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THE EFFECT OF JIGSAW II TECHNIQUE ON MATHEMATIC ATTITUDES AND CONSTRUCTIVE LEARNING

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Abstract

The aim of this research was to examine the effects of mathematics activities prepared by using Jigsaw II technique on fourth grade students. A mixed design was used, consisting of a combination of pre-test post-test without control group a Quasi-experimental design and qualitative data. The research's study group consisted of 21 fourth-grade students. The researchers created math activities for the Jigsaw II technique which were used throughout the process. The "Mathematics Attitude Scale" and "Constructivist Learning Environment Scale" were used as pre-test and post-test data collection. In addition, at the end of the application, students' opinions on the application were recorded. The Wilcoxon Signed Ranks Test was used in the analysis of the data, and content analysis was used to analyze the student views on the application, as well as direct quotations from the students' statements. The analysis concluded that there was a significant difference between the pre-test and post-test average scores of the research group's mathematics attitude and constructivist learning environment situations of the in favor of the post-test. At the end of the process, most of the students expressed positive opinions about these activities. This technique is recommended to use more frequently in classrooms because it improves students' attitudes towards mathematics lesson and constructivist learning.

Keywords: Jigsaw II technique, mathematics, mathematics attitude, constructivist learning environment.

INTRODUCTION

Math lesson are monotonous, repetitive, and pointless due to concerns such as the fact that the topics are quite abstract in mathematics teaching, the lectures are only focused on the topic and the lessons are teacher-oriented which prevents the students from participating actively in the lesson (Akar, 2006). Studies show that, a new approach to mathematics tea can increase student success while decreasing students' negative attitudes toward mathematics (Umay, 1996). This new learning approach is a constructivist approach. It is an epistemological approach based on the understanding that an individual develops their own knowledge through active interaction with their environment. According to Piaget, the founder of Constructivism, which is used to build a structure by putting the pieces together, learners are not empty plates but create their own learning. He explains how an individual acquires knowledge as a result of active interaction with their environment via two sequential processes called accommodation and assimilation. As a result, the individual recognizes the new situation he is in and tries to recognize and make sense of it using his current knowledge and

experience. After this recognition process, they absorb the new situation, and the individual thus establishes their knowledge about the new situation (Baki, 2014; 2018; Van de Walle, 2012). In addition, constructivist approach allows the learner to structure, construct, interpret and improve the information. The constructivist approach recognizes that the learners allow them to think, understand, take responsibility for self-learning and learn basic knowledge and skills in order to control their behaviour (Von Glasersfeld, 1999; Miller, 2002; Bal & Doğanay, 2009). Mathematics educators favor the constructivist approach since mathematic is one of the areas where constructivist-learning environments can be optimized (Baki, 2014; 2018; Tezer & Cumhur, 2016). In Turkey, it occupies a particularly important place in mathematics education, thanks to the updating of the educational curriculum in 2006 and the constructivist approach. This approach has a significant impact on the development of student-centered learning and teaching approaches (Özkal, Tekkaya, Cakiroglu, & Sungur, 2009). As it has been demonstrated that traditional teacher-centered education cannot solve the problems (Keskin & Yıldırım, 2008; Yılmaz, 2004), constructivist learning defends student-centred learning and provides an effective learning environment by contributing to high level student motivation and thinking skills (Atasoy & Akdeniz, 2006). Cooperative learning in the best way to create such a learning environment (Atasoy, Genç, Kadayıfçı, & Akkus, 2007). In constructivist learning, it is possible to state that not only one student but also all members of the group are active in the cooperative learning process (Bosfield, 2004; Panitz, 1999), and that the knowledge is permanent and the learning is successful because of teamwork. Cooperative learning is a method in which students take an active role in the learning process by working together to be successful and the teacher serving as a guide at this stage (Demirel, 2011). Cooperative learning, like other methods, has positive effects on students' cognitive and affective learning. It not only improves the academic success of the student, especially in difficult subjects, but also improves the student's attitude toward the lesson, motivation and self-confidence (Genç & Şahin, 2012). Cooperative learning is a student-centered learning approach in which students work in small groups to increase the learning levels of both themselves and their group mates (Çalık, 2017).

Student Teams and Success Departments, Team-Game-Tournament, Collaborative Combined Reading and Composition Team Supported Individualization, Let's Ask Together, Learn Together, Mutual Inquiry, Jigsaw and Jigsaw II are all cooperative learning techniques (Sönmez, 2005). The Jigsaw technique, as seen, one of the cooperative learning techniques in which students are active. Eliot Aranson pioneered this technique, which includes two different applications for increasing student's collaboration in 1978 (Hedeen, 2003). This technique, also known as Jigsaw I, is similar to other cooperative learning techniques. Jigsaw II (Slavin, 1986), Jigsaw III (Stahl, 1994), Jigsaw IV (Holliday, 2002), Reverse Jigsaw (Hedeen, 2003) and subject Jigsaw (Doymuş, 2007) were developed and implemented from the original jigsaw technique. Although the basis of all Jigsaw techniques are the same, there are some differences in applications (Avcı & Fer, 2004). The groups consist of 2 to 6 people. In the Jigsaw II technique, which is one of these techniques and also used in this research. The members of the group work together and must trust each other (Aykaç, 2005; Sharan, 1999). The number of students in each group divides the subject to be covered. Each group is given the same topic, and students are asked to choose one of the divided topics, and students from different groups who choose the same topic come together in "expert groups" to work, discuss and learn about these common topics. Students who return to their original groups after learning the subject discussed in the expert group is responsible for teaching the subject, they are working on to one another within time frame specified. In this technique, all students are both learners and teachers at the same time. As a result, it is a technique that allows all students to be active in the learning process, rather than just one student in the group (Sönmez, 2005).

Looking at previous studies that used Jigsaw technique, it was discovered that mathematics achievement of secondary school students (Adams, 2013; Cumhur, 2017; Çalık, 2018; Dellalbaşı & Soylu, 2012), geometry attitude and self-efficacy of secondary school students (Kaba, Özdişçi, & Soylu, 2017), success and problem solving skills of secondary school students (Sevim, 2015; Gelici & Bilgir, 2012) and self-efficacy and anxiety (Yıldırım-Doğru, 2012) of secondary school students were

examined. There are also research in the literature that examine at primary school students' mathematical problem solving skills (Carlan, Rubin, & Morgan, 2004) and mathematics achievement (Moskowitz, et. al., 2004; Slavin & Karweit, 1979; Varank & Kuzucuoğlu, 2007) are examined. Unamba and Ugochkwu (2015) stated that cooperative methods can be used in mathematics learning for all age groups, but as can be seen, the scarcity of primary school research is notable. According to this viewpoint, the findings of this study will contribute to the literature. In the light of all this, the purpose of the study is to investigate the impact of Jigsaw II technique on elementary school students' attitude towards mathematics and constructivist learning situations in the mathematics class. Answers to the following questions were pursued for this reason:

(1) What are the students' math attitude and constructivist learning environment pretest and posttest scores?

(2) Is there any difference between students' mathematics attitude and constructivist learning environment pre-test and post-test scores?

(3) What do the students think about Jigsaw II activities?

METHOD

A mixed design was used in the study, which included a pre-test post-test without control group, a quasi-experimental design, and qualitative. When the controls as required by the True Experimental Design are not reached or are insufficient, the Quasi-Experimental Design is preferred (Karasar, 2005). It is a design that examines the effect of the experimental process by administering pre-test and post-tests applied to the same groups before and after the experiment. (Büyüköztürk, 2007). The limitation of this study is that the experimental design was carried out with a single group. The "Hawthorne Effect", which is defined as one of the factors affecting external validity in experimental studies, occurs when participants exhibit reactions that they would not exhibit under normal conditions as a result of the physical and psychological effects created by the experimental environment. In this case, it is assumed that the participants are aware that an experiment has been carried out on them, which has led to the development of a group action style. As they are chosen for the experimental group, participants may exhibit these behaviours (Eren, 2004). There is no control group in this study. Despite the fact that here was no sample for the study, it was ensured that the researchers spent time with other students at the same school. As a result, it was attempted to prevent the students in the application group from developing the misconception that only changes related to them were made within the scope of the research. In addition, the students' perspectives on Jigsaw II activities were also included in the qualitative dimension of the study.

Study Group

All educational levels were updated on April 11, 2012, when the education law became effective after being published in the official newspaper in Turkey. With the new Primary, secondary and high school trainings were rearranged as a result of the new education periods, which were expressed as 4 + 4 + 4 (Kol, 2019). The primary school start age is 6 years and the education period is 4 years, according to a legal agreement reached in 2012. Primary school is in the scope of compulsory education (MEB, 2019). Students attend elementary school for the first 4 years (1, 2, 3, 4th grades), secondary school for the next four years (5^{th}, 6^{th}, 7^{th}, and 8^{th} grades), and high school for the final four years (9^{th}, 10^{th}, 11^{th}, and 12^{th} grades) (Kol, 2019). In Turkey, primary school students are aged 6 to 9, secondary school students are aged 10 to 13 and high school students are aged 14 to 17 years old. Twenty-one fourth-grade students from Istanbul, Turkey, participated in the study. The acquisitions of 'Division by Natural Numbers', a sub-learning field of the "Numbers and Operations" learning area, begins in the second grade and lasts until the fourth grade (MEB, 2018). As a result, for the purpose of the study, the sample was drawn from among the fourth-grade students, the highest grade of primary school, after all division gains had been completed. Given the students' educational levels and the teaching methods employed, it was determined that a sample of fourth grade students, the final grade of

primary school, would be appropriate for the research. The principal and classroom teacher of the school where the application will be carried out were given information about the study's content. The research was also shared with the students' parents by the classroom teacher. With their approval, the research has begun. Students were invited to participate in the research on the basis of their willingness to volunteer. In the photographs used in the research, it was important to conceal the identities of students. Table 1 shows the gender distribution of the sample.

Table 1. Students' gender

Gender	*n*	%
Girl	8	38.1
Boy	13	61.9
Total	21	100.0

The sample consists of a total of 21 primary school fourth grade students, 8 (38.1%) girls and 13 (61.9%) boys.

Research Process and Materials

The study is divided into three stages. In the first stage, students were given the "Mathematics Attitude Scale" and "Constructivist Learning Environment Scale" as pre-test. The scales were used to try to specify students' attitudes towards mathematics and their thoughts on constructivist learning. The implementation of the activities was the next stage of the research.

Process

Jigsaw II was used in this study. Jigsaw II is a variation on basic structure of Jigsaw. It was created in 1986 by Robert Slavin and adds one powerful enhancement to the basic one. The distinction is in how the assessment is handled. In the original Jigsaw (Jigsaw 1), students are assessed individually and receive one score. In Jigsaw 2, quiz scores are assigned to individual students once, and then the scores of each group are averaged to produce a group score. This technique, encourages students to work harder to assist one another in learning the material (Mattingly & VanScikle, 1991). The researchers created appropriate activities that involve the outcomes in the 4th grade mathematics curriculum for the study's purpose.

The following are the outcomes of "the division of natural numbers" according to the curriculum used in Turkey (MEB, 2018, p. 46):

- Elements of the division
- This function divides the three-digit natural numbers by two-digit natural numbers.
- Convert a number with up to four digits to a one digit number.
- Divides natural numbers with up to five digits, the last three of which are zero into 10, 100, and 1000.
- Estimates the result of a division problem and compares it to the actual result of the operation.
- Realizes the relationship between multiplication and division.
- Estimates the number of digits in the quotient.
- In the division process, the remainder is always less than the divisor.
- Addresses problems that necessitate at least one division operation with natural numbers

The following activities have been planned based on the outcomes. 10 lessons were taught over the course of two weeks, with 5 + 5 period activities. Students are told during the first week of practice that they will learn to divide today in a very different way. The 21-student class was divided into seven groups of three students each. When forming groups, researchers are encouraged to be heterogeneous within the group while remaining homogeneous between the groups. The application courses' main topics are organized into seven subtitles. Children are divided into groups and given one minute to come up with a name for their group. Then, they are instructed to write and decorate the group names on A5 paper as they see fit. Sortation is used to assign subjects to students. (It is determined by selecting the topic number between 1 and 7.) After that, they divide the experts into groups based on

the numbers they have. The teacher informs the students of the time they will be able to work in the expert group. As a result, they make group plans around this time. Each student is given a set of objects based on their subject. These groups attempt to clarify the issue, and before returning to their previous groups, they must plan how to inform and educate their friends. Students from different groups who are studying the same subject are brought together and discussed.

In the process, the teacher participates by guiding and asking questions in order to accompany the students into the subject. After finishing their work in the expert group, students are given a few materials for their main group. In the expert group, they are given 10 minutes to paint and decorate these materials as they see fit. After that, students are asked to rejoin their original group. After all students have explained their topics to each other one another in the main groups, they are asked to write questions, one for each outcome. They are instructed to check and answer their questions. The teacher circulates among the groups, checking the questions. The groups write their names on the paper along with the questions. Students are expected to answer these questions by switching groups. After the students have completed their work, they are distributed to the groups that are preparing the questions for testing. . When students finish answering the questions, they send them back to the groups that prepare them for checking. The course is summarized by the researcher. In addition, students will be informed about the topic for the following week.

It is divided into 5 groups of 4 students during the second week of the process. Because the class size is 21 students, there will be six people in each group. Consideration is given to ensuring that students work in a variety of groups, as opposed to last week. The main subject of the application course is divided into five subtitles. As in the first week, students are given time to divide into groups and familiarize themselves with the materials.

Activity 1 - Elements of the Division

The student group is given a template with numbers and division for the division numbers. They are instructed to arrange these numbers in the form of a division operation. They are instructed to write down which element of the division operation these numbers they placed.

Activity 2 - The Relationship between Multiplication and Division

A card is given to each student to explain the relationship between multiplication and division. They are instructed to carefully read the problems on the card. Problems that can be solved using the multiplication process are said to be marked with the multiplication peg, and problems that can be solved using the division process are said to be marked with the division peg. They are instructed not to use both processes to mark problems. After their operations, they are instructed to write the number of pegs and to take the envelope that containing the result they discovered.

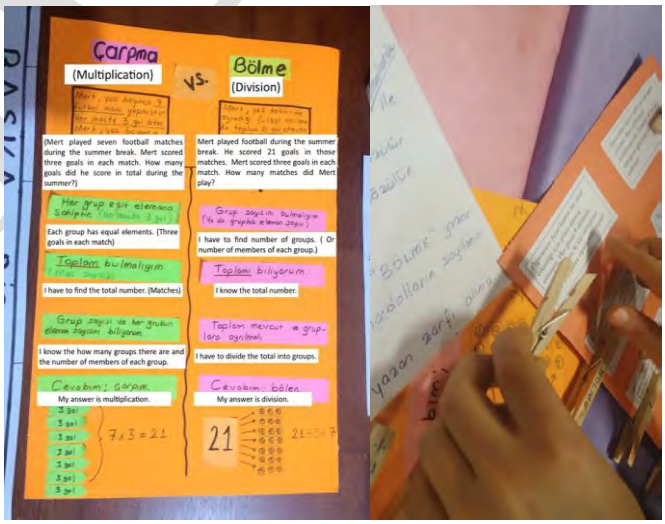

Figure 1. The relationship between multiplication and division

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Activity 3 - Estimating how many digits in quotient is

A poster is distributed to the student group to serve as a guide. They are expected to comprehend the outcome via this poster before the activities begin.

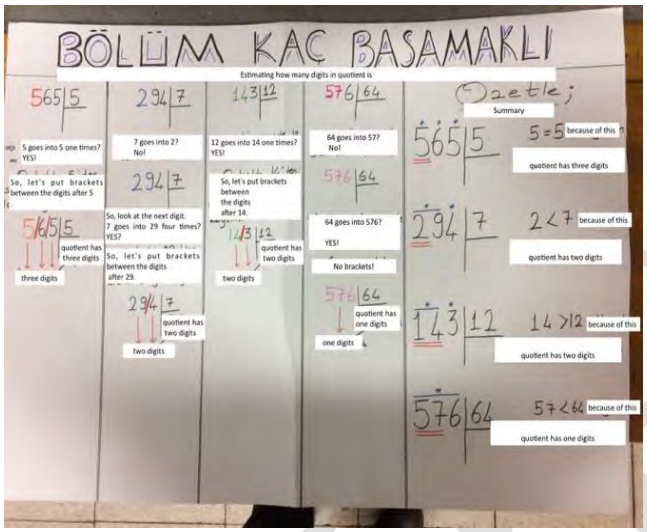

Figure 2. Estimating how many digits in quotient is

Activity 4 - An alternative division

This activity demonstrated that the student group can be divided in a variety of ways. A poster is provided to guide the student group. Then, in the activities provided, they are asked to solve the problems using this method.

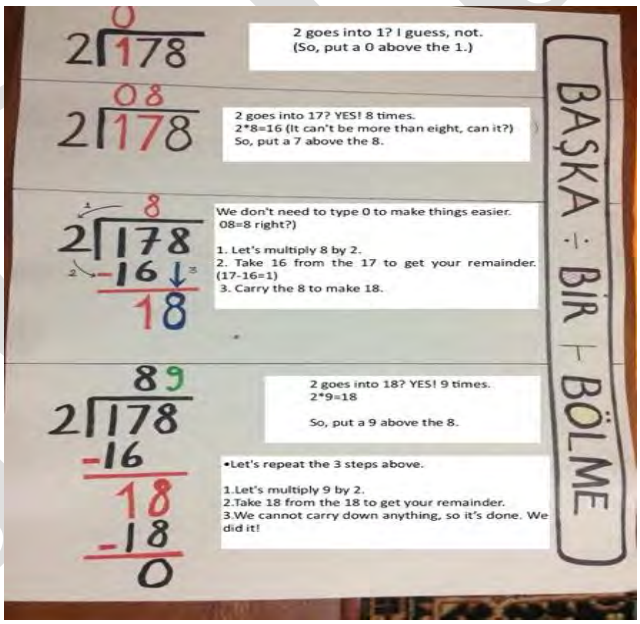

Figure 3. An alternative division

Activity 5 - Remainder is always smaller than divisor

In this activity, students are given an activity sheet, on which they will place division and chickpeas elements. For each operation, they are instructed to circle the divider and the remainder. While working on the activity sheet, the elements of the division place the chickpeas on the paper and solve the process. They are then asked to explain the relationship between divider and remainder after all transactions have been completed.

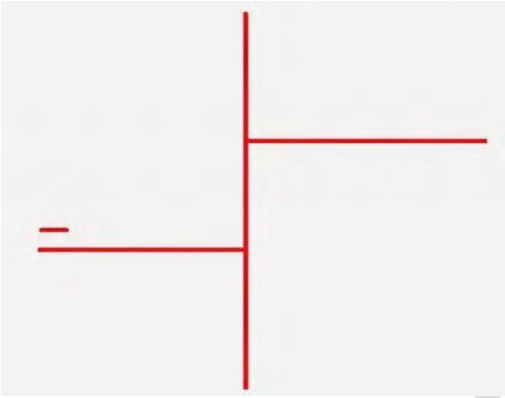

Figure 4: Remainder is always smaller than divisor

Activity 6 - Divides the one-digit natural numbers by one-digit natural numbers
In this activity, students are given a template of sheet, beans, and activities paper. The beans were placed in the center of the template papers by the students. They put the beans in the circle one by one until they divide. Every circle must have an equal number of beans. After placing 9 beans in the pentagon, one bean in each of the circles numbered 1-4, and another one in each of the circles, there is one bean in the pentagon and two beans in the circles. In the circle, the quotient is the number of beans. The remainder in the pentagon is the number of beans. After writing the results on the activity sheets, they can move on to the next exercise.

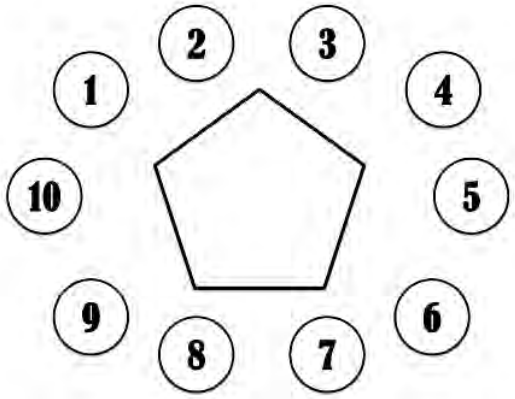

Figure 5. Template paper 1 and activity process

Activity 7 - Divides the two-digit natural numbers by one-digit natural numbers
In this activity, students are given beans, template paper, and activities. The same is true for Activity 6.

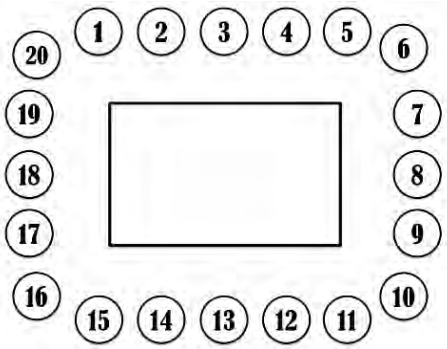

Figure 6. Template paper 2 and activity process

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Activity 8-10

These three activities were developed in response to the results of dividing the three-digit natural numbers into two-digit natural numbers. Students were given posters labeled "Dividing the two-digit number into a two-digit number, dividing the three-digit number into one-digit number, dividing the three-digit number into a two-digit number".

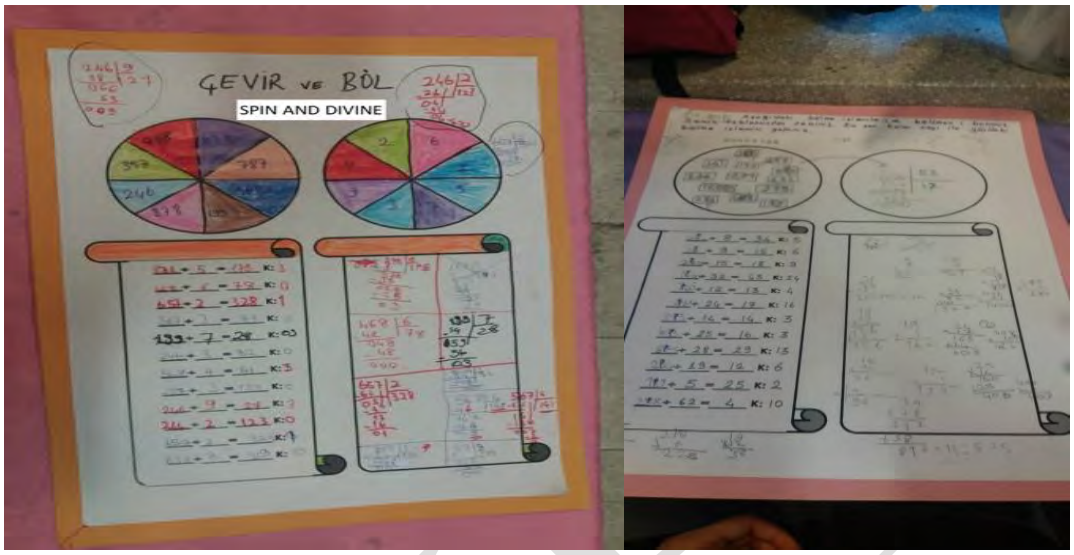

Figure 7. Spin and divide

Activity 11 - Divide in mind

There are activities in which the last three digits are zero and can divide the natural numbers up to five digits into 10, 100 and 1000. The students are asked to discuss the issue using the examples provided to the group and identify relationship. When they have grasped the subject, they are asked to perform the activities quickly without any operation.

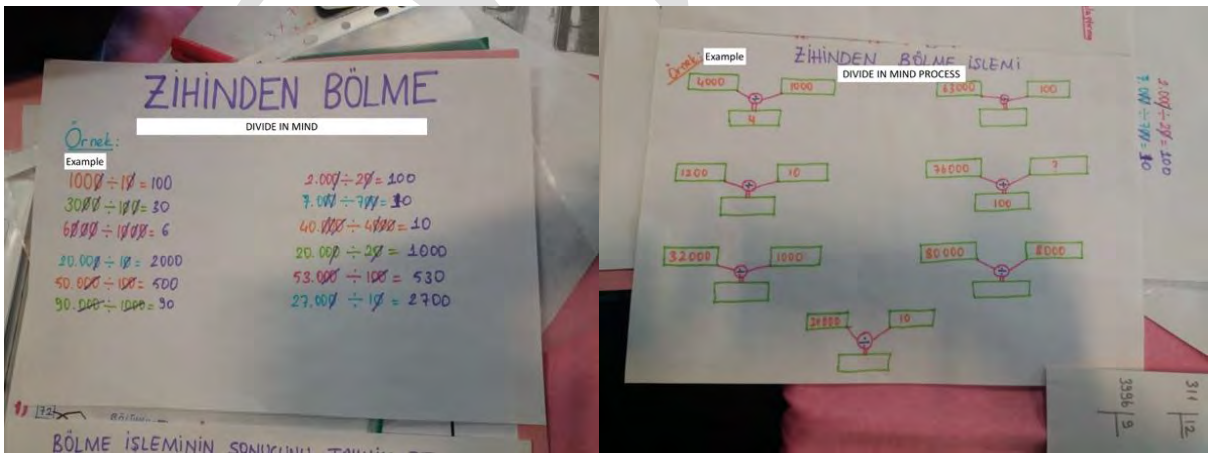

Figure 8. Divide in mind

Activity 12 - Estimating the result of dividing

In order for the students to estimate the result of the division, an explanatory paper was distributed, followed by worksheets.

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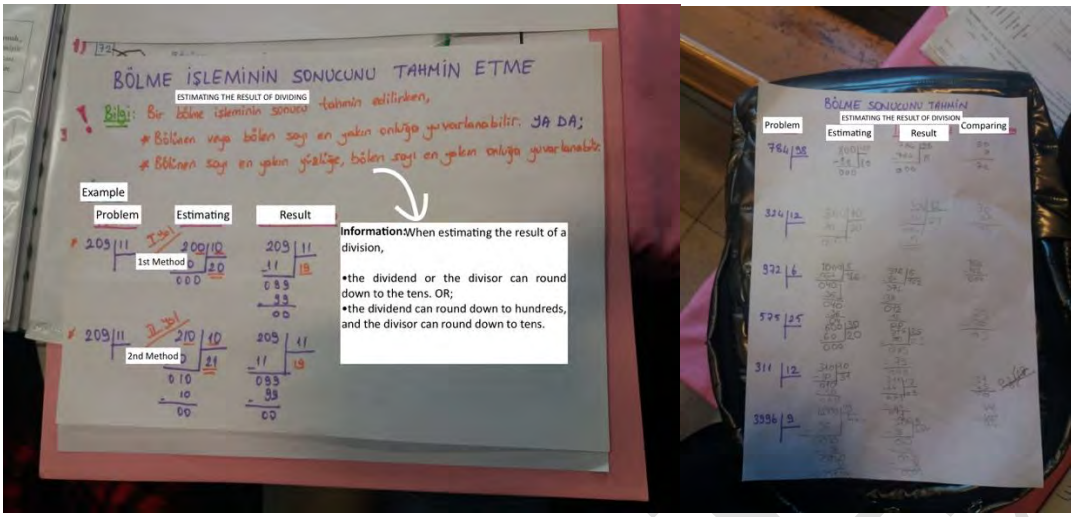

Figure 9. Estimating the result of dividing

Activity 13-Problem

To relate the subject to real life, an example of a real-life problem is shown. Then they are given another activity sheet and asked to solve these problems and write down where they can apply this problem in real life. Finally, each student in the group is asked to write a real-life problem and solve with their groupmates. The teacher guides by checking the written questions ensure that the process is progressing correctly.

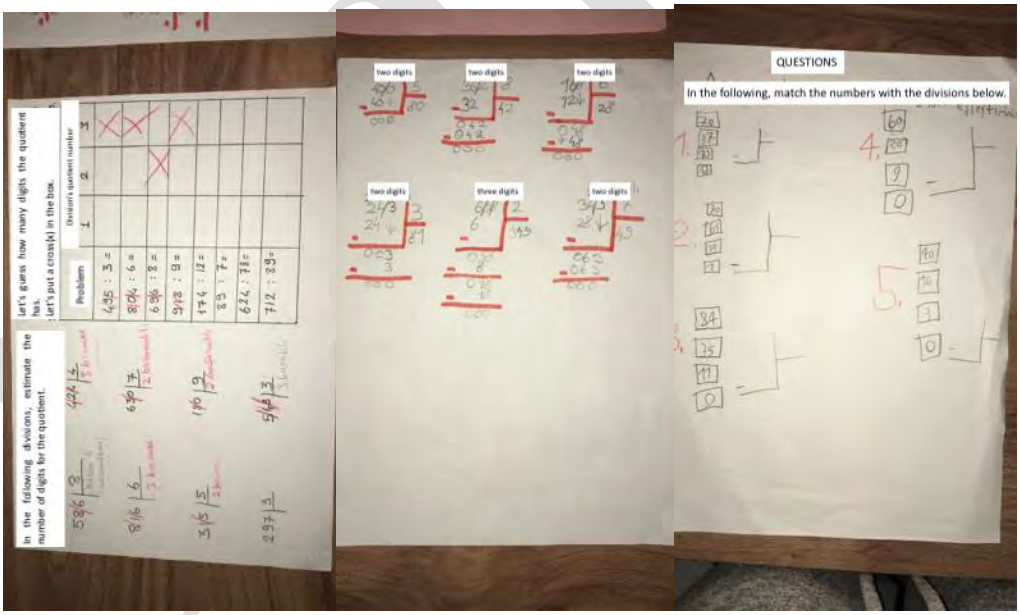

Figure 10. Problem

As the final stage of the research, the same data collection tools were used on the students as post-tests a week after the process was completed. In addition, at the end of the process, students were asked to write down their thoughts on the application.

Data Collection Tool

The "Mathematics Attitude Scale" and "Constructivist Learning Environment Scale" were used as data collection tools in the study. In addition, at the end of the application, the students were asked what they thought of the application and were asked to express their thoughts in sentences.

Mathematics Attitude Scale: The "Mathematics Attitude Scale" developed by Baykul (1990) and adapted to the fourth grade of primary school by Karalı (2017) was used as a data collection tool in research to determine students' attitudes toward mathematics lessons. Karalı (2017) performed an explanatory factor analysis on the 30-item attitude scale and the scale was reduced to 23 items. "Mathematics Attitude Scale", 14 positive question items rated as 'I Disagree Strongly (1)', 'I Disagree (2)', 'I Am Undecided (3)', 'I Agree (4)', 'Strongly Agree (5)'. Respectively the items were scored as 1, 2, 3, 4, 5, and 9 negative question items were scored as 5, 4, 3, 2, and 1. The validity and reliability studies of the scale developed by Baykul (1990) were calculated as Cronbach's Alpha coefficient .96, the adapted scale .93, and the reliability coefficient in this study .92.

Constructivist Learning Environment Scale: The Constructivist Learning Environment Scale, developed by Özkal, Tekkaya, Cakiroglu, and Sungur (2009), and 20 positive items. The scale was graded as 'Never (1)', 'Rarely (2)', 'Sometimes (3)', 'Often (4)', 'Always (5)'. The scale can thus be used to obtain the lowest 20 and the highest 100 points. The scales's validity and reliability were assessed in this study and the Cronbach's Alpha coefficient was found to be .81.

Activity Evaluation Form: The form was created by researchers. This form is a form in which students in the experimental group are asked to express their thoughts after the application in a single sentence. Quotations were derived directly from the students' thoughts.

The Validity and Reliability of the Research

The study's data collection tools' reliability is calculated and reported. The activities developed were finalized with the input of mathematics educators, especially classroom teachers. For the qualitative data analysis, the researchers conducted separate evaluations and shared their findings.

Analysis of Data

SPSS 16.0 was used to generate statistical solutions for quantitative data collected in the study. Before beginning the analysis, the Kolmogorov-Smirnov test was used to check the normality of the data distribution, as well as the Skewness - Kurtosis values of the scores. According to George and Mallery (2010), the results of the Kolmogorov-Smirnov test, it revealed that the data did not have a normal distribution because the significance value was greater than .05 and the skewness flatness coefficient was not between +2.0 and -2.0. Nonparametric tests were used in this context. Simultaneously, because the number of data points is less than 30, nonparametric techniques are thought to be appropriate (Pallant, 2005). The Wilcoxon Marked Ranks Test was used to analyze the data. Written activity evaluation forms were used to solicit student's feedback on the application. Students were asked to evaluate how they found the application in one sentence. To analyze student perspectives on the application, content analysis was used and the expressions of the students were provided in the form of direct quotations.

RESULTS

The findings were analyzed using three questions that arose as a result of the research problem. Table 2, and Table 3 show the results of the first subproblem.

Table 2. Mathematics attitude scale scores

Mathematics Attitude	N	Mean	Std.Dev.
Pre-test	21	84.06	15.75
Post-test	21	91.40	17.10

The students in the study had pre-test point average of 84.06 and a post-test point average of 91.40 on the Mathematics Attitude Scale. As can be seen, the average of mathematics attitude points increased after the application (Table 2).

Table 3. Constructivist learning environment scale scores

Constructivist Learning	N	Mean	Std.Dev.
Pre-test	21	67.94	10.01
Post-test	21	75.62	11.20

The sample's Constructivist Learning Environment Scale pre-test point average of the sample was 67.94, and the post-test point average was 75.62. As can be seen, the mean of constructivist learning environment has increased as a result of the application (Table 3).
Table 4, and Table 5 show the results of the second sub-problem.

Table 4. Wilcoxon Test Results According to Mathematics Attitude Scale Pre-test and Post-test Scores

	Ranks	N	Mean Rank	Sum of Ranks	z	p
Pre-test - Post-test (Mathematics Attitude)	Negative Ranks	5	9.00	45.00	-2.452	.014*
	Positive Ranks	16	11.63	186.00		
	Ties	0				
	Total	21				

*p<.05

The difference in mean Math Attitude Scale scores between pre-test/post-test was statistically significant (z=-2.452; *p<.05*) (Table 4). When the mean rank and total of the difference scores are considered, it is clear that the observed difference favors the positive ranks and posttest score. As a result, it can be stated that teaching mathematics with Jigsaw II activities improved their math attitude in favor of post-test.

Table 5. Wilcoxon test results according to the constructivist learning environment scale pre-test and post-test scores

	Ranks	N	Mean Rank	Sum of Ranks	Z	p
Pre-test - Post-test (Constructivist Learning Environment)	Negative Ranks	6	7.58	54.50	-2.433	.015*
	Positive Ranks	15	12.37	185.50		
	Ties	0				
	Total	21				

*p<.05

The difference in mean Constructivist Learning Environment Scale scores between pre-test and post-test was statistically significant (z=-2.433; *p<.05)* (Table 5). When the mean rank and total of the difference scores, it is clear that the observed difference favors the positive ranks and posttest score. It can be stated that teaching mathematics with Jigsaw II activities promotes constructivist learning over post-test learning.

The last sub-problem of the research was the students' ability to express their thoughts about the application in one sentence. As a result of Jigsaw II Technique, students' opinions were solicited, and based on what they wrote, they were divided into two groups; those who expressed "positive" and "negative" opinions about the technique. 17 (80.96%) of 21 students in the study thought the implementation was positive, while 4 (19.04%) thought it was negative. According to result, the number of people who like the application outnumber who dislike it. The following are direct quotations from the statements of students who expressed positive opinions:

S1: "I always want it to be like this. I liked all the topics very much. Thank you. It was very nice. All the time, come to our class."
S2: "I wish, we learn all the time like that, I was never bored."
S4: "I like these lessons very much. They were beautiful."

S5: "When you first arrived, I did not like mathematics at all. I mean, I loved it a little bit. Then you brought some activities, which made me very happy and satisfied."
S6: "This practice was legendary. Thank you so much for teaching us things that we didn't know."
S7: "I had a lot of fun in this lesson. We are grateful to our teachers. We loved you."
S8: "I thought the event was very nice and it worked very well. I liked it very much."
S9: "The topics of this lesson were more beautiful than the other lessons. I had a lot of fun and learned the subjects as usual. "
S10: "I thought this application was very good. We had fun and learned from this application. I want to do this practice again."
S11: "It was excellent, and I am very sorry. I am sorry, because we will not do activities and problems like that. It was beautiful."
S12: "You did your best to teach us math. Thanks a lot for that. And I liked this application very, very much."
S13: "I wish mathematics was always this enjoyable."
S14: "It was fantastic, I loved it, and it was a good thing. I am satisfied."
S15: "I liked the application very much. Estimating division activities were my favorites. I like this topic very much. It was a useful mathematics exercise for me."
S17: "It was very funny. I have learned. You are the best."
S18: "It was very nice. So, we comprehended mathematics very well. We will miss you terribly."
S19: "I think it was all a lot of fun. I'd like for them to happen again. This is how I better understood the division better."

As can be seen, the sentences written by the students who agreed with this technique are displayed above. The following are the statements of the students who have a negative view of this practice, albeit in one aspect:

S3: "It wasn't bad, it wasn't good either. In the middle."
S16: "I like this application very much. I like it very much whether or not I can solve problems."
S20: "The event was very nice, I was glad. But I was not satisfied with my groupmates."
S21: "It wasn't too bad."

DISCUSSION and CONCLUSION

That effective learning can be achieved by implementing educational programs designed in accordance with the constructivist approach rules (Keskin & Yıldırım, 2008). The first finding of this study, which looked at the effect of a mathematics lesson in which Jigsaw II was used as a cooperative learning technique -one of the learning methods of this constructivist approach- on the mathematics attitudes and constructivist learning situations of elementary school fourth grade students, is that students' math attitudes and constructivist learning environment improved. According to previous research on constructivist learning environments (Akay, 2005; Ayaz & Şekerci, 2016; Decorte, 2004; Özgen & Alkan, 2014), activities appropriate for constructivist learning environments had a positive effects on students' success, attitude and motivation.

According to the second finding of the study, Jigsaw II mathematics activities improved students' math attitudes in favor of the posttest. It is expected that their attitudes toward the lesson will improve as a result of these practices, because the students may have accessed, structured and understood the information by themselves. This may have influenced their attitudes toward the mathematics lesson. Turgut (2018) conducted a meta-analysis study on the effect of cooperative learning on mathematics attitude, 23 effect size values of 16 studies were calculated. Three of these values are negative, while the other twenty are positive. As a result, the cooperative learning technique used favored the experimental group with 20 effect sizes. Akbuğa (2009) conducted a study with fourth grade primary school students on the subject of 'group fractions', and significant differences in their attitude toward mathematics were discovered in favor of the experimental group. Andersen (2009) attempted to determine her sixth-grade students' responsibilities, participation and attitudes toward cooperative learning mathematics. During this process, she also attempted to evaluate her own teaching strategies. As she continued to practice, she observed that whether the students were attempting to learn only in

their groups or not, and their studies were not limited to the group, and that their level of participation and attitudes changed. As a result of the study, the students stated that they learned better with this method, and the teacher herself changed her teaching style, enjoyed using this technique while teaching, and began to use it more frequently. In her study, Glassman (1988) looked at the effects of collaborative learning on academic achievement, lesson attitude and personal respect. The study included 24 classes of third, fourth, and fifth grade students. At the conclusion of the study, no significant difference was discovered. In a 50-day experimental study, Johnson et al. (1978) investigated the effects of cooperative learning on the academic achievements and attitudes of 30 fifth and sixth grade students. According to the findings of the study, cooperative learning is more effective in increasing academic achievement and developing positive attitude in mathematics lessons. In many experimental studies involving cooperative learning methods, students' post-experimental mathematics attitude scores favored the experimental group's post-test (Akbuğ, 2009; Barbato, 2000; Efe, 2011; Ifamuyiwa & Akinsola, 2008; Koç, 2015; Pınar, 2007; Özdoğan, 2008).

Taking into account the studies in which the Jigsaw technique was used, Kaba, Özdişçi, & Soylu (2017) concluded that this technique did not result in a difference in the attitude towards geometry in their research, which examined the effect of Jigsaw-I on the 7th grade students' attitude towards geometry and self-efficacy, one of the cooperative learning methods. In their study at the fifth-grade level, Moskowitz et al. (2004) investigated the effectiveness of the Jigsaw method in terms of students' self-attitude, dual attitude toward their friends and attitudes toward school, course success and participation variables. The method was taught to 11 classroom teachers, and the lessons were taught using this method for one semester. Pre-test and post-test applications, on the other hand, have been chosen as a control group by 13 classes. They divided the evaluation into two parts: process and result, and came to the conclusion that Jigsaw applications performed exceptionally well in process evaluation. However, in terms of outcome evaluation, they did not achieve any positive effects, even in classes where the method was intensively used. In their experimental study, Slavin and Karweit (1979) investigated co-learning techniques with 388 fourth and fifth grade students from five schools, two of which were experimental and three of which were control groups. They created language, art, mathematics, and social lessons for 6-12 weeks using the technique of Team-Game-Tournament (mathematics), Student Teams-Success Departments (language and art lessons) and Jigsaw 2 (all social lessons). They achieved significant success in their success test (CTBS-Comprehensive Test of Basic Skill) in favor of the experimental group. Other variables (academic self-efficacy, self-esteem and anxiety) concluded that social convergence increased significantly in the experimental groups, though there was a little difference between the experimental and control groups. Many studies (Adams, 2013; Dyson, 2002; Zakaria, Solfitri, Yusoff, & Abidin, 2013) show that this technique has a positive effect on students' learning.

One of the second findings of the study was that structured learning environment scores of elementary school fourth grade students who used Jigsaw II Technique were significantly higher in favor of the post-test. One of the structured learning approach's learning techniques, the Jigsaw II technique may have assisted students learn as a group by making them feel comfortable in their mathematics lessons. There are many studies that support this research finding (Akay, 2005; Liang, 1997; Moore, 2005; Mulryan, 1994; Yılmaz, 2006).

Finally, at the end of the application, students were asked to express their thoughts on how the mathematics lesson was taught. According to this, students overwhelmingly favored the application. At the end of the application, the students said that they liked this practice very much because they were not bored, they had fun while learning, they liked mathematics more, and they wished their math lessons were like this. They said that this practice was not bad, that it did not satisfy with their group friends, and it was not too bad, in a way, even though it was at a very low rate. In many studies, including this one, students preferred the applications with activities designed in accordance with the constructivist-learning environment (Altun & Büyükduman, 2007; Bal & Doğanay, 2009; Baş, 2012;

Bayrak & Hacıömeroğlu, 2018; McManus & Gettinger, 1996; Tsai, 2000; Özgen & Alkan, 2012; Özkal, et.al. 2009).

Consequently, educating children who are exposed to mathematics education at an early age is crucial, as it should have positive impact on the students' attitude toward mathematics in the future. As a result, rather than providing students with information, it would be more appropriate to use active methods and techniques for effective teaching, such as various cooperative learning techniques (Şengül & Ekinözü, 2004). The biggest limitation of this study is that it is based on a single group experimental design. Unfortunately, this limitation may have resulted in a negative situation when it came to revealing the finding of the study.

The following recommendations are made based on the conclusion that the Jigsaw II technique is effective in increasing students' attitudes toward mathematics:

- Its biggest limitation is that it can only conduct research with a single group. As a result, a study with a control group is feasible.
- It is recommended that teachers use this technique in their classrooms on a regular basis.
- Using Jigsaw technique at other lesson and classroom levels, the effect on various variables can be investigated.
- This technique's effects on other cognitive and affective characteristics can be studied.

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