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Full Length Research Paper

The effect of realistic mathematics education on student achievement in 8th grades geometric objects teaching

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ABSTRACT

The purpose of this study is to answer if there is a reasonable difference on academical success of students who get education with traditional and RME approach question on “Teaching geometrical objects to 8th grade students” subject. Study group consists of 47 students which contains 21 experimental and 16 control group from “Ordu Anadolu İmam Hatip High School Project School” in Altinordu, Ordu. Experimental and control group have same academical success level, as the school which this study has runned is a school which accepts students with an exam only. After the experimental and control groups were created, a 25 question pre-test was performed to understand the level of knowledge of the group regarding geometrical objects. The same test was performed on the same groups 8 weeks later as retention test. To determine opinions of the students in experimental group regarding RME and related learning activities, semi-structured interviews are conducted. The data obtained from the pretest, posttest and retention tests were analyzed with t-test for independent samples and t-test for dependent samples and variance analysis for mixed measurements with 0.05 significance level. According to the results, it is seen that learning activities prepared according to RME approach are much more effective than learning activities prepared according to the traditional approach on students’ academic success.

Keywords: Geometrical objects, academical success, realistic mathematichs education, middle school students, eighth grade.

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INTRODUCTION

Although mathematics is a part of our daily life, a precise definition of the word mathematics cannot be made (Ersoy, 2013). It should not be forgotten that although mathematics is the general name of the sciences that examine the properties of quantities based on numbers and measures such as algebra, arithmetic, geometry, there is also mathematics that is not based on numbers and measures. In addition, mathematics is a science that examines not only the properties of quantities but also the properties of systems (Alkan and Altun, 1998).

According to the curriculum of the Ministry of National Education (MNE), mathematics is the science of patterns. In other words, math is a science that studies number, size, shape, space and the relationships among them. However, it is a universal language based on mathematics, symbols and figures. Maths includes processing information, making predictions, generating information and solving problems using this language (MEB, 2009).

Mathematics is a very wide system that is thought to be a different science from other sciences, it is abstract, can be expressed as the science of number, and is found in all areas of life; and it is thought that everyone can always work with appropriate methods (Ersoy, 2013).

It is observed that people living in Turkey generally have low problem-solving skills, and their success in

mathematical operations is higher than the behaviors that require reasoning. The reason for this can be that teaching methods and strategies that are in accordance with the structure of mathematics are not used in teaching mathematics in Turkey (Baykul, 2003). The monotony, abstraction, and memorization-based structure of the methods used in mathematics teaching make it difficult to understand the place and logical structure of mathematics in daily life. In addition, teaching students the practical ways that lead to solutions without thinking for various exams makes it difficult for students to grasp the logical structure of mathematics (Abdik, 2002).

Although mathematics has an important place in daily life, it is accepted that it is difficult to learn as well as difficult to teach all over the world. In fact, the difficulty of mathematics is not only due to its structure but also due to fear, anxiety, and prejudice against mathematics (Yuksel-Sahin, 2004).

One of the reasons why mathematics is feared and considered difficult is that mathematics-related concepts are abstract in nature. The abstract concepts in the lessons should be taught with the support of concrete materials to students aged 7-12, who are in the concrete operational stage (Erden and Akman, 2002). Another reason is the students' inability to establish a connection between the information they learn in mathematics lessons and daily life. Explaining mathematics subjects to students by establishing a connection with daily life will make mathematics more understandable and meaningful for students (Bildircin, 2012)

It is impossible to see all the facts of mathematics in life due to the negative attitudes towards mathematics. Individuals are expected to reach mathematical knowledge with their own approaches and methods in their own worlds formed in their minds (Yesildere and Turnuklu, 2004). In this context, constructivism has an important place in teaching mathematics, and with it, approaches such as the Realistic Mathematics Approach (RMA) have been introduced (Unal, 2008).

The problem

The main problem of this research was "Does realistic mathematics education have an effect on student achievement in 8th-grade geometric objects teaching?"

The sub-problems

1. Is there a statistically certain difference between the pretest scores of the control and experimental groups?
2. Is there a statistically certain difference between the post-test scores of the control and experimental groups?
3. Is there a statistically certain difference between the pretest and post-test scores of the experimental group?
4. Is there a statistically certain difference between the pretest and post-test scores of the control group?
5. What are the opinions of the students of the experimental group, who do RME-based practices for the geometric objects subject in the 8th grade, about the RME activities, geometry teaching, and practices?

Realistic mathematics education

A curriculum and pedagogical theory developed by the Freudenthal Institute, an internationally respected organization, is used in mathematics education in the Netherlands. Based on a philosophy called Realistic Mathematics Education (RME), this curriculum has been implemented in high schools in the Netherlands for more than 95 years. One of the main features of this approach is that the matter is 'logical'. Available RME features are often determined from Freudenthal's view of mathematics (Freudenthal, 1991). The most important feature of realistic mathematics education is that he advocates that mathematics is a human activity and that mathematics is realistic. According to this approach, mathematics should engage children and children should associate problems with daily life situations. However, the word 'realistic' refers not only to the connection with the real world, but also to the real problems students are thinking about (Zulkardi, 2002).

Research on the effects on the subjects at the primary stage of GMA approach in Turkey (Campbell, 2012; Jahan, 2017; Donmez, 2018; Erdogan, 2018; Gozka in 2015; Kaylaka, 2014, Korkmaz, 2017; Nama-Aydin, 2014, Sezer, 2013; Tas, 2018; Uzel, 2007) and studies on its effects on secondary education issues (Akyuz, 2010; Cansiz, 2015; Demir, 2017; Kaya, 2018; Ozdemir, 2015). In studies conducted abroad, it has been applied to grade levels at all levels of education from primary education to higher education. In this study, it is aimed to determine whether there is a certain difference between the subject learning levels of the students in the experimental group in which the subjects of geometric objects taught in 8th grades were applied and the learning levels of students in the control group where traditional activities were applied, and how the RME method affects student achievement in teaching geometric objects. The reason why 8th class geometric objects was chosen is because of the fact that there are many studies on algebra and the few studies on geometry in the literature review. In addition, this study is a unique study in its field in terms of being carried out with students in an educational institution that accepts students with an exam.

METHOD

In this study, qualitative and quantitative research methods were used together. Therefore, the research method is a mixed research method. Creswell (2008)

defines the mixed research method as a procedure for collecting and analyzing qualitative and quantitative data in a mixed way at the stages of the relevant research process in order to fully understand a research problem. Creswell (2013) determined three basic mixed-method patterns in mixed research methods in accordance with the purpose. In this research, an explanatory sequential pattern from these designs was used. In explanatory sequential research studies, quantitative data are collected first, and qualitative data are collected and analyzed in order to examine the results obtained from quantitative data in depth (McMillan and Schumacher, 2010). In this study, firstly, quantitative data were collected in order to determine the learning levels of 8th-grade students about geometric objects, and then the results obtained in the light of the collected qualitative data were examined in depth.

The research was conducted by choosing one of the two equal branches as the experimental group and the other as the control group. During the research process, applications were conducted before and after the research in both groups. The research design is shown in Table 1.

After the application, interviews were made with the students in the experimental group using the interview form prepared. An interview is defined as communicating with people for specific purposes. The main purpose of the interview is to reveal the feelings, thoughts, and beliefs of the individual interviewed about the subject being studied (Cepni, 2001). For this reason, interviews were conducted to learn the thoughts of the students about teaching activities based on RME after the application.

Participants

The legal permissions required for the research were obtained from the necessary official institutions. Participants the universe of this research consisted of 2nd-level primary education students in Ordu.

The sample of the study consisted of 8-A and 8-C classes in the Metropolitan Municipality Ordu Anadolu Imam-Hatip High School and Science and Social Sciences Project School in the district of Altinordu in the province of Ordu in the second semester of the 2018-2019 academic year. In the sample, there were 37 students in total, 21 students in 8-C class that made up the experimental group, and 16 students in 8-A class that made up the control group. The distribution of the students by gender in the experimental and control groups is given in Table 2.

Table 1. Experimental design of the study.

Groups	Preliminary measurements	Applications	Final measurements
Experimental Group	Mathematical achievement test (Pretest)	Activities for RME	Mathematical achievement test (Post-test) Semi-structured interview form
Control Group	Mathematical achievement test (Pretest)	Applications for the MoNE program	Mathematical achievement test (Post-test)

Table 2. Distribution of students in the groups by gender.

Gender	Experimental group (Learning according to RME approach)	Control group (Traditional learning)	Total
Female	0	16	16
Male	21	0	21
Total	21	16	37

Data collection tools

The following data collection tools were used to collect data in this study:

1. Mathematical achievement test
2. Semi-structured interview form

Mathematical achievement test

In order to measure the success of the participating students towards the unit of "geometric objects", a mathematical achievement test was created by asking the same questions asked by the Ministry of National Education (MNE) in previous years. The achievement

test consisted of 40 test questions. In addition, the achievements of the "Geometric objects" unit were taken into account while preparing the achievement test. In order to ensure the content validity of the mathematical achievement test, the opinions of 1 expert in the field of mathematics education and 3 mathematics teachers were taken. The pilot application regarding the questions in the achievement test was carried out with a total of 100 students who were taught the "Geometric objects" unit in the previous year. The answers given by each student to the questions were recorded one by one, and the discrimination powers (d) of the questions were calculated. The distribution of the discrimination power of the items in the test is shown in Table 3.

Table 3. Distribution of items according to discrimination power for mathematical achievement test.

Discrimination power	Number of items	Percentage %	Evaluation
d > 0.40	6	24	Very good
0.30 > d > 0.39	8	32	Fairly good
0.20 > d > 0.29	11	44	Need to be corrected

Source: Can (2017).

Interview form

Semi-Structured Interview Form before preparing the interview form in the research, the documents used in the studies on RME were examined. As a result of the examination, a draft interview form was prepared from the documents obtained using the observations of the researcher during the application, secondary school mathematics textbooks, and the mistakes made by the students during the application. This interview form was then discussed with three academicians who were experts in their fields and two math teachers. Before applying the semi-structured interview form to the students in the experimental group, a pilot study was conducted with 3 students who were not members of the experimental group on the clarity and comprehensibility of the interview items and the adequacy of the 15 items. 20 minutes was reserved for the interview. The final version of the interview form was created by eliminating the identified deficiencies in all the interviews and making the necessary arrangements. In the interview form, questions about the place of the RME approach and other approaches in the current mathematics curriculum, the applicability of the in-class activities and the approaches offered by the program, and the students' opinions about RME were included.

Application process

The following procedures were applied respectively to both the experimental and control groups in the study:

1. Academic achievement tests and semi-structured interview form, which were the data collection tools of the research, were prepared.
2. For the application, a permit application was made to the Ordu Directorate of National Education through Giresun University Institute of Educational Sciences, and necessary permissions were obtained.
3. The experimental and control groups of the students studying in the 8th-grade branches in the school where the application would be held were determined by the neutral assignment method.
4. Before starting the application, teaching materials were prepared in accordance with the objectives and target behaviors of the geometry course.
5. Before starting the application, monthly course hours were determined in the experimental and control groups, and the total course hours recommended by the Ministry of Education were followed.
6. The mathematical achievement test was applied as a pretest to the experimental and control groups.
7. Teaching techniques suitable for the RME approach were used in the experimental groups. In the control groups, traditional teaching methods, i.e. lecturing and question-answer techniques, were used.
8. All subjects were taught to the experimental and control groups by the researcher.
9. After the application, the academic achievement test was applied to both groups as a post-test.
10. All quantitative data obtained were analyzed.
11. After the application, interviews were made with randomly selected students in the experimental group. The qualitative data obtained were analyzed.

Data analysis

The analysis of the results obtained in the research was made as follows:

Analysis of quantitative data

SPSS package program was used to analyze the data.

All the data obtained were entered into the program, and necessary measurements were made.

To determine whether there was a certain difference in the comparison of pre-test, post-test, and retention test results of the experimental group and the control group, *t-Test for Independent Groups* was used. To determine whether there was a certain difference in the comparison of the pre-test and post-test results of the experimental group and the control group and the post-test retention test results, *t-Test for Dependent Groups* was used.

Analysis of qualitative data

The content analysis method was used to analyze the students' views about teaching according to the RME approach. Buyukozturk et al. (2008) define content analysis as a systematic, renewable technique in which the words of a text emphasizing what is intended to be told are summarized in smaller content categories by coding according to certain rules.

FINDINGS

In this section, statistical analysis results of the data obtained from data collection tools in line with the purpose of the research are included.

Results regarding the first sub-problem

Since the number of observations in the experimental group was 21 in the normality test performed with the data related to the first sub-problem, the Shapiro-Wilk analysis was performed, and it was found that the p-value indicated by the significance level was 0.508. Since the number of observations in the control group was 16 in the normality test performed with the data related to the first sub-problem, the Shapiro-Wilk analysis was performed again, and it was observed that the p-value indicated by the significance level was 0.135.

The results of the t-test for independent groups are shown in Table 4.

In the t-test conducted to determine whether there is a certain difference between the pre-test results of the students in the experimental group and the control group students, no certain difference was observed between the test score averages of the students in the experimental group ($\bar{X}$ experimental = 7.86) and the average test scores of the students in the control group (X control = 7.19), [t (35) = 0.613, p > 0.05]. In this case, it can be said that the students in the experimental and control groups before the application were at the same level.

Results regarding the second sub-problem

Since the number of observations in the experimental group was 21 in the normality test performed with the data related to the second sub-problem, the Shapiro-Wilk analysis was performed, and it was found that the p-value indicated by the significance level was 0.210. Since the number of observations in the control group was 16 in the normality test performed with the data related to the first sub-problem, the Shapiro-Wilk analysis was performed again, and it was observed that the p-value indicated by the significance level was 0.238.

The results of the t-test for independent groups are shown in Table 5.

Table 4. Test results regarding the pretest results of the groups.

Groups	N	$\bar{X}$	S	sd	t	p	Effect (d)
Experimental	21	7.86	3.719	35	0.613	0.544*	0.21
Control	16	7.19	2.613				

*p < 0.05 certain.

Table 5. Test results regarding the post-test scores of the groups.

Groups	N	$\bar{X}$	S	sd	t	p	Effect (d)
Experimental	21	15.71	4.064	35	2.141	0.039*	0.71
Control	16	12.44	5.253				

*p < 0.05 certain.

In the t-test conducted to determine whether there was a certain difference between the post-test results of the experimental group students and the control group students, a certain difference was observed between the

average test score of the students in the experimental group ($\bar{X}_{experimental}$ = 15.71) and the average test score of the students in the control group ($\bar{X}_{control}$ = 12.44), [$t_{(35)}$ = 2.141, p < 0.05]. When the test averages of the groups are examined, it is seen that the students in the experimental group to whom the RME method was applied were more successful in 8th-grade geometric objects than the students in the control group who were taught with the traditional method. The effect size of this success ($d = t.\sqrt{\frac{N1+N2}{N1.N2}}$) was calculated as 0.71. This shows that the difference in achievement between the students in the experimental group and the students in the control group is medium.

Results regarding the third sub-problem

Since the number of observations in the normality test conducted with the third sub-problem was 21, the Shapiro-Wilk analysis was performed, and it was found that the p-value indicated by the significance level was 0.241.

The results of the t-test for dependent groups are shown in Table 6.

As a result of the t-test for dependent groups conducted to determine whether there was a certain difference between the pretest and post-test scores applied to the students in the experimental group, a certain difference was observed between the average pretest score ($\bar{X}$ = 7.86) and the average post-test score after the application ($\bar{X}$ = 15.71) [$t_{(20)}$ = -18.402, p < 0.05]. The effect size calculated according to the test result (d = 4.02) shows that this difference is at a high level. In general, in terms of the value of d, a value above one is interpreted as very large, while 0.8 is referred to as large, 0.5 medium, and 0.2 small (little) effects (Taspınar, 2017). In this case, it can be interpreted that teaching with the realistic mathematics education method has a positive effect on the test success of the students in the said group.

Results regarding the fourth sub-problem

Since the number of observations in the normality test conducted for the fourth sub-problem was 16, the Shapiro-Wilk analysis was performed, and it was found that the p-value indicated by the significance level was 0.225.

The results of the t-test for dependent groups are shown in Table 7.

Table 6. Test results regarding the experimental group's pretest and post-test scores.

Measurement	N	$\bar{X}$	S	sd	t	p	Effect (d)
Pretest	21	7.86	3.719	20	-18.402	0.000*	-4.02
Post-test	21	15.71	4.064				

*p < 0.05 certain.

Table 7. T-test results for dependent groups regarding the control group's pretest and post-test scores.

Measurement	N	$\bar{X}$	S	sd	t	p	Effect (d)
Pretest	16	7.19	2.613	15	-5.375	0.000*	1.37
Post-test	16	12.44	5.253				

*p < 0.05 certain.

As a result of the t-test for dependent groups conducted to determine whether there was a certain difference between the pretest and post-test scores applied to the students in the control group, a certain difference was observed between the average pretest score ($\bar{X}$= 7.19) and the average post-test score after the application ($\bar{X}$= 12.44) [$t_{(15)}$ = -5.375, p < 0.05]. The effect size calculated according to the test result (d = 1.37) shows that this difference is at a high level. In this case, it can be interpreted that teaching with traditional methods applied in the aforementioned group had a certain effect on students' test success.

Results regarding the fifth sub-problem

After the activities were carried out with the students in the experimental group using the RME method, the students' opinions were taken by applying the semi-structured interview form in the Annex developed by the

researcher. Students' opinions taken with open-ended questions were examined and evaluated separately. These questions and the answers given by the students to these questions are presented below in tables.

Question 1: What do you think about the Realistic Mathematics Education method?

Participants' responses to Question 1 are presented in Table 8.

When Table 8 is examined, it is seen that most of the students found the RME method useful, that students could better understand the issue of the geometric object and interpret the questions better, that it was stated the RME method should be applied in other courses and other schools, that RME method provided ease of learning by ensuring active participation of students in the course, improved abstract thinking skills, and that it enabled the retention of the subjects learned.

A participant's (P_5) following thoughts on the RME method are remarkable:

> *P_5: I think it's great. In this way, I understand the subject better and interpret it better. I can visualize the subject and answer the questions asked. This should be applied to all educational institutions. Students should not be deprived of this method. In this way, better efficiency can be obtained from students. In short, this method is very good.*

When the opinions are examined, the participants thought that the RME method was useful.

Question 2: Do you like the use of the Realistic Mathematics Education method in your lessons? Why?

The responses of the participants in Question 2 are presented in Table 9.

When Table 9 is examined, it is seen that all participants were satisfied with the use of the RME method in their lessons. Most of the participants stated that the RME method helped them understand the subjects better. Some participants stated that the RME method provided them with convenience and that their lessons were more enjoyable.

A participant's (P_7) opinions about the application of the RME method in his/her lessons are as follows:

> *P_7: Yes, because with this method, I have a more enjoyable lesson and I learn more easily.*

When the opinions are examined, the participants are satisfied with the application of the RME method in their lessons.

Question 3: What are your thoughts on activities suitable for the RME method on geometric objects?

The responses of the participants in Question 3 are presented in Table 10.

When Table 10 is examined, most of the participants thought that their activities on geometric objects in accordance with the RME method were educative. In addition, the participants stated that these activities supported creative and concrete thinking, were also productive and fun, and improved their mathematics success.

A participant's (P_4) views on this issue are as follows:

> *P_4: When a question arises about geometric bodies, it is difficult to imagine the shape in the question in three dimensions. Thanks to this method, it becomes much easier to imagine.*

When the opinions are examined, the participants think that the activities of the RME method on geometric objects are educative.

Table 8. Responses to question 1 of the interview form.

Participants	Views
P_1	Usefulness Facilitation Ensuring Participation Retention
P_2	Usefulness Ensuring Participation
P_3	Usefulness
P_4	Commitment to mathematics Retention Demand to popularize
P_5	Usefulness Better understanding and interpretation Developing abstract thinking skills Demand to popularize
P_6	Usefulness
P_7	Better understanding and interpretation Facilitation
P_8	Better understanding and interpretation
P_9	Usefulness Demand to popularize

Table 9. Responses to question 2 of the interview form.

Participants	Approval status	Liked aspects
P_1	Yes	Providing better understanding Facilitation
P_2	Yes	Providing better understanding
P_3	Yes	Providing better understanding
P_4	Yes	Being enjoyable
P_5	Yes	Providing better understanding
P_6	Yes	Providing better understanding Facilitation
P_7	Yes	Being enjoyable Facilitation
P_8	Yes	Providing better understanding
P_9	Yes	Providing better understanding

Table 10. Responses to question 3 of the interview form.

Participants	Views
P_1	
P_2	Efficiency
P_3	Supporting creative and concrete thinking Providing improvement
P_4	Supporting creative and concrete thinking
P_5	Being educative
P_6	Being educative
P_7	Being enjoyable Being educative
P_8	Being educative
P_9	Providing improvement

Question 4: What are your opinions about the popularization of the lessons held using the RME method?

Participants' responses to Question 4 are presented in Table 11.

When Table 11 is examined, all the participants stated that the RME method should be popularized. As a reason, the participants stated that the RME method was educative, efficient, and fun, provided permanent learning, and caused them to like mathematics. One participant said that this method should be experienced by everyone.

When the opinions are examined, the participants think that the RME method should be popularized.

Question 5: Would you like to repeat the subject of geometric objects with a realistic mathematics education method? Or would you like another subject to be handled with this method?

Participants' responses to Question 5 are presented in Table 12.

When Table 12 is examined, all the participants stated that they would like to learn with the RME method again. A participant's (P_1) views on this issue are as follows:

> *P_1: Yes, because that way we are repeating the subject and having fun. If all subjects are handled like this, we will learn the subjects better.*

Participants stated that the RME method was fun and educative, as well as providing permanent learning.

Table 11. Responses to question 4 of the interview form.

Participants	Popularization status	Views
P_1	Should be popularized	Causing mathematics to be liked Being enjoyable Facilitation
P_2	Should be popularized	Providing retention
P_3	Should be popularized	Being educative
P_4	Should be popularized	Should be benefited by everyone
P_5	Should be popularized	Being educative
P_6	Should be popularized	Being educative
P_7	Should be popularized	Efficiency
P_8	Should be popularized	Providing retention
P_9	Should be popularized	Being educative

Table 12. Responses to question 5 of the interview form.

Participants	Request status	Views
P_1	I would like to.	Fun Educative
P_2	I would like to.	
P_3	I would like to.	Educative
P_4	I would like to.	
P_5	I would like to.	
P_6	I would like to.	
P_7	I would like to.	Fun
P_8	I would like to.	Fun Permanent
P_9	I would like to.	Permanent

Question 6: If the subject of geometric objects was taught with traditional methods without using the RME method, what would be the difference between your learning and that learning? Please explain.

Participants' responses to Question 6 are presented in Table 13.

When Table 13 was examined, the participants stated that they might have difficulties if the subject of geometric objects was explained with the traditional method, they might get bored in the lesson, they would have to memorize the formulas, and that they might fail with learning that was non-permanent in the long-term. On the other hand, the participants stated that by exploring the subject of geometric objects with the RME method, permanent learning was achieved, that they could visualize more easily and be successful in this subject.

Table 13. Responses to question 6 of the interview form.

Participants	Using the traditional method	Using the RME method
P_1	Memorization requirement Difficulty	Permanent Exploration
P_2	Memorization requirement Difficulty Being boring	
P_3	Difficulty	
P_4	Non-permanent	Permanent
P_5	Difficulty	Visualization
P_6		Educative
P_7	Failure	Educative Success
P_8	Long time	Permanent
P_9	Being boring	

A participant's (P_4) following thoughts on the RME method are remarkable:

> *P_4: The RME method not only enables us to learn the subject but also provides memorability. The traditional method is merely explaining the subject.*

As a result of the interviews, when the responses given by the students to the interview questions are examined in general, it can be said that all the students found the RME method useful, and they thought that they could improve themselves in a positive way by using this method in all lessons. The students generally stated that they had the opportunity to learn abstract concepts much better by having fun and exploring with the RME method. They also stated that this method and similar methods should be used in other subjects and other lessons and that these methods should be generalized in a way that everyone can benefit from them.

DISCUSSION

In this study, the effect of the teaching "8th grade geometric objects" using the RME method on the academic success of students. In this section, the results obtained using the findings of the research are mentioned.

For the purpose of the study, pre-test performed to understand level of knowledge of both experimental and control groups regarding geometrical objects. According to the analysis results, it is seen that there is no certain difference between the preliminary knowledge of both groups about geometric objects ($p = 0.544$).

This result shows that the experimental and control groups in which the research was conducted are homogeneous, in other words identical.

In the study, both groups educated with the subject of geometric objects and the mathematical achievement test was applied to both groups as a post-test after the education. According to the analysis results, it is seen that the average test scores of the experimental group in which teaching was carried out using the RME method increased more than the test score average of the control group where the teaching was carried out using the traditional method. Analysis results show that there is a statistically certain difference between the post-test mean scores of both groups ($t = 2.141$, $p = 0.039$).

It is expected that the scores of the post-test appiled to the groups in the research will increase compared to the scores of the pre-test. The difference between the scores of the experimental group students is greater than the difference between the scores of the control group students indicates that the RME method is a more effective teaching method in teaching the geometric object. The students in the control group, where traditional teaching was given, did not have much difficulty in solving the standardized questions because they learned the formulas in the subject by memorizing them as shown by the teacher. However, the students in this group had considerable difficulties in solving the questions asked in real life situations other than the standard questions that required different interpretation skills. This situation caused the increase in the pre-test and post-test scores of the students to be low. As the students in the experimental group discovered the formulas in the subject themselves, their interpretation skills also improved. Therefore, in addition to the standardized questions, the students in this group did not have much difficulty in solving the questions asked in real life situations, apart from the standard questions that required interpretation skills. This situation caused the increase in the pre-test and post-test scores of the students in the experimental group to be higher than the increase in the pre-test and post-test scores of the control group students.

In the study, the mathematical achievement test was applied as a retention test to both groups 8 weeks after the application. According to the analysis results, no statistically certain difference was found between the post-test scores and the retention test scores of the experimental group students ($p = 1.00$). This situation shows that the knowledge of the students in the experimental group about geometric objects, which they have learned by discovering, is permanent. A statistically certain difference was found between the post-test scores and retention test scores of the control group students ($p = 0.002$). This situation shows that the control group students' knowledge about geometric objects, which they learned through rote learning, is not permanent.

Two questions were asked about Geometric objects in the High School Transition Exam in 2019 which was also entered by the eighth grade students who constitute the sample of the study,. While 10 students (47.6%) in the experimental group gave correct answers to these two questions asked in this exam, 10 students (47.6%) answered one of the questions correctly and the other incorrectly, only 1 student (4.8%) answered both questions incorrectly. While only two (12.5%) of the students in the control group answered both questions correctly, 8 students (50%) answered one of the questions correctly and one incorrectly, and 6 students (37.5%) answered both questions incorrectly. Considering the low averages in mathematics achievement in the HSTE exams, which constitute the main problem of the study, the students in the experimental group, who learned the subject of Geometric Objects with the RME method, could answer the questions asked in the exam with a high rate, clearly showed the positive effect of the RME method on

mathematics achievement.

It is clearly shown with this study conducted in an institution that enrolled students with an exam and had students with equal academic success that RME method certainly increases the mathematics achievement of the students. This situation shows that the good or bad academic achievement of the students does not change the positive effect of RME method on student achievement. In addition, when the literature is examined, it is seen that the RME method has positive effects on students' mathematics achievement and mathematical thinking skills in all studies, although the studies are conducted in different subjects and units at all levels of education from 3rd grade to 12th grade. This situation shows that the RME method is applicable to all grade levels and all math subjects at all grade levels.

In the study, in the semi-structured interviews with the experimental group students, all of the students stated that they found the RME method useful and that the use of this method in all lessons would improve them positively, suggesting that the applied method achieved the targeted effects on the students. During the interviews with the students, it was stated that the information learned in the lessons taught by applying the RME method is more meaningful for them, therefore the information is more permanent in their minds, thanks to this method, they have the opportunity to be more active and participatory in the lessons, they can better understand the abstract information in mathematical concepts and the fact that they say that their creative thinking skills have developed shows that the RME method serves the general purposes of National Education. The students expressing that the lessons taught with the RME method are more enjoyable and that they expect the next lesson to be taught with this method with curiosity and interest and that the use of this method in lessons is more effective is a proof that the RME method makes students more active in lessons and improves students' sense of curiosity. Students stated that this method should be used by everyone, therefore, the use of the RME method should be widespread in Turkey, and that the lessons they feel boring when they are taught with traditional methods, they feel that the lesson takes longer, they have difficulty in learning the information and that they fail because the information is not permanent for them. These statements are also an indicator that RME method should be included in the National Education cirruculum.

The positive effect of the RME method on teaching the subject of eighth grade geometric objects to students is clearly seen in the results of the research. The answers given by the students in the interviews also support this situation. Students saw that mathematical problems with the RME method were similar to many problems they encounter in daily life and they understood much better what mathematics does in our daily life.

Student-centered teaching methods are generally used in today's National Education programs. Since the RME method is a student-centered teaching method, it can be easily integrated into existing education programs. By providing teachers with in-service training on this method, the method can be spread in Turkey. The question types in the central exams conducted in Turkey since 2017 also clearly show the importance of using RME and student-centered methods similar to this method. When the number of correct answer averages of our students in mathematics in the central exams held after 2017 are examined, it is clearly seen that the current education programs are insufficient. It is clear that this failure will continue unless the necessary changes are made in the curriculum. It is a result of the methods applied in the current curriculum that students think mathematics is a difficult lesson and accordingly students see mathematics as a boring and unbearable lesson. As in the results of this study, it is seen that student-centered applications such as RME will improve students' thoughts about mathematics in a positive way, as well as many studies in the literature.

In this study, the effects of teaching geometric objects subject to 8th grade students with the RME method on students were tried to be determined. As a result, it has been determined that the RME method is very effective in teaching the specified subject, it enables students to acquire permanent information as they learn by discovering the information themselves, and enables students to learn by having fun during the activities. This study conducted with students at an equivalent level in an school that accepts students with an exam and the results show how effective and efficient the RME method is for students at all levels. While updating the next curriculum, Ministiry of Education should definitely include the RME method in the program, taking into account the results obtained from this and similar studies.

SUGGESTIONS

Suggestions that can be given for future similar studies are listed below:

- Similar studies can be conducted with larger groups by increasing the number of students with whom the research is conducted.
- Since there are few studies on geometry subjects in the literature, similar studies can be done on geometry subjects with different samples.
- Studies on different dimensions can be conducted with prospective teachers on the effect of RME method on mathematics teaching.
- By applying the long-term RME method to one or more students, monitoring the progress of the students over the years and studies on the degrees of these students in

central exams can be done.
- Similar studies can be carried out with larger groups in schools that accept students with central examination as in this study.

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