the t-test was applied, and t(38)= -0.158, p>0.05 was found. The result of p=0.875, which is greater than the significance value of 0.05, shows that there was no significant difference between the attitudes toward mathematics scores of the two groups of students.

To address to the question *What is the difference between the pre-test and post-test attitude towards mathematics scores of the students in the experimental group?*, the paired samples t-test was applied, and the statistical values obtained are given in Table 6.

Table 6. t-Test Results of the Pre-Test and Post-Test Scores of the Experimental Group's Attitude Towards Mathematics

	N	*Mean*	*SD*	*df*	*t*	*p*
Pre-test	20	81.40	12.80	19	2.182	0.04*
Post-test	20	76.60	7.96			

*p<.05

In Table 6, as a result of the tests applied to determine the pre-test and post-test scores of the experimental group students from the attitude towards mathematics lesson scale, the pre-test scores of the experimental group were $\bar{x}$=81.40 and the post-test scores were $\bar{x}$=76.60. To determine whether the difference between the mean pre-test and post-test scores of the experimental group students was significant, the t-test was applied and t(19)= 2.182 was found. The fact that the value of p= 0.042 is less than 0.05 significance value shows a significant difference between the attitude towards mathematics scores of the experimental group students after the pre-test and the post-test.

According to the result of the paired samples t-test, there was a significant difference between the pre- and post-test scores, but it did not reveal any information about the magnitude of the difference. For this reason, in addition to statistical significance, the effect size should also be found (Can, 2018). Dividing the t-value found as a result of the paired samples t-test by the square root of the number of data items explains the effect size (Can, 2018: 141):

$d = t / \sqrt{N}$

$d = 2.182 / \sqrt{20} = -0.49$ (effect size.)

A d value of greater than 1 is defined as a very large effect, 0.80 as a large effect, 0.5 as a medium effect and 0.2 as a small effect (Can, 2018: 141). In the study, an effect size value of 0.49 was found, which shows that the cooperative teaching approach had a moderate effect on the experimental group students' attitudes towards mathematics.

To address the question *What is the difference between the pre-test and post-test scores of the students in the control group of the study?*, a paired samples t-test was applied and the scores obtained from the pre-test and post-test of attitudes towards mathematics lessons and the statistical values obtained are shown in Table 7.

Table 7. t-Test Results for Attitude Towards Mathematics Pre-test and Post-test Scores of the Control Group

	N	*Mean*	*SD*	*df*	*t*	*p*
Pre-test	20	82.00	11.17	19	-0.215	0.83
Post-test	20	82.25	7.26			

As indicated in Table 7, in the application conducted to find the pre-test and post-test score levels of the students in the control group from the attitude towards mathematics lesson scale, the mean pre-test score of the control group students was $\bar{x} = 82.00$ and the mean post-test score was $\bar{x} = 82.25$. When the pre- and post-test scores of the students in the control group were compared, the t-test was applied to determine whether the difference was significant or not and t(19)= -0.215 was found. The fact that the value of p=0.832 is greater than the significance level of 0.05 indicates no significant difference between the pre-test and post-test results.

To address the question *What is the difference between the attitudes towards mathematics course achievement scores of the experimental and control group students?*, the attainment scores of the students found from the attitude towards mathematics pre-test and post-test results and the statistical values found from the t-Test application are shown in Table 8.

Table 8. t-Test Results for Attitude Towards Mathematics Scores of the Experimental and Control Groups

Group	*N*	*X*	*SD*	*df*	*t*	*p*
Experimental	20	-4.80	9.84	38	-2.030	0.04*
Control	20	0.25	5.19			

*p<.05

The attitudes towards mathematics attainment scores of the students in the experimental and control groups are shown in Table 8. The attainment scores were determined by subtracting the scores obtained before the application from the scores obtained after the attitude towards mathematics application. It was found that the mean attitude towards mathematics attainment score of the experimental group students ($\bar{x} = -4.80$) was less than that of the control group students ($\bar{x} = 0.25$). When the values found were compared with an independent t-test, the result showed a statistically (t(38)= -2.030, p<0.05) small significant effect between the mean achievement score of the students in the experimental group and that of the students in the control group.

Although the results of the independent samples t-test showed a significant difference between the two groups, they did not provide sufficient information about the magnitude of the difference. Hence, it was necessary to determine the effect size as well as the level of statistical significance. The formula for effect size in the independent samples t-test is given below (Can, 2018: 121):

$d = t \times \sqrt{N1+N2 / N1 \times N2}$

$d = -2.030 \times \sqrt{20 + 20 / 20 \times 20} = -0.64$ (effect size)

An effect size value greater than 1 is accepted as very large, 0.80 as large, 0.5 as medium and 0.2 as small (Can, 2018: 141). In the study, the effect size value was found to be 0.64. This value can therefore be stated to be a moderate effect of the cooperative teaching approach on the attitude towards mathematics achievement scores of the experimental and control group students.

Findings Related to Critical Thinking Dispositions

The Mann-Whitney U test was applied to address the question *What is the difference between critical thinking disposition pre-test scores of the experimental and control group students?* and the means and statistical values of the scores of the experimental and control group students are presented in Table 9.

Table 9. Mann-Whitney U Test Results for Critical Thinking Disposition Pre-Test Scores of the Experimental and Control Groups

Group	*N*	*Mean Ranks*	*Ranks Sum*	*U*	*p*
Experimental	20	20.65	413	197	0.93
Control	20	20.35	407		

In the application conducted to determine the pre-test scores of the students in the experimental and control groups for critical thinking disposition towards mathematics course, the mean score of the students in the experimental group was x= 92.35 and that of the students in the control group was x= 93.85. The Mann-Whitney U test was performed to determine whether the difference between the two groups was significant, and p= 0.935 was higher than 0.05, which is the significance level, indicating that there was no significant difference between the critical thinking disposition scores of the two groups.

To address the question *What is the difference between the critical thinking disposition pre-test and post-test scores of the students in the experimental group of the study?*, the paired samples t-test was applied, and the pre-test and post-test mean scores and statistical values obtained by the students in the experimental group are shown in Table 10.

Table 10. t-Test Results for Critical Thinking Disposition Pre-test and Post-test Scores of the Experimental Group

	N	*Mean*	*SD*	*df*	*t*	*p*
Pre-test	20	92.35	11.62	19	0.536	0.59
Post-test	20	90.75	8.98			

As seen in Table 10, in the application conducted to determine the pre-test and post-test scores of the experimental group students from the scale of critical thinking disposition towards mathematics lessons, the mean of the pre-test scores of the experimental group students was $\bar{x}$= 92.35 and that of the post-test scores was $\bar{x}$ = 90.75. To compare the pre-test and post-test scores of the experimental group students, the t-test was performed to explain whether the difference was significant or not and t(19)= 0.536 was found. The value of p=0.598 was greater than the significance level of 0.05, indicating that there was no significant difference between the pre-test and post-test scores.

To address the question *What is the difference between the critical thinking disposition pre-test and post-test scores of the students in the control group of the study?*, the paired samples t-test was applied, and the means and statistical values of the scores obtained by the students from the critical thinking disposition scale are shown in Table 11.

Table 11. t-Test Results for Critical Thinking Disposition Pre-test and Post-test Scores of the Control Group

	N	*Mean*	*SD*	*df*	*T*	*p*
Pre-test	20	93.85	13.20	19	-2.369	0.02*
Post-test	20	96.15	12.61			

*p<.05

As Table 11 shows, in the application conducted to determine the pre-test and post-test scores of the students in the control group from the critical thinking disposition scale for the mathematics course, the mean of the pre-test scores of the control group students was $\bar{x}$= 93.85 and that of the post-test scores was $\bar{x}$= 96.15. A t-test was conducted to determine whether the difference between the pre-test and post-test scores of the control group students was significant or not and t(19)=-2.369 was found. The fact that the significance level of p=0.029 was less than 0.05 showed that there was a significant difference between the pre-test and post-test scores.

Although the results of the paired samples t-test showed a significant difference between the two means in the pre-test and post-test, they did not give information about the magnitude of the difference. To find that magnitude, the effect size should be determined in addition to the statistical significance (Can, 2018: 140). Dividing the t-value found in the paired samples t-test by the square root of the number of

data items expresses the effect size (Can, 2018):

$d = t / \sqrt{n}$

$d = -2.369 / \sqrt{20} = -0.53$ (effect size)

An effect size value greater than 1 is defined as a very large effect, 0.80 as a large effect, 0.5 as a medium effect and 0.2 as a small effect (Can, 2018: 141). In the study, the effect size was found to be 0.53. In this case, the cooperative teaching practice had a moderate effect on the critical thinking disposition of the experimental group students.

To address the question *What is the difference between the critical thinking disposition scores of the students in the experimental and control groups?*, the independent samples t-test was applied and the means and statistical values of the scores obtained by the students from the critical thinking disposition scale are shown in Table 12.

Table 12. t-Test Results for Critical Thinking Disposition Scores of the Experimental and Control Groups

Group	*N*	*X*	*SD*	*df*	*T*	*p*
Experimental	20	-1.60	13.36	38	-1.242	0.22
Control	20	2.30	4.34			

As Table 12 shows, the critical thinking disposition attainment scores of the students in the experimental and control groups were compared. The attainment scores were determined by subtracting the pre-test scores from the critical thinking disposition post-test scores. It was found that the mean attainment score of the students in the experimental group ($\bar{x}$ = -1.60) was smaller than that of the students in the control group ($\bar{x}$ = 2.30). When these means were compared with the independent t-test, there was no statistically significant difference found between the mean attainment score of the students in the experimental group and that of the students in the control group ($t(38) = -1.242$, $p > 0.05$).

CONCLUSION and DISCUSSION

At the beginning of the study, the students' achievement scores in the experimental and control groups in the pre-test application in the mathematics lesson were close to each other and the achievement levels of both groups were similar. After the cooperative learning method activities were implemented, a significant difference was observed between the achievement test scores of the experimental group students in the pre- and post-application tests in the mathematics course, with a high level of effect size. There was a significant difference between the achievement test scores of the students in the control group, who studied in accordance with the current curriculum, from the pre-test and post-test applications in the mathematics course. The findings showed that there was a statistically significant difference between the students' achievement test scores in both groups.

In the study, the application of the ST-AD and TGT cooperative teaching methods and techniques was performed for one month of twenty lesson hours, and it was concluded that the cooperative learning technique was more effective in increasing the academic achievement of the students than the current curriculum. Although the academic achievement of the experimental and control groups increased, it was seen that the increase in the success level of the group working with the cooperative method was higher than that of the group working with the current curriculum.

The result that cooperative learning methods are more effective in raising academic achievement than traditional methods has been reported in previous studies. In studies at various grade levels, it was found that cooperative teaching methods applied with ST-AD and TGT techniques contributed more positively to students' academic achievement in mathematics courses compared with the current curriculum (Ünlü, 2008; Gelici, 2011; Karalı, 2017; Çırakoğlu, 2009; Akbuğa, 2009 and Koç, 2015). In other studies conducted with cooperative teaching methods, it was shown that students' academic achievement increased more than in the current curriculum (İflazoğlu, 1999; Yıldız, 2001; Effandi, 2003; Kolawole, 2007; Genç, 2007; Ural, 2007; Şen, 2008; Göktaş, 2017; Çelik, 2017; Akkaya, 2018; Tshering & Dorji, 2022). Zenginobuz (2005) and Hazer (2013), however, reported no significant difference between the achievement levels of the cooperative teaching group and the group taught with the current teaching method.

This result may be due to some of the strengths of cooperative teaching. Cooperative teaching is perceived as a teaching method which contributes to the development of students' academic success, social skills, attitudes and self-confidence (Slavin, 1991; Johnson, Johnson & Holubec, 1993; Williams, 2005). Panitz (2000) stated that when used effectively, the cooperative teaching method improved students' thinking skills and their interest in study and mathematics lessons positively. In addition, their self-confidence increased, their anxiety about the lesson decreased and they had the opportunity to get to know other friends. In the cooperative learning method, students interact with more educational materials and this increases their interest in learning (Johnson, Johnson & Holubec, 1993).

Cooperative learning increases interest and participation in the course from an academic point of view and allows students to evaluate what has been learned from different perspectives. In addition, this approach develops students' social skills, such as listening to each other with respect and valuing each other's opinions while communicating, which contributes to an increase in their academic success (Johnson, Johnson & Smith, 1991; cited in Williams, 2005). Also, it supports the development of self-esteem and positive attitude, and helps to eliminate the anxiety and fear of failure towards the lesson (McLean, 1992).

In the study, before the application, the pre-test attitude scores of the experimental and control group students towards the mathematics course were very close and the attitude scores of both groups towards mathematics were very similar. After the implementation, it was found that the attitude scores of the students in the experimental group towards mathematics had decreased significantly in the post-test application compared with the pre-test application. This decrease is thought to be due to the students' failures in their previous experiences of mathematics courses, their perception of mathematics as challenging, and variables which could not be controlled due to the conditions of the implementation of the research. It was observed that the post-test attitude scores of the students in the control group towards mathematics increased slightly compared with the pre-test attitude scores, but the increase was not significant.

In previous studies, similar results have been obtained. In a study in which the Team-Assisted Supported Individualization technique was applied, it was found that it did not have a significant effect on the attitudes of fifth-grade students towards mathematics (İflazoğlu, 1999: 60), and in another study in which the Team Game Tournament supported with Student Teams and Achievement Sections (TGT Supported with STAS) was applied; it was found that there was a non-significant decrease in students' attitudes toward mathematics (Karalı, 2017: 124). The implementation conditions and process of those studies were not more effective on students' attitudes towards mathematics than the method in the current curriculum.

According to the results of the current study, the relationship between the attitude attainment scores of the students in the experimental and control groups towards the mathematics course was at a higher level and there was a statistically significant difference in favor of the attitude attainment scores of the students in the control group than those of the students in the experimental group. The cooperative learning techniques ST-AD and TGT were applied over four weeks and it was seen that these techniques were not effective in increasing the attitude towards mathematics in the experimental group students who were taught using the cooperative teaching method compared with the control group students who were taught using the existing method. It was found that the attitude towards mathematics scores of the experimental group students who received cooperative teaching decreased significantly, whilst the control group students who received an education with the current teaching methods increased at a non-significant level.

In previous studies, it has been shown that cooperative teaching is not significantly more effective in terms of attitudes towards mathematics than teaching with existing teaching methods. For example, Gelici (2011) and Karalı (2017) studied an algebra course and reported that the cooperative practice was less effective at a non-significant level compared with the current teaching method. Ural (2007), Akbuğa (2009) and Göktaş (2017), in studies conducted at different grade levels, all found that the cooperative teaching method in a mathematics course was more effective on students' attitudes towards mathematics than the current teaching method. İflazoğlu (1999) and Genç (2007) reported that it did not

change students' attitude scores towards mathematics. As can be understood, therefore, different results have been reported in the literature.

The findings of the current study showed that the critical thinking disposition scores of the experimental and control group students before implementation were found to be close to each other. It was found that there was no significant difference between the two groups regarding critical thinking disposition mean scores and that the experimental and control groups were similar regarding critical thinking disposition.

When the critical thinking disposition scores of the students in the experimental group before and after the application were compared, the post-test score had decreased at a non-significant level compared with the pre-test score. The critical thinking disposition scores of the control group students in the post-test increased significantly compared with the pre-test. It can be interpreted that the efforts of the MoNE in recent years to develop curriculums designed to raise individuals who produce knowledge and can use it in their everyday lives and tend to think critically have contributed to this result. In the curriculums, the aim is to develop students' skills from primary school to high school at all levels and for them to be ready for higher education and professional life (MoNE, 2018).

The findings also showed that the mean achievement scores of the students in the experimental group were lower than those of the students in the control group. Although there was a difference between the achievement scores of the experimental and control group students, it was not a significant difference.

In conclusion, the findings showed that the cooperative teaching technique was ineffective in increasing the mean scores of the students' critical thinking disposition compared with the current curriculum. At the same time, they showed a significant difference in the group which studied with the current curriculum. In a previous study on critical thinking disposition, it was found that the critical thinking skill test scores showed a non-significant increase, which is similar to the results of the current study (İflazoğlu, 1999).

Many studies have been conducted in recent years to explore how cooperative teaching methods and techniques affect students' academic achievement and social skills. In many of these studies, it has been found that cooperative practices do contribute to students' academic achievement at a higher level than the practices conducted in line with the available curriculum. It has been concluded that this contribution is more effective, especially for intermediate-level students, and helpful in increasing students' self-confidence. Previous studies have also shown that it will support the positive development of communication between students as well as their academic achievement (Bosfield, 2004; Gelici, 2011; Olson, 2002; Ural, 2007; Whicker, 1999).

Implications

- Cooperative learning methods in mathematics lessons should be initiated at the first stages of education, and students should be made aware of group work and exchange information with each other. Thus, the mathematics achievement of students in the first years of education can be increased and their attitudes towards mathematics can be improved.
- The textbooks and mathematics-related materials used by teachers in education should be prepared in a cooperative learning context.
- Different cooperative teaching methods and techniques can also be used in applications to show their effects on students' development.

Declarations

Conflict of Interest

No potential conflicts of interest were disclosed by the author(s) with respect to the research, authorship, or publication of this article.

Ethics Approval

This research was carried out with the permission of the Social and Human Sciences Scientific Research and Publication Ethics Committee of the Republic of Turkey Afyon Kocatepe University, with the decision numbered 2019/103-08 dated 11/12/19.

Funding

No specific grant was given to this research by funding organizations in the public, commercial, or not-for-profit sectors.

Contribution Rates of Authors to the Article

The authors provide equal contribution to this work.

REFERENCES

Açıkgöz, K. (1992). *İşbirlikli öğrenme kuram-araştırma–uygulama* [Cooperative Learning Theory-Research-Practice]. Malatya: Uğurel Matbaası.

Açıkgöz, K. Ü. (2011). *Aktif öğrenme* [Active learning]. İzmir: Kanyılmaz Press.

Akbuğa, S. (2009). *İlköğretim 4. sınıf matematik dersinde işbirlikli öğrenme ilkelerine göre yapılandırılmış grup etkinliklerinin öğrenci erişilerine ve tutumlarına etkisi* [The effect of group activities structured according to cooperative learning principles on students' level at the beginnig and at the end and attitudes in 4th grade mathematics lesson in primary school] (Unpublished Master's Thesis). Dokuz Eylül University, İzmir.

Akkaya, E. (2018). *Küme destekli bireyselleştirme tekniğinin çember ve daire konusunda 7.sınıf öğrencilerinin başarı, kalıcılık ve tutumlarına etkisi* [The effects of team-assisted individualization technique on 7rd grade students' achievement, retention and attitude in circle subject] (Unpublished Master's Thesis). Atatürk University, Erzurum.

Aladağ, S. (2005). *İlköğretim matematik öğretiminde proje tabanlı öğrenme yaklaşımının öğrencilerin akademik başarısına ve tutumuna etkisi* [The effect of project based learning approach in teaching mathematics to the academic achievements and attitudes in primary education] (Unpublished Master's Thesis). Gazi University, Ankara.

Arısoy, B. (2011). *İşbirlikli öğrenme yönteminin ÖTBB ve TOT tekniklerinin 6. sınıf öğrencilerinin matematik dersi "istatistik ve olasılık" konusunda akademik başarı, kalıcılık ve sosyal beceri düzeylerine etkisi* [The effects of STAD and TGT techniques of cooperative learning on sixth grade students' academic achievement, retention and social skill levels in "statistic and probability" subject in mathematics lesson]. (Unpublished Master's Thesis). Çukurova University, Adana.

Artut, P. D., & Tarım, K. G. (2004). Okul öncesi kubaşık öğrenme uygulamaları: Toplama işlemine yönelik bir uygulama [Preschool cooperative learning applications: An application for the addition process]. *Çukurova University Journal of Social Sciences, 13*(2), 1-9.

Artz, A. F., & Newman, C. M. (1993). *How to use cooperative learning in the mathematics cla*ss (Third Printing). Virginia: The National Council of Teachers of Mathematics.

Atılgan, H., Kan, A., & Doğan, N. (2014). *Eğitimde ölçme ve değerlendirme* [Measurement and evaluation in education]. Ankara: Anı Publishing.

Baltacı, A. (2018). Nitel araştırmalarda örnekleme yöntemleri ve örnek hacmi sorunsalı üzerine kavramsal bir inceleme [A Conceptual Review of Sampling Methods and Sample Size Problems in Qualitative Research]. *Bitlis Eren University Journal of Social Sciences Institute, 1*(7), 231-274.

Baykul, Y. (2014). *Ortaokulda matematik öğretimi (5-8.sınıflar) (ikinci baskı)* [Teaching mathematics in secondary school (grades 5-8) (2nd Edition)]. Ankara: Pegem Akademi

Bilgin, İ. (2006). İşbirlikli öğrenme [Cooperative Learning], In *Fen ve teknoloji öğretimi* [Science and Technology Teaching], (Ed. M. Bahar). Ankara: Pegem Akademi Yayıncılık.

Bilgin, İ.; Aktaş İ. & Çetin, A. (2014). Öğrenci takımları başarı bölümleri tekniğinin ilköğretim öğrencilerinin zihinsel yapılarına etkisi [The Effect of Student-Team Achievement Division Technique on Mental Ability of Elementary Students]. *İlköğretim Online, 13*(4), 1352-1372.

Bosfield, G. F. (2004). *A comparison of traditional mathematical learning and cooperative mathematical learning* (Unpublished Master's Thesis). California State University.

Büyükkaragöz, S. (1997). *Program geliştirme* [Curriculum development]. Konya: Kuzucular Press.

Can, A. (2018). *SPSS ile bilimsel araştırma sürecinde nicel veri analizi* [Quantitative data analysis in the scientific research process with SPSS]. Ankara: Pegem Akademi Publishing.

Connolly, P. (2007). *Quantitative data analysis in education: A critical introduction using SPSS*, London: Routledge.

Çırakoğlu, C. (2009). *İşbirliğine dayalı öğrenme yöntemi ile geleneksel öğretim yaklaşımının ilköğretim 6. sınıf öğrencilerinin geometri dersindeki akademik başarılarına etkisi* [The effects of cooperative learning and traditional learning approaches on 6th grade students' academic achievements in geometry course].(Unpublished Master's Thesis). Gazi University, Ankara.

Effandi, Z. (2003). *The effects of cooperative learning on students in a matriculation mathematics class* (Unpublished Doctoral Dissertation). Universiti Kebangsaan Malaysia, Bangi

Eurydice. (2011). *Avrupa'da matematik eğitimi: Temel zorluklar ve ulusal politikalar* [Mathematics education in Europe: Key challenges and national policies.] Ankara: Education, Audiovisual and Culture Executive Agency.

Gelici, Ö. (2011). *İşbirlikli öğrenme tekniklerinin ilköğretim yedinci sınıf öğrencilerinin matematik dersi cebir öğrenme alanındaki başarı, tutum ve eleştirel düşünme becerilerine etkileri* [The effect of the cooperative learning techniques on the seventh grade students' achievement, attitude and critical thinking skills in mathematics course algebra learning space]. (Unpublished Master's Thesis). Mustafa Kemal University, Hatay.

Gök, T. (2006). *Fizik eğitiminde işbirlikli öğrenme gruplarında problem çözme stratejilerinin öğrenci başarısı, başarı güdüsü ve tutumu üzerindeki etkileri* [The effects of problem-solving strategies on students' achievement, achievement motivation and attitude in the cooperative learning groups in physics teaching]. (Unpublished Doctoral Dissertation). Dokuz Eylül University, İzmir.

Göktaş, E. (2017). *Eğitim politikası bağlamında işbirlikli öğrenme ve geleneksel öğrenme yöntemlerinin başarı ve tutuma etkisinin meta analitik biçimde incelenmesi* [A meta analytic review of the effect of cooperative learning and traditional learning methods on achievement and attitude in connection with educational policy] (Unpublished Doctoral Dissertation). Marmara University, İstanbul.

Hossain, M. A., & Ariffin, M. R. K. (2017). Integration of structured cooperative learning in mathematics classrooms. *International Journal of Psychology and Educational Studies, 5*(1), 23-29.

İflazoglu, A. (1999). *Küme destekli bireyselleştirme tekniğinin temel eğitim beşinci sınıf öğrencilerinin matematik başarısı ve matematiğe ilişkin tutumları üzerindeki etkisi* [The effectiveness of the team-assisted individualization technique on the mathematics achievement and attitudes toward mathematics at the 5th grade elementary education]. (Unpublished Master's Thesis). Çukurova University, Adana.

Johnson, D. W., & Johnson R. T. (1989). *Cooperation and competition: Theory and research.* Interaction Book: Edina, MN.

Johnson, D. W., Johnson, R. T., & Holubec, E. J. (1993). *The new circles of learning: Cooperation in the classroom and school.* InteractionBook: Edina, MN.

Karaca, Ş. (2005). İşbirlikli öğrenme yöntemi ile geleneksel öğretim yaklaşımının lise 1.sınıf öğrencilerinin maddenin sınıflandırılması konusunu anlamalarına ve akademik başarılarına etkileri [The effects of cooperative leatning method on 9th class high school students' academic success and their comprehension of classification of substance] (Unpublished Master's Thesis). Gazi University, Ankara.

Karalı, Y. (2017). *İşbirliğine dayalı öğrenme yönteminin matematik dersinde öğrencilerin akademik başarısına ve tutumuna etkisi* [Impact of cooperative learning method on students` academic achivement and attitude on Mathematics] (Unpublished Doctoral Dissertation). İnönü University, Malatya.

Karasar, N. (2014). *Bilimsel araştırma yöntemi* [Scientific research method]. Ankara: Nobel Akademi Publishing.

Kılıç, H. E., & Şen, A. İ. (2014). UF/EMI eleştirel düşünme eğilimi ölçeğini Türkçeye uyarlama çalışması [Turkish adaptation study of UF/EMI critical thinking disposition instrument]. *Education and Science*, *39*(176), 1-12.

Koç, B. (2015). *İşbirlikli öğrenme yönteminin matematik dersindeki erişiye, kalıcılığa ve sosyal beceriye etkisi* [The effects of cooperative learning on academic achievement, retention and social skills]. (Unpublished Master's Thesis). Adnan Menderes University, Aydın.

Kolawole, E. (2007). Effects of competitive and cooperative learning strategies on academic performance of Nigerian students in mathematics. *Educational Research and Design, 3,* 33-37.

Marshall, C., & Rossman, G. B. (2014). *Designing qualitative research*. New York: Sage.

Mclean, D. L., & Deborah, L. (1992). Cooperative learning: Theory to practice in the young child's classroom. New York: Teachers College Press.

Millis, B. J. (2010). *Why faculty should adopt cooperative learning approaches. cooperative learning*. Virginia: Stylus Publishing, LLC.

MoNE (2020). *TIMSS 2019 Türkiye ön raporu* [TIMSS 2019 Turkey preliminary report].https://odsgm.meb.gov.tr/meb_iys_dosyalar/2020_12/10175514_TIMSS_2019_Turkiye_On_Raporu_.pdf

MoNE (2019). *PISA 2018 Türkiye ön raporu* [PISA 2018 Turkey preliminary report]. https://www.meb.gov.tr/meb_iys_dosyalar/2019_12/03105347_PISA_2018_Turkiye_On_Raporu.pdf.

MoNE (2018). *Matematik dersi öğretim programı* [Mathematics course curriculum]. Ankara: Official Books.

MoNE (2017). *Akademik becerilerin izlenmesi ve değerlendirilmesi 8. sınıflar raporu* [Monitoring and evaluation of academic skills 8th grade report]. https://abide.meb.gov.tr/.

NCTM. (2007). *Second handbook of research on mathematics teaching and learning: a project of the national council of teachers of mathematics.* Reston VA: The Council.

OECD. (2018b). *World class: How to build a 21st-century school system.* Paris: OECD Publishing.

Olson, V. E. (2002). *Gender differences and the effects of cooperative learning in college level mathematics* (Unpublished Doctoral Dissertation). Curtin University of Technology.

Orcan, M. (2013). Erken çocukluk dönemi matematik eğitimi için örnek bir model: Yapı taşları [A sample model for early childhood mathematics education: Building blocks]. *Journal of Research in Education and Training*, *2*(2), 1-13.

Önal, N. (2013). Ortaokul öğrencilerinin matematik tutumlarına yönelik ölçek geliştirme çalışması [A study on the development of a middle school students' attitudes towards mathematics scale]. *Elementary Education Online*, *12*(4), 938-948.

Özerbaş, M. A., & Safi, B. N. (2022). İngiltere, Japonya, Norveç, Finlandiya, Singapur, Rusya ve Türk eğitim sistemlerinin karşılaştırmalı olarak incelenmesi [A comperative analysis of England, Japan, Norway, Singapore, Russia and Turkey education systems]. *MANAS Journal of Social Studies, 11*(1), 63-80.

Panitz, T. (2000). *Using Cooperative learning 100% of the time in mathematics classes establishes a student-centered ınteractive learning environment.* EDRS (ED 448 063, SE 064 364), Opinion Papers.

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.).Thousand Oaks, CA: Sage.

Phillips, S. R. (2010). *Student discussions in cooperative learning groups in a high school mathematics classroom: A descriptive multiple case study*. (Unpublished Doctoral Dissertation). The University of Akron, USA.

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

Slavin, R. E. (1991). Synthesis of research on cooperative learning. *Educational Leadership, 48*(5), 71-82.

Slavin, R. E. (1982). *Cooperative learning: Student teams. What research says to the teacher*. (ERIC Document Reproduction service No. ED 222489),

Susanto, A.S., Bharata, H., & Dahlan, S. (2018). The effect of cooperative learning model think-talk-write (ttw) type on mathematical problem-solving abilities in terms of learning habits. *Al-Jabar: Jurnal Pendidikan Matematika, 9*(1), 33-40.

Torchia, S. P. (2012). Cooperative learning and its effect on fourth-grade mathematics students' achievement, motivation, and self-efficacy", Opinion Paper, ERIC: ED540918.

Tshering, N., & Dorji, T. (2022). Enhancing grade six students' mathematics achievement through the use of cooperative learning strategy: An action research. *Asian Journal of Education and Social*

Studies, 31(1): 31-39.

Ural, A. (2007). *İşbirlikli öğrenmenin matematikteki akademik başarıya, kalıcılığa, matematik özyeterlilik algısına ve matematiğe karşı tutuma etkisi* [The effect of cooperative learning on mathematics academic achievement, retention, mathematics self-efficacy and attitudes toward mathematics]. (Unpublished Doctoral Dissertation). Gazi University, Ankara.

Ünlü, M. (2008). İşbirlikli öğrenme yönteminin 8. sınıf öğrencilerinin matematik dersi permütasyon ve olasılık konusunda akademik başarı ve kalıcılık düzeylerine etkisi [The effect of cooperative learning method on the academic success and recall levels of 8th grade students in permutation and probability subject] (Unpublished Master's Thesis). Gazi University, Ankara.

Whicker, K. M. (1999). Cooperative learning in high school advanced mathematics courses. (Unpublished Doctoral Dissertation). The University of Memphis.

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

Yenilmez, K., & Duman, A. (2008). İlköğretimde matematik başarısını etkileyen faktörlere ilişkin öğrenci görüşleri [Students' opinions about the factors which affect the mathematics success in elementary education]. *Eskişehir Osmangazi University Sosyal Bilimler Dergisi,* 19, 251-268.

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