



# THE EFFECTS OF REALISTIC MATHEMATICS EDUCATION ON STUDENTS' ACHIEVEMENT AND ATTITUDES TOWARDS MATHEMATICS ON INTEGER OPERATIONS

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**Abstract.** The aim of this study is to examine the effects of Realistic Mathematics Education (RME) on 7<sup>th</sup> grade students' achievement on integer operations and their attitudes towards mathematics and to determine students' views about the RME approach. The research was carried out with the participation of 11 students. Exploratory sequential mixed design was used. In the quantitative part of the research, one group pre-test-post-test design as one of the weak experimental designs was used. On the other hand, case study was used in the qualitative part. In the research, the achievement test consisting of 10 open-ended questions prepared by the researcher and the mathematics attitude scale developed by the Department of Education Research and Development (EARGED) were used as quantitative data sources. On the other hand, semi-structured interview form developed by the researcher and student diaries were collected as qualitative data sources. Also, they were asked to write a diary in which they expressed their opinions about the activities in each week, and interviews were held within 3 weeks after the application had been completed. As a result of the research, it was observed that Realistic Mathematics Education increased the students' achievement and positively affected their attitudes towards mathematics.

**Key words:** Attitudes towards Mathematics, Mathematics achievement, Operations on Integers, Realistic Mathematics Education (RME).

## 1. Introduction

According to Freudenthal (1991), mathematics lessons should guide students to rediscover mathematics through their own experiences. Within the framework of this thought, Hans Freudenthal laid the foundations of Realistic Mathematics Education (RME), a field-specific educational theory in the 1970s, in order to improve mathematics education. This understanding put forward by Freudenthal has been accepted in many countries such as England, Germany, Japan, America, Denmark (Cansız, 2015; Dickinson & Eade, 2006; Erdoğan, 2018; Ersoy, 2013; Kaylak, 2014; Korkmaz & Tutak, 2017; Korkmaz & Korkmaz, 2017; Okuyucu & Bilgin, 2019; Özdemir, 2008; Üzel, 2007).

According to the RME approach, the process of learning and teaching mathematics is a kind of social activity in which students engage in mathematical conversations both individually and among each other while trying to find solutions to problems (Akyüz, 2010). The education process supported by RME attracts the attention of students because it includes problems from their own lives and enables them to actively participate in learning by using the knowledge they have. In addition, it is observed that there is parallelism between the teaching process of the RME approach and the teaching processes mentioned in the mathematics curriculum. Therefore, it is thought that RME approach can be used actively in the mathematics learning and teaching process.

RME is interested in how mathematics should be learned by children, sees mathematics as a kind of human activity (Van den Heuvel-Panhuizen & Lin F.L., 2001), as well as using, developing and applying various mathematical concepts and tools to solve the problem situations of individuals from daily life, in short, by discovering their own unique ways. They defend what they learn when they produce (Akyüz,

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Stephan, & Dixon. 2012; Çetin, 2018; Van den Heuvel- Panhuizen, 2003). According to RME approach, the basis of mathematics education is the informal knowledge that students have, their previous experiences and strategies. The students learn mathematics when they create mathematical concepts themselves and adapt them to their daily lives (Kayhan Altay, Kurt Erhan, & Batı, 2020). This approach argues that learning should take place from concrete to abstract, and that problem solving is not instructive after definitions and formulas are given to teaching the subject. (Arseven, 2010; Ayvalı, 2013; Özdemir & Üzel, 2011).

RME can affect attitudes towards mathematics. The positive attitude developed can affect the academic achievement positively, while the negative attitude can cause the academic success to decrease (Tuncer & Yılmaz, 2016). For this reason, attention is drawn to the necessity of developing positive attitude towards mathematics in the secondary school mathematics curriculum published in 2018. The positive attitude mentioned in the curriculum and desired to be realized can only be developed when the student begins to enjoy mathematics. In order for the mathematics course to be liked by students and become more understandable, it must first be liberated from abstraction. Altaylı (2012) argues that abstract concepts should be made concrete as much as possible, otherwise the permanence of the acquired knowledge will be low. Abstract mathematical concepts can be made concrete with the help of concrete experiences. For this reason, the importance of the studies on the application of mathematics in daily life is emphasized in the current curriculum applied in our country, as in many countries (Özgeldi & Osmanoğlu, 2017).

The studies in the literature have shown that RME has effects on students' achievement. The effects of using RME approach on academic achievement and attitude was examined by Çakır (2011) in 6th grade algebra; by Özçelik (2015) on 7<sup>th</sup> grade students ; by Özkaya (2016) on 5th grade students; by Taş (2018) on 6th grade students; In the study performed by Korkmaz & Tutak (2017) on transformation geometry. In this study, integers, which have an important place in the field of numbers learning, are a bridge in the transition to advanced mathematics, and one of the subjects that students have difficulty with, are mentioned. The subject of integers is the key point of secondary school mathematics, which has strong and spiral relationship with many subjects such as natural numbers, fractions, rational numbers, square root numbers, algebraic expressions, equations in the secondary school mathematics curriculum. The subject of integers has an important place in mathematics teaching as it provides the transition to other learning areas and contributes to abstract thinking (Ak Beyatlı, 2019; Zehir & Zehir, 2019). For this reason, any misconception that the student will experience while learning the subject of integers can cause problems in advanced mathematics subjects (Ak Beyatlı, 2019). As a result of the researches, it was determined that the students had difficulties in distinguishing the minus sign from the sign of the operation, ordering integers, performing operations with integers, and showing negative integers on the number line (Ak Beyatlı, 2019; Aydın Ünal, 2008; Erdoğan, 2019; Yürekli, 2020).

Through teaching integers to students in order to prevent difficulties and misconceptions that students may experience and to facilitate their understanding of integers. It should be emphasized that integers are directional numbers, and the student should be intuited about the need of negative integers as well as positive integers. While introducing integers to students, expressions containing daily life situations such as credit-debt, profit-loss, temperature values on the thermometer, location relative to the ground, north-south should be used (MEB, 2009; Kumar, Subramaniam, & Naik, 2017). For this reason, in the study, RME-based activities were used with the idea that by associating integers and the situations of operations containing these numbers with the daily life situations mentioned in the curriculum, it allows the student to discover the concepts and rules about the subject, as well as to prevent possible misconceptions and facilitate the understanding of operations on integers. It is thought that RME activities will be effective on students' achievement and mathematics attitudes in operations on integers.

When the literature has been examined, it has been seen that there have been studies on RME in Turkey. However, there have been limited studies in which RME approach has been adapted to the issue of integers. For example, in the master's thesis prepared by Çetin (2018); the effect of using RME in the 6th grade subject of integers on student motivation was examined and it was concluded that RME increased students' motivation. In Aydın-Ünal (2008)'s master's thesis, the effect of RME on the 7<sup>th</sup> grade students' achievement in multiplication and division on integers and their attitudes towards mathematics was examined, and as a result of the research, a result in the favor of the experimental

group was obtained in the multiplication part with integers, but no difference could be reached between the groups in the division by integers operation. The aim of this study is to examine the effects of RME on the 7<sup>th</sup> grade students' achievements on integer operations and their attitudes towards mathematics and to determine the students' views on RME approach. In this study, with the application of the mixed method design in which both quantitative and qualitative data are combined, qualitative data indicating the student views are included. With this motivation, it is thought that the study would make an important contribution to the literature. Students who encounter the subject of integers have difficulties when comparing integers, determining their position on the number line, and especially when dealing with integers with different signs (Van De Walle, Karp & Bay- Williams, 2004; Işitan& Doğan, 2018). In order to eliminate this negative situation experienced by students and to make teaching about integers effective, it should be associated with daily life. Considering that it would be appropriate to use activities based on RME in the preparation of environments where students would need integers, in this study, the effect of RME on the 7th grade students' success in operations with integers and their attitudes towards mathematics was examined. From this point of view, the aim of the researcher is to answer the following research problems:

1. Is there significant difference between the mathematics achievement scores conducted to the group of students before and after the treatment of RME?
2. Is there significant difference between the mathematics attitude scores conducted to the group of students before and after the treatment of RME?
3. What are the views of the group in which RME is applied about the learning and teaching process?
4. What are the students' views on the effect of RME on their mathematics achievement?
5. What are the students' views on the effect of RME on their attitudes towards mathematics?

## 2. Method

### 2. 1. Research Model

In this study, examining the effects of RME on students' achievements and attitudes towards mathematics in operations with integers, as well as student views on the RME approach, explanatory sequential mixed design, one of the mixed research methods using qualitative and quantitative data together, was used. According to the exploratory sequential mixed design, firstly, quantitative data was collected, then qualitative data was collected in order to interpret the quantitative data more effectively and to diversify the data.

In the quantitative part of the study, one group pre-test-post-test design, one of the weak experimental designs, was used in order to investigate the effects of RME on the 7th grade students' achievement and mathematics attitude on integer operations. Before the experimental application, the achievement test prepared by the researcher and the mathematics attitude scale developed by the Education Research and Development Department (EARGED) in the 6th-8th grades curriculum and guide published in 2009 were applied to the students. After the experimental application, the achievement test and the mathematics attitude scale were conducted to the students again.

The case study was used to investigate the qualitative part of the research. Semi-structured interview form prepared by the researcher and student diaries filled by the students after each activity were used in order to detail and support the quantitative data and to determine the students' views on the learning and teaching process. By using semi-structured interviews and student diaries, it was researched how the students' mathematical attitudes and views changed on "Operations with Integers" in RME.

### 2. 2. Study Group

The population of the research consists of 7th grade students studying in the 2020-2021 academic year, and the sample consists of all 7th grade students with 11 students in a public secondary school in Gazipaşa, Antalya for the quantitative part and 9 students for the qualitative part. Of these 11 students, 6 are girls and 5 are boys. In the determination of the research group, the "appropriate/accidental sampling" method, one of the purposeful sampling methods, was used. The selection of the sample,

which aims to prevent time, financial expense and labor loss, is easily accessible and provides ease of work, is called the appropriate/accidental sampling method (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz & Demirel, 2014). Considering the pandemic conditions of the researcher, this sampling method was preferred because it provided ease of communication with the students in the school where she worked and that the study could be carried out without any disruption. The fact that the researcher wanted to do the research herself, but there was a branch from each grade level in the school where she worked and the conditions of the research made it necessary to use a single group in the study. In addition, all 11 students were asked to be interviewed, but due to the pandemic process, 2 students could not be contacted because they could not be interviewed. The research was carried out in coordination with the achievements in the curriculum, taking into account the rules of the RME approach in a way that would not disrupt the education.

### 2.3. Data Collection Tools and Process

In order to find an answer to the research problem and to examine the learning process in detail, the achievement test prepared by the researcher and the mathematics attitude scale developed by EARGED were applied to the students in the collection of quantitative data. During the collection of qualitative data, the semi-structured interview form prepared by the researcher and the student diaries in which the students expressed their thoughts on the applied activities and learning processes were used in order to determine the students' views on the learning process.

**2.3.1. Achievement test.** The achievement test used in the research was created by the researcher. Before the achievement test was created, the current secondary school mathematics curriculum was examined in detail and the achievements to be obtained were determined and a table of indications was prepared. Afterwards, the literature on integers was searched and information was obtained about the difficulties of the students. As a result of the researches, an achievement test consisting of 10 open-ended questions was created, with at least one question containing the acquisitions that should be gained by the students based on the objectives in the curriculum. A holistic rubric was prepared by the researcher for the objective scoring of the created achievement test, and opinions were received from an expert who has completed her doctorate in mathematics education and two experienced mathematics teachers about the prepared holistic rubric. In line with the opinions received, a few more acquisitions suitable for some score ranges were added and the holistic rubric was finalized. After the achievement test took its final form, two students who were not in the participant group were given an application to find the faults, and some words that could cause misunderstandings in a question and lead the students to the wrong conclusion were corrected and the problems were eliminated. Students were given 30 minutes to solve the achievement test. The opinions received were evaluated and the holistic rubric was finalized. According to the holistic rubric used in the evaluation, students get a minimum of 0 and a maximum of 5 points for each question in the achievement test. In total, the lowest score that students can get from the applied achievement test is 0, and the highest score is 50. In order to eliminate bias and ensure objectivity, pre-test and post-test achievement tests were evaluated by 2 mathematics teachers. The scores of the participants were determined by taking the average of the scores given by the raters for each question.

**2.3.2. Mathematics attitude scale.** The mathematics attitude scale used in the research is a 5-point Likert-type scale consisting of 20 items, the validity and reliability of which have been previously tested and developed by the Department of Education Research and Development (EARGED), which is included in the 6th-8th grades curriculum and guide published in 2009. In this study, the Cronbach Alpha reliability coefficient of the test was found to be 0.87. This result shows that the reliability level of the scale is high (Cronbach's Alpha > 0.70). Each item in the scale has 5 options graded between completely agree and strongly disagree. The one-dimensional scale has 12 positive and 8 negative items. The highest score that can be obtained from this scale is 100, and the lowest score is 20..

**2.3.3. Semi-structured interview form.** A semi-structured interview form was prepared by the researcher in order to examine the change in the students' attitudes towards mathematics and to determine the student views on RME approach. In semi-structured interviews, the researcher may ask the participant questions that she prepared before the interview, as well as questions that will enable the participant to elaborate on the answers given in line with the relevant field (Yıldırım & Şimşek, 2018).

By examining the relevant literature, 6 questions were prepared by the researcher. Opinions were taken from an expert and two experienced mathematics teachers who completed their doctorate in mathematics education, and minor adjustments were made by removing items that could express the same feelings and thoughts. Then, necessary changes were made on the questions. After determining the questions, a Turkish teacher assisted in order to examine the questions in terms of grammar rules and to examine the questions in terms of meaning. After the necessary examinations and arrangements, the semi-structured interview form took its final form. One of the questions used in the interview form is as follows: "Do you think that the RME Method has any effect on understanding the subject of operations with integers?", "If your answer is that there is a positive effect; In what respect do you think it has a positive impact?" and "If your answer is that there is a negative effect; In what respect do you think it has a negative impact?".

**2.3.4. Student diaries.** In order to determine the students' views on RME approach and the teaching process, the questions to be answered in the student diaries were prepared by the researcher. It is thought that student diaries would be useful in reaching individual feelings, thoughts, reactions, comments and explanations (Yıldırım & Şimşek, 2018). For this purpose, students were asked to write answers to the diaries containing the following questions after each activity: "What you liked about the event we did today?", "What you don't like about our event today?", "What did you learn from today's event that might be new for you?", "The places where you have difficulty in today's activity?" and "Do you have any different thoughts you would like to express about the event? If yes, write."

The research started with the official permission of the Antalya Provincial Directorate of National Education and the parents of the students in the 2020-2021 academic year. After obtaining the necessary permissions, the 5-week implementation process started. Before starting the research, it was explained to the students that a study would be conducted with them and that they had the right to withdraw from this study whenever they wanted. In addition, it was stated that regular participation in activities was necessary for the healthy progress of the work. In the first week of the study, the mathematics achievement test and mathematics attitude scale were conducted to the students. The application of the achievement test took 30 minutes and the application of the attitude scale took about 10 minutes. After the achievement test and the mathematics attitude scale were applied, the teaching process started with the activities prepared in accordance with RME approach. A total of 9 activities were carried out with the students under the guidance of the researcher. The implementation process of these activities was carried out as follows. In Activity 1, students were asked to show the temperature values of the provinces on the number line in accordance with the given problem situation. Then, another question was asked to the students and they were asked to show the appropriate operation on the number line again. Finally, the students were given the opportunity to make an inference about the addition with integers based on the model. In Activity 2, students were asked to find solutions to their problem situations based on different models. In the case of the problem in Activity 3, they were expected to make discoveries about addition with opposite signed integers. At the end of the activity, they were also asked to rank integers, which would require them to relate to the knowledge they had previously acquired. In Activity 4, students were expected to produce solutions to 3 different context problems that require addition and subtraction with integers. After reaching the solution, they were asked to produce solutions to new situations by giving a situation again, and finally to express the change that occurred between the first situations and the last situations. In Activity 5 and Activity 6, students were given a daily life situation where they could make integer subtraction and make inferences about this operation, and they were asked to produce solution strategies for these context problems. In Activity 7 and Activity 8, daily life situations were given to the students in order to obtain formal information about multiplication with integers. While this context was producing solutions to the problems, the students were expected to discover the formal knowledge of multiplying integers with the same sign and multiplication with integers with opposite signs. In Activity 9, it was aimed to develop a solution strategy for context problems that would require students to divide by integers, and to reach the formal information that was aimed to be obtained based on the strategies they developed. After each activity, students were asked to keep a diary individually and they were collected regularly every week. After the completion of the 5-week education, the achievement test and the mathematics attitude scale were conducted to the students again. After the post-tests were collected, semi-structured interviews were conducted with the students in order to observe the qualitative change in their attitudes towards their mathematics lesson and to

determine the opinions of the students about their experiences in the treatment process. Before starting the interviews, permission was requested from the students to take audio recordings and the interviews were recorded. The interviews were completed within 3 weeks after the end of the training. Then, the student diaries were collected..

## 2. 4. Data Analysis

SPSS 23 package program was used in the analysis of the data obtained from the achievement test and mathematics attitude scale, which constitute the quantitative data of the study. When the number of individuals in a research group is less than 50 people, normality can be checked with the Shapiro-Wilk test. If the  $p$  value is greater than 0.05 as a result of the test, it can be said that the data show a normal distribution and parametric tests can be used (Büyüköztürk, 2016). Since there were 11 participants in the study, the Shapiro-Wilk normality test was applied to test the normality of the achievement test and the mathematics attitude scale before starting the analysis. According to the analysis results, achievement pre-test scores ( $p=0.696 > 0.05$ ), the achievement post-test scores ( $p=0.094 > 0.05$ ), the pre-test scores in mathematics attitude scale ( $p=0.666 > 0.05$ ) and the post-test scores in mathematics attitude scale ( $p=0.069 > 0.05$ ) showed normal distribution. Since normality was ensured,  $t$ -test for dependent samples (paired-samples  $t$ -test) was applied in the analysis of scores of achievement test and mathematics attitude scale. Also, interview data were analyzed by content analysis technique. In addition, the data obtained from student diaries and interviews were evaluated qualitatively. content analysis method was used to analyze the interview data. The answers given by the students were listened to from the recording and converted into text, and then the answers were tabulated. The frequencies of the answers corresponding to the questions are shown in the tables.

## 3. Findings

In this section, the findings of the statistical analysis of the research problems are given. Since the data for each identified problem is evaluated under a separate heading, this section consists of five titles.

### 3.1. The Effects of RME on Mathematics Achievement

The research problem, "Is there significant difference between the mathematics achievement scores conducted to the group of students before and after the treatment of RME?" is answered under this heading. The analysis results of the data obtained by using the  $t$ -test for dependent samples (paired-samples  $t$ -test) to investigate the research problem are given in Table 1.

**Table 1.**  $t$ -Test Results of Achievement Test Pre-Test and Post-Test Scores

Test	N	$\bar{X}$	$SD$	df	$t$	$p$
Pre-test	11	23.86	10.78	10	-5.296	0.000
Post-test	11	33.55	13.26			

According to Table 1, there is a significant difference between the mathematics achievement test pre-test scores ( $\bar{X}=23.86$ ,  $SD=10.78$ ) and the mathematics achievement test post-test scores ( $\bar{X}=33.55$ ,  $SD=13.26$ ). It was found that there was a difference ( $t(10)=-5.296$ ,  $p < 0.05$ ). According to these results, it was concluded that RME method applied in the study increased the students' mathematics achievement by positively affecting them. In addition, the effect size on mathematics achievement was found to be 1.597. In general, in terms of effect size value, above 1 is interpreted as very large, 0.8 large, 0.5 medium, and less than 0.2 (Green & Salkin, 2005; Morgan, Leech, Gloeckner & Barret, 2004; Can, 2019). Accordingly, it is seen that RME method has very high effect on the students' mathematics achievement.

### 3.2. The Effects of RME on Attitudes Towards Mathematics

"Is there significant difference between the mathematics attitude scores conducted to the group of students before and after the treatment of RME?" was answered. The results of the analysis of the data obtained by using the  $t$ -Test for dependent samples to investigate the research problem are given in Table 2.



**Table 2.** *t*-test Results of Mathematics Attitude Scale Pre-Test and Post-Test Scores

Test	N	$\bar{X}$	SD	df	<i>t</i>	<i>p</i>
Pre-test	11	80.64	8.74	10	-2.708	0.022
Post-test	11	91.00	8.92			

According to Table 2, there is a significant difference between the students' mathematics attitude scale pre-test scores ( $\bar{X}$ =80.64,  $SD$ =8.74) and mathematics attitude scale post-test scores ( $\bar{X}$ =91.00,  $SD$ =8.92). It was found that there was a difference ( $t(10) = -2.708$ ,  $p < 0.05$ ). According to these results, it was concluded that RME method applied in the study affected the students' attitudes towards mathematics positively. In addition, the effect size of mathematics attitude was found to be 0.816. In general, in terms of effect size value, above 1 is interpreted as very large, 0.8 large, 0.5 medium, and less than 0.2 (Green & Salkin, 2005; Morgan, Leech, Gloeckner & Barret, 2004; Can, 2019). Accordingly, it was seen that RME method has a high effect on the students' mathematics attitude.

### 3.3. The Student Views on the Effect of RME on Learning and Teaching Process

The answer of "What are the views of the group in which RME is applied about the learning and teaching process?" was explained. The findings of the answer to this question were expressed by making use of the students' answers to the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 6<sup>th</sup> questions of the interviews and the student diaries. All of the participants were asked to be interviewed, but 9 participants accepted to be interviewed and 2 participants could not be contacted for the interview. The student opinions were coded as S1, S2, S3,..., S9.

The answers given by the students to the questions are summarized in the tables below each question:

Question 1. "When you consider the mathematics lessons you have taught in previous years, how do you think it would be appropriate to teach the mathematics lesson?"

**Table 3.** Students' Expectations for Mathematics Lesson

Categories	The Student	f
The event should be done	S1, S2, S8, S9	4
Question must be solved	S1, S2, S7, S8	4
It should be made fun	S2, S3, S4, S5, S6, S7, S8, S9	8
The game must be played	S2, S3, S4, S5	4
Questions from daily life should be asked	S5, S9	2
Award must be given	S9	1
The competition should be	S5, S9	2
Should be chatted	S6, S7	2
Images should be used	S6	1

As seen in Table 3, the majority of the students stated that mathematics lessons should be made fun, by doing activities, playing games and solving questions. In addition, relatively few students stated that daily life questions should be included in mathematics lessons, visuals should be used, conversations should be held and competitions should be held.

Question 2. "Do you like teaching with RME Method?"

**Table 4.** Students' Enjoyment of RME

Like Status	Categories	The Student	f
Yes		S1, S2, S3, S4, S5, S6, S7, S9	8
	Because it raises my level of logic and thinking	S1, S2	2
	Educational, informative	S1, S2	2
	Because it's fun	S1, S3, S6, S8, S9	5
	Because it's easy	S2, S7	2
	Because it allows me to communicate with my friends	S3	1
	Because cartoon characters and images are used	S3, S4, S6, S7, S8, S9	6

	Because it is similar to the questions we come across in daily life.	S4, S5, S7, S8	4
It's not to my liking but it was useful		S8	1

Looking at Table 4, almost all of the students stated that they liked the RME approach. One student, on the other hand, stated the feeling he experienced as a method that was beneficial for him, not as liking. In addition, 6 students used cartoon characters and visuals, 5 students found it entertaining, 4 students proposed questions similar to the questions that they encountered in daily life, 2 students explained it as educational and informative, 2 students' thinking levels increased, 2 students stated that they liked the RME method because the questions were easy for them and 1 student said that it provided the opportunity to communicate with their friends.

Question 3. "Do you think that RME Method has any effect on understanding the subject of operations with integers?"

If your answer is "there is a positive effect"; In what ways do you think it has a positive effect?

If your answer is "there is a negative effect"; In what way do you think it has a negative impact?

When the answers given were examined, it was seen that all of the students stated that RME had positive effects on the students' understanding of operations on integers.

**Table 5.** Student Opinions on the Impact of RME on the Students' Understanding of Operations on Integers

Categories	The Student	f
It was effective because it led to thinking and strengthened the level of thinking.	S1	1
It was effective because it made me think of simpler and different methods.	S1	1
It was effective because it provided permanence.	S1, S2, S9	3
It made it easier for me to understand the subject.	S2, S5, S6	3
It was on everyone's mind because it was fun.	S2, S3	2
It stayed in my mind more because there were questions that I constantly faced in my normal life.	S3, S5, S8	3
Although we are not aware of integers in many parts of our lives, I have seen that mathematics is present.	S4	1
Normally, I couldn't ask about the places I didn't understand and got stuck while solving questions, but I understood this issue because I was able to ask questions while doing these activities.	S7	1

As seen in Table 5, 3 students stated that the activities provided permanence, 3 students stated that RME facilitated the understanding of the subject, and 3 students stated that it was fun because it was fun.

Question 6. "What are your thoughts and suggestions about the RME Method used in the lessons?"

**Table 6.** Student Views on the RME Approach

Categories	The Student	f
Using the same method, we can also do activities on other subjects.	S1, S2, S5, S7	4
The events were nice and became more permanent.	S3, S4, S6	3
It was good that the questions were thought provoking.	S3	1
I was able to compare my own solution with the ways my friends found. I've seen other solutions as well.	S3	1
It made me understand the subject better.	S4, S9	2
It piqued my interest.	S4	1
It made it easier for me to ask questions.	S5, S6, S9	3
It was fun.	S6, S7, S8, S9	4



As seen in Table 6, the students stated that RME activities should also be used in other subjects, that they found the activities enjoyable, entertaining and thought-provoking, that they helped them understand the subject more easily and better, and that the information they have acquired was permanent. The data obtained from the student diaries for the stated research question supports this inference. The data obtained from the student diaries are given in Table 7.

**Table 7.** Student Views on the GME Approach Obtained from Student Diaries

Categories	The Student	f
It was fun.	S1, S3, S4, S5, S6, S7, S8, S9	8
It was thought provoking.	S1, S3, S6, S7, S9	5
It was easy.	S1, S2, S4, S5, S6, S7, S9	7
It was interesting because there were questions from daily life.	S1, S5, S7, S8, S9	5
It made realize the fun side of doing mathematical operations.	S4, S5, S6	3
It took away my fear of math.	S4	1
It made it easy for me to understand the subject.	S9	1

As can be seen in Table 7, students evaluate teaching activities based on the RME approach as fun, thought-provoking and easy. In addition, the students stated that they were interested in the problem situations in the activity being from daily life. One student stated that these activities eliminated their fear of mathematics. Another student stated that these activities made it easier to understand the subject.

### 3.4. The Student Views on the Effect of RME on Mathematics Achievement

“What are the students' views on the effect of RME on their mathematics achievement?” was answered under this heading. The findings of the answer to the question are expressed by making use of the answers given by the students to the 4<sup>th</sup> question of the interviews, and these dialogues are shown as follows.

Question 4. “Do you think that teaching the subject of operations on integers using RME Method is effective in achieving success in the mathematics course?”

When the answers given were examined, all of the students who participated in the study stated that RME was effective in reaching achievement in mathematics.

**Table 8.** Student Views on the Effect of RME on Mathematics Achievement

Categories	The Student	f
The questions came easy to me.	S1, S4, S5, S6, S7, S8, S9	7
I was able to learn more.	S1, S2, S6	3
Accurate count increased.	S3, S9	2
I wanted to be more curious and solve the questions.	S3	1
I saw that I could be successful in math class.	S4, S5, S8	3
After doing the activities, my mistakes decreased.	S6	1

When Table 8 was examined, it was seen that 7 students found the questions easy, 3 students stated that they gained more information, 3 students realized that they could be successful in mathematics, and 2 students stated that the number of correct answers increased.

### 3.5. The Student Views on the Effect of RME on Attitudes towards Mathematics

“What are the students' views on the effect of RME on their attitudes towards mathematics?” was answered. The findings of the question were obtained from the answers given by the students to the 5<sup>th</sup> question of the interviews.

Question 5. “Would you explain if there was any change in your thoughts about the mathematics lesson after the training with RME, if there was any change?”

**Table 9.** The Effect of GME on Students' Thoughts About Mathematics Lesson and Changes in Their Thoughts

Impact Status	Categories	The Student	f
It had an effect.		S2, S3, S5, S6, S7, S8, S9	7
	Mathematics was difficult at first, but it was easy.	S2, S5, S7, S8, S9	5
	Before, I didn't have confidence in myself. But now I know I can do the questions.	S3, S9	2
	Now my favorite subject is math.	S3, S9	2
	Mathematics was actually a fun subject, not boring.	S5, S6, S8, S9	4
	Before, I was afraid that I would be wrong. But now I'm not afraid even if I'm wrong.	S6	1
It had no effect.		S1, S4	2

As seen in Table 9, 7 students stated that RME affected their thoughts about the mathematics course, while 2 students stated that it had no effect. It was concluded that RME activities contributed to the students' views about the mathematics lesson as an easy and funny lesson rather than a difficult, boring one, increasing the students' self-confidence and reducing their fear of being unable to do it.

### 3. Discussion, Conclusion and Recommendation

Students encounter integers in the number learning area for the first time in the 6th grade. Positive integers are numbers that students have encountered since elementary school. However, negative integers are a new concept for students. The minus sign, which has previously taken place in the minds of students as subtraction, causes confusion when it is called as negative integer (Altun, 2015).

As a result of the research on success, the post-test achievement scores and the pre-test achievement scores of the students who participated in the education with RME were compared, and it was observed that there was a significant difference between the pre-test and post-test scores. The results showed that the use of RME-based education in the teaching of the 7<sup>th</sup> grade topic of "Operations on Integers" affected the students' achievement positively and increased the achievement levels of the students. This result is in parallel with the studies in the literature. In the studies conducted by Aydın Ünal & İpek (2010), Erdoğan (2018), Işıtan & Doğan (2018), Ödemiş (2019), Özkürkçüler (2019) and Papadakis, Kalogiannakis & Zaranis (2021), it was found that RME positively affected and increased the success of the students. Demirdöğen (2007), Üzel (2007), Aydın Ünal (2008), Özdemir (2008), Özdemir & Üzel (2011), Altaylı (2012), Palinussa (2013), Özkaya (2016) and Cezlan Kavuran (2019) conclude that when RME is compared with the traditional approach, it is more effective on students' success. Bildircin (2012), Kaylak (2014), Korkmaz & Tutak (2017) and Sevim (2019) concluded that RME activities were more effective in terms of students' mathematics achievement compared to the education carried out with the activities in the textbooks. Uygur (2012), Ersoy (2013), Kurt (2015), Özçelik (2015), Büyükkiz Kütküt (2017) and Özkan (2019) also emphasized the increase on the students' mathematics achievement. In addition, Korkmaz & Korkmaz (2017) examined the effects of RME on the 8th grade students' mathematics achievement, and the students' opinions against RME approach, and it was concluded that RME activities were not more effective on the students' success than the constructivist approach.

As a result of the research regarding the attitude towards mathematics, the mathematics attitude scale scores acquired after the treatment and the mathematics attitude scale scores acquired before the treatment, the students who participated in the treatment based on RME were compared and it was observed that there was significant difference between the pre-test and post-test scores. According to the results obtained, it was seen that RME-based education had positive effect on the students' attitudes towards mathematics. This result is similar to the findings of the studies in the literature. In the studies carried out by Üzel (2007), Ersoy (2013), Özçelik (2015), Özkaya (2016), Özkürkçüler (2019), they stated that RME enables students to develop positive attitudes towards mathematics. On the other hand, there have been studies of Aydın Ünal (2008), Bildircin (2012), Kaylak (2014), Korkmaz & Korkmaz

(2017), Cezlan Kavuran (2019) stating that they did not find any effect of RME on students' mathematics attitudes. Cezlan-Kavuran (2019) stated in his studies that the reason why RME does not affect students' attitudes towards mathematics may be the fact that RME is used for a short time, such as a teaching process of a mathematical concept. If RME is a technique that students use more often to be used in teaching some subjects during an education process or teaching some subjects rather than teaching a subject, it can be observed that it affects students' attitudes towards mathematics.

After the interviews with the students after the application and the analysis of the student diaries collected from the students after the activity, most of the students stated that they liked RME activities, that RME method facilitated their learning and ensured the permanence of the knowledge they had acquired, that it made the mathematics lesson fun, and that they wanted RME to be used in other subjects as well. In addition, they stated that after the treatment of RME, the mathematics lesson was not difficult but easy, and their fears in the mathematics lesson decreased. When the previous studies conducted are examined, it has been seen that there are results that support the results of this research. Widjaja & Heck (2003), Özdemir (2008), Özdemir & Üzel (2011), Özçelik (2015), Kurt (2015), Korkmaz & Korkmaz (2017), Cezlan Kavuran (2019) and Sevim (2019) ) stated that the students had positive views of RME.

The suggestions that can be made based on these results could be that this research was carried out with the participation of 7<sup>th</sup> grade students by adopting the RME approach on operations with integers. In order to continue researching the effectiveness of the method, longer-term studies can be conducted with more participants on different mathematical subjects and at other grade levels of students, including primary, secondary, high school and university levels. The activities designed based on RME in the textbooks distributed by the Ministry of National Education may include more activities based on RME approach. Studies that investigate how the learning of students at various levels are supported can be designed by preparing teaching activities based on RME for the teaching of other mathematical concepts. Longer-term and comprehensive studies can be carried out with the help of the Ministry of National Education and universities in order to investigate the effectiveness of RME against different learning and teaching methods.

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