THE EFFECTS OF REALISTIC MATHEMATICS EDUCATION ON STUDENTS' ACHIEVEMENTS AND ATTITUDES IN FIFTH GRADES MATHEMATICS COURSES

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THE EFFECTS OF REALISTIC MATHEMATICS EDUCATION ON STUDENTS' ACHIEVEMENTS AND ATTITUDES IN FIFTH GRADES MATHEMATICS COURSES[1]

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Abstract

The aim of this research is to analyse the effects of realistic mathematics education on student achievement and attitudes towards mathematics on the unit 'numbers and operations' for the 5th grades. The Effectiveness of Academic Achievement, Attitude and Mathematical Self-Report of Students in Teaching with Realistic Mathematics Education is the experimental direction of the research. This aspect of the research was carried out with the pretest-posttest control group pattern.For this reason, two classes were randomly identified. After seeing that the groups were equivalent using the Achievement test of Group Equivalency, Learning Area Achievement Test and Scale of Attitudes towards Mathematics were applied to both groups. After the application was conducted, the experimental group was taught the unit using the Realistic Mathematics Education activities for 7 weeks. On the other hand, the control group was taught the topic using the activities suggested by the Ministry of Education. Learning Area Achievement Test and Scale of Attitudes towards Mathematics were conducted again as post-tests, and the results were evaluated by comparing them with the pre-test results. After this comparison, it was seen that the Academic Achievement and the attitudes of students who were taught in accordance with the Realistic Mathematics Education was higher than the students who were taught by classical methods.

Keywords: realistic mathematics education, mathematics attitude Scale, academic achievement test, maths education.

1. Introduction

Mathematics is a phenomenon that the humankind has used directly or indirectly since ancient times. From the simplest daily life situations to the most complicated problems, all solutions have been found thanks to mathematics. This proves how crucial mathematics is for societies (Altaylı, 2012). The purpose of mathematics education is; to help individuals acquire the knowledge and skills that would enable them to grow as individuals that can think critically by reasoning on issues that may occur in their daily lives, establishing bonds between processes and mathematical concepts (Yazıcı, 2004). Accordingly, in mathematics curriculum; it is deemed important to train individuals who can use mathematics in daily life, resolve problems, share their resolutions and thoughts, take part in teamwork, be confident in mathematics and develop positive attitude towards mathematics (Altaylı, 2012).

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[1] This study is based on a part of the doctoral thesis entitled "The Effects of Realistic Mathematics Education on Students' Achievements, Attitudes and Mathematics Self-reporting in Fifth Grades Mathematics Lessons."

Realistic Mathematics Education (RME) is a mathematics education approach, developed by Dutch mathematician and educator Hans Freudenthal in the Freudenthal Institute of the University of Utrecht in the Netherlands (Çakır, 2013). Freudenthal states that mathematics started in history with real life problems, the real life is mathematicised, and then the system is formalized; therefore it is anti-didactic to teach formal mathematics knowledge first and apply later. According to Freudenthal; "Mathematics, for the child, starts with sense-making, and sense-making should be principal in all phases to conduct real mathematics." According to him, mathematics is a human activity, it is not discovered, it is invented (Altun, 2006).

Students are enabled to reach mathematical concepts by thinking on daily life problems, with the RME method, discussing probable solutions and developing rational solution offers; therefore structure these concepts in their minds. It is considered that the mathematics course, which is a source of concern, would thus become a mathematics activity; helping students develop a positive approach towards the mathematics lesson and therefore increase their success in mathematics. In RME, problems presented to students can come from the real world but also from the fantasy world of fairy tales, or the formal world of mathematics, as long as the problems are experientially real in the students' mind. Freudenthal took over Treffers' distinction of horizontal and vertical mathematization. In horizontal mathematization, the students use mathematical tools to organize and solve problems based on real life situations. It involves going from the world of life into that of symbols. Vertical mathematization refers to the process of organization within the mathematical system resulting in shortcuts by using connections between concepts and strategies.

Turkish primary mathematics curriculum has many characteristics: its learning areas supported by skills, understanding and attitudes; there is a spiral approach for each learning areas; mainly based on the constructivist approach; enriched with teaching activities and multiple assessment methods and techniques. According to curriculum, students shall develop more creative and constructive attitudes as they become successful at the problem solving process and as they feel that their own ways for solving problems are appreciated, since their confidence about their mathematical abilities shall increase. When they learn to communicate by using mathematics they shall restructure what they learnt and by this way they shall develop their high level thinking abilities. The students shall realize that mathematics does not only consist of rules and memorizing but that it is an entertaining, meaningful and logical profession as in RME.

1.1. Problem Statement

This study examines the effect of Realistic Mathematics Education in the 2014-2015 academic year, which is the first year in which the 5th grade is accepted as middle school. The problem sentences is "Does teaching the Natural Numbers and Operations subject in fifth grade mathematics courses with the Realistic Mathematics Education Method have an effect on students' success and their attitude towards mathematics courses?"

1.2. Sub problems

1. Is there a significant difference between the experimental group and the control group in terms of students' academic success?
2. Is there a significant difference between the experimental group and the control group in terms of students' attitudes towards mathematics?

2. Method

2.1. Model

The experimental part of the research is comprised of the effects of teaching the Natural Numbers and Operations with Natural Numbers subject, the first subject of the primary school fifth grade, by the Realistic Education Method on students' academic success, attitudes and mathematics self-reporting. This part of the research is conducted by the pre-test-post-test control group design. Of two equal classes, one group is randomly assigned to be the experimental group and the other the control group; pre-test and post-test measurements were carried out in both groups.

Experimental Design of the Study: Pretest - Pattern with Control Group

Groups	Pre-tests	Processes	Post-tests
Experiment	Maths attitude scale, Learning field success test	Activities Prepared for Realistic Mathematics Education	Maths attitude scale, Learning field success test
Control	Maths attitude scale, Learning field success test	2014-2015 Education Year Primary Mathematics Curriculum	Maths attitude scale, Learning field success test

2.2 Research Group

The research group of this study is comprised of 45 fifth grade students, studying in Antalya, Muratpaşa, as of 2014-2015 academic year. One of the two selected classes is randomly assigned as the experimental group (n=23), and the other as the control group (n=22). Before conducting the research, to ensure the equivalence between the experiment and control groups, the academic grade averages of the students in mathematics in 2013-2014 academic year were identified by their average written exam grades. The arithmetic mean of the collected scores was calculated and tested through unrelated samples t-test.

2.3. Data Collection Tools

2.3.1. Group Equivalence Success Test

In order to develop the Primary School Fourth Grade Group Equivalence Success Test (GEST), the fourth grade mathematics curriculum was examined; the program was classified according to its gains. A multiple choice test of 31 questions was prepared with at least one question for each gain.

The 31-question multiple-choice test form that covers all the objectives was applied to a total of 228 fifth grade students, except for the research group. The difficulty index and discrimination power index were calculated by Microsoft Excel and Statistica software. While selecting the articles, the articles of mid-level difficulty and the articles with discrimination power higher than 0.25 were chosen (Tekin, 1993; Turgut, 1984). The percentages and frequency values of right answers were compared to the critical value of 70% as analysing accessibility regarding gains, (Büyüköztürk, 2010). Tetrachoric correlation coefficients were used to examine any pre-existing relationship between behaviours. According to these criteria, the better one between two articles measuring the same behaviours was selected to constitute the Group Equivalence Success Test final questionnaire. As a result of the analyses made, the average difficulty of the articles was calculated to be 0.49 and the KR20 dependability coefficient was 0.75. After having its final

form and dependability tests, the conclusion that the Group Equivalence Success Test was able to measure the predefined gains and had high dependability was reached. The developed test was used to measure group equivalence and its application to the research group was carried out in the third week of September in 2014-2015 academic year.

2.3.2. Learning Field Success Test (LFST)

In order to follow the students' success process and to develop the success test for the first subject of primary school fifth grade mathematics course, which is Natural Numbers and Operations in Natural Numbers, firstly the fifth grade mathematics curriculum was examined and the gains of the program were identified. In parallel with the identified gains, a table of specifications was prepared and at least two questions per gain were written. The question articles were structured with four choices, bearing the developmental features of fifth grade students in mind. For scope validity of the measurement tool, expert views were taken on whether the article had the quality to measure the gains expected to be measured, the compliance with spelling rules, the meaning and scope suitability of the articles, the suitability of distractors to the article, the suitability and the scientific validity of the right answer to the article, and the technical features of the test and the articles. In accordance with the views from experts working on measurement and assessment in education, as well as in primary school mathematics education, necessary revisions on articles were made. A 50-question multiple choice success test that covers all the gains was applied to a total of 102 sixth grade students outside the research group that had already taken these subjects. The difficulty and discrimination power indexes of the test articles were calculated by Microsoft Excel and Statistica software. Articles of mid-level difficulty with a discrimination power higher than 0.25 were selected (Tekin, 1993; Turgut, 1984). In analysing accessibility in terms of acquisitions, the percentages and frequency values of right answers were compared to the critical value of 70%. To examine any pre-existing relationship between behaviours, tetrachoric correlation coefficients were used. According to these criteria, the best between two articles measuring the same behaviours was selected to constitute the Learning Field Success Test (LFST) of 25 articles. As a result of the analyses made, the average difficulty of articles was calculated to be 0.57 and the KR20 dependability coefficient was 0.74. Having had its final form and dependability tests, it was concluded that the 25-article Learning Field Success Test was able to measure the predefined acquisitions and had a high level of dependability.

2.3.3. Mathematics Attitude Scale (MAS)

In order to identify students' attitude level towards mathematics, a Likert-type scale on the subject was used. In defining the scale, firstly a literature review was conducted and the scales already used for this purpose were examined. Since there have been a number of studies on this subject in the academic literature, an attitude scale which has already passed the dependability and validity studies was used. The attitude scales found by the researcher were presented to the views of curriculum development experts, education measurement and evaluation experts and three mathematics teachers working in schools of the Ministry of National Education. After assessments from the experts and the teachers on grammar rules, question writing principles, suitability to the students' level, suitability to mathematics subject matter etc. were received, as per suggestions and views, the "Attitude Scale Towards Mathematics Courses (MAS)" developed by Baykul (1990) was selected to be used in this research. This scale was developed for the study entitled as "Changes on Attitudes towards Mathematics and Science Lessons from Primary School Fifth Grade to the Final Year of High Schools and Equivalency Programs and Some Factors Considered to be related to Success in Student Selection Exams" and applied to 1056 persons. The scale is comprised of

30 articles. In the tool, the responders were given a five-grade scale. The scale explained by a single factor has 15 positive (1, 2, 5, 6, 10, 11, 12, 16, 17, 18, 23, 25, 26, 27) and 15 negative (3, 4, 7, 8, 9, 13, 14, 15, 19, 20, 21, 22, 24, 28, 29, 30) factors. The factor analysis on the factor structure of the scale indicates that the variance explained by a single factor is 56%. The alpha internal consistency coefficient of the scores obtained by the scale was found to be 0.96. The highest possible score to be obtained in the scale was 150, while the lowest score was 50. A high score to be obtained in the scale indicates a student's positive attitude towards mathematics.

2.4 Obtaining data

The research was conducted in the 2014-2015 academic year, in a Secondary School in classes 5/D and 5/E, Muratpaşa Antalya, after necessary permissions had been granted. With a random selection, 5/E class was assigned to be the experiment group, and 5/D class was assigned to be the control group. Before the experiment process, the Mathematics Attitude Scale (MAS) and the Learning Field Success Test (LFST) were applied both to the experiment and the control groups.

During the process, the performance applications on mathematics courses were only conducted at school for both groups. To ensure this, the experiment group continued their studies at the mathematics learning centre within the school after each subject. In both classes assigned as the experiment and control groups, the lecturing was conducted by a teacher regularly trained by the researcher. Courses related to these processes were conducted in the control group according to the current Mathematics curriculum based on the general teaching approach of the academic year 2014-2015. As for the teaching material, the research collaborated with the Freudenthal Institute working on realistic mathematics education in the Netherlands before the research, the literature on the subject was reviewed and the activities were prepared. The activities were given their final form after receiving the field experts' views, and the activities and the syllabus prepared by the teacher were used. The class activities for the control group were prepared according to the teachers' guidebook. In the experiment group, the activities prepared according to the Realistic Mathematics Teaching approach were applied. After the experiment process in the experiment and control groups, the MAS and the LFST were applied as post-tests.

2.5 Data analysis

Data was analysed through unrelated samples t-test to define whether the students' pre-test and post-test scores for the Learning Field Success Test and Mathematics Attitude Test indicate a significant difference per groups. Related sample t-test was applied to define whether there was a significant difference between the pre-test and post-test scores of the experiment and control groups within themselves. While Arithmetic means were compared the significance level was questioned and the effect size was also calculated. The Cohen's d formula is widely used in calculating the effect size for the statistical methods (Single group t-test, t-test for related samples, t-test for unrelated samples, etc.) where the difference between the two group means is calculated.

The normality hypothesis has been tested and found to have been provided before analyzing data. A significance level of 0.05 was considered in interpreting for all results.

3. Findings

In order to define whether the pre-test and post-test scores of the students' Learning Field Success Test and Mathematics Attitude Scale vary per groups, the data was analysed through independent t-test. Meanwhile, to define whether there is a significant difference between

pre-test and post-test scores within the experiment and control groups, paired sample t-test was conducted.

3.1 Findings on the First Sub-Problem of the Research

The first sub-problem of the research is "Is there a significant difference between the experimental group that the fifth grade mathematics course Natural Numbers and Operations subject is taught by lesson activities prepared according to the Realistic Mathematics Education and the control group that the subject is taught according to the present curricular practice, per students' academic success?" Accordingly, to define whether the students' pre-test and post-test scores for the Learning Field Success Test indicate a significant difference per groups, the data was analysed through unrelated samples t-test. The results of this analysis were presented in Table 1 and Table 2.

Table 1. *The comparison of Pre-Test Academic Success Scores between the Experiment and Control Groups*

Group	N	X	S	sd	t	p
Experiment	23	14.43	4.42	43	-0.741	0.462
Control	22	15.36	3.96			

As a result of the conducted t-test, since the significance value of the pre-test academic success scores is higher than 0.05 (p=0.462 >0.05), there has been no significant difference between the academic success scores of the groups.

Table 2. *The comparison of the Post-Test Academic Success Scores between the Experiment and Control Groups*

Group	N	X	S	sd	t	p
Experiment	23	18.34	3.44	43	2.052	0.046
Control	22	16	4.20			

As a result of the conducted t-test, since the significance value of the post-test academic success scores is lower than 0.05 (p=0.046 < 0.05), there has been a significant difference between the academic success scores of the two groups. The arithmetic mean of the academic success post-test scores of the experiment group ($\bar{X}$=18,34), is higher than the arithmetic mean of the control group ($\bar{X}$=16). According to the effect size correlation (0.30) per this calculated Cohen d value, the applied program has a "minor" effect size for this variable. As a result, it is concluded that the academic success of the groups has differentiated in favour of the experiment group, to which the Realistic Mathematics Education was given.

After it had been established that the experiment group was more successful according to the post-test scores of the experiment and the control groups after the experimental procedure applied, the relationship between the pre-test and post-scores of experiment and control groups within themselves was sought for. To define whether there was a significant difference between the pre-test and post-test scores of the experiment and control groups within themselves, a related samples t-test was applied. The results of the analysis were given in Table 3 and Table 4.

Table 3. *The Comparison of the Pre-Test and Post-Test Academic Success Scores in the Experiment Group*

Group	N	X	S	sd	t	p
Test (pre)	23	14.43	4.42	22	-8.324	0.000
Test (post)	23	18.35	3.44			

As a result of the conducted t-test, since the significance value of the pre-test and post-test academic success scores is lower than 0.05 (p=0.000 < 0.05), there has been a significant difference between the group's academic success scores. The arithmetic mean of the experiment group's academic success post-test scores ($\bar{X}$=18,35) is higher than the pre-test arithmetic mean ($\bar{X}$=14,43). Equally, the calculated Cohen d value shows that the difference between the means is approximately 0.98 standard deviation. According to the effect size (0.44) per this calculated Cohen d value, the applied program has an "average" effect size for this variable. As a result, it is concluded that the academic success of the experiment group has differentiated significantly in favour of the post-test scores.

Table 4. *The Comparison of the Pre-Test and Post-Test Academic Success Scores in the Control Group*

Group	N	X	S	sd	t	p
Test (pre)	22	15.36	3.95	21	-2.536	0.019
Test (post)	22	16	4.20			

As a result of the conducted t-test, since the significance value of the pre-test and post-test academic success scores in the control group is lower than 0.05 (p=0.019 < 0.05), there has been a significant difference between the group's academic success scores. The arithmetic mean of the control group's academic success post-test scores ($\bar{X}$=16) is, though slightly, higher than the pre-test arithmetic mean ($\bar{X}$=15.36). According to the effect size (0.08) per this calculated Cohen d value, the applied program has a "minor" effect size for this variable. As a result, it concluded that the academic success of the control group has differentiated significantly in favour of the post-test scores. Considering the findings in Table 4.3 and Table 4.4, the significance level between the pre-test and post-test means of the experiment group, to which realistic mathematics education was given, is higher than that of the control group.

3.2 Findings on the Second Sub-Problem of the Research

The second sub-problem of the research is "Is there a significant difference between the experimental group that the fifth grade mathematics lesson Natural Numbers and Operations subject is taught by lesson activities prepared according to the Realistic Mathematics Education and the control group that such methods are not used, per students' attitudes toward mathematics lessons?" Accordingly, to define whether the students' pre-test and post-test scores for the Mathematics Attitude Scale indicate a significant difference per groups, the data was analysed through unrelated samples t-test. The finding of the analysis was given in Table 5 and Table 6.

Table 5. *The comparison of Pre-Test Attitude Scores between the Experiment and Control Groups*

Group	N	X	S	sd	t	p
Experiment	23	3.13	0.33	43	0.861	0.394
Control	22	3.02	0.50			

As a result of the conducted t-test, since the significance value of the pre-test attitude scores is higher than 0.05 (p=0.394 >0.05), there has been no significant difference between the attitude scores of the groups.

Table 6. *The comparison of the Post-Test Attitude Scores between the Experiment and Control Groups*

Group	N	X	S	sd	t	p
Experiment	23	3.47	0.49	43	4.205	0.000
Control	22	2.91	0.39			

As a result of the conducted t-test, since the significance value of the post-test attitude scores is lower than 0.05 (p=0.000 < 0.05), there has been a significant difference between the attitude scores of the two groups. The arithmetic mean of the attitude post-test scores of the experiment group ($\bar{X}$=3,47) is higher than the arithmetic mean of the control group ($\bar{X}$=2,91). Equally, the calculated Cohen d value shows that the difference between means is approximately 1.26 standard deviation. According to the effect size correlation (0.53) per this calculated Cohen d value, the applied program has an "average" effect size for this variable. As a result, it can be concluded that the attitude of the groups towards mathematics has differentiated in favour of the experiment group, to which the Realistic Mathematics Education was given. After it had been established that the experiment group was more successful according to the attitude scale post-test scores of the experiment and the control groups after the experimental procedure applied, the relationship between the pre-test and post-scores of the experiment and control groups within themselves was sought for. To define whether there was a significant difference between the pre-test and post-test scores of the experiment and control groups within themselves, a related samples t-test was applied. The results of the analysis were given in Table 7 and Table 8.

Table 7. *The Comparison of the Pre-Test and Post-Test Attitude Scores in the Experiment Group*

Group	N	X	S	sd	t	p
Test (pre)	23	3.13	0.33	22	-3.687	0.001
Test (post)	23	3.47	0.49			

As a result of the conducted t-test, since the significance value of the pre-test and post-test attitude scores is lower than 0.05 (p=0.001 < 0.05), there has been a significant difference between the group's average attitude scores. The arithmetic mean of the experiment group's attitude scale post-test scores ($\bar{X}$=3,47) is higher than the pre-test arithmetic mean ($\bar{X}$=3,13).

Equally, the calculated Cohen d value shows that the difference between the means is approximately 0.81 standard deviation. According to the effect size correlation (0.37) per this calculated Cohen d value, the applied program has a "minor" effect size for this variable. As a result, it can be concluded that the attitude towards mathematics of the experiment group has differentiated significantly in favour of the post-test scores.

Table 8. *The Comparison of the Pre-Test and Post-Test Attitude Scores in the Control Group*

Group	N	X	S	sd	t	p
Test (pre)	22	3.02	0.50	21	0.991	0.333
Test (post)	22	2.91	0.39			

As a result of the conducted t-test, since the significance value of the pre-test and post-test attitude scores in the control group is higher than 0.05 (p=0.333 < 0.05), there has not been a significant difference between the group's average attitude scores.

Considering the findings presented in Table 4.7 and Table 4.8, the significance level between the pre-test and post-test means of the experiment group, to which realistic mathematics education was given, is higher than that of the control group.

4. Results

According to the results taken from the research findings, it has been detected that teaching the fifth grade "Natural Numbers and Operations in Natural Numbers" subject by activities prepared in line with Realistic Mathematics Education principles is more effective on student success, compared to the current curriculum. In order to measure the effectiveness of RME-based teaching on student success, pre-tests and post-tests were applied to the experiment and control groups. With no significant difference according to the pre-test results, the post-tests results of the two groups display a significant difference in favour of the experiment group. The post-tests applied to both groups indicating a significant difference in favour of the experiment group shows that the RME-supported education is more effective. It was detected that in the groups' own comparisons, there were significant differences in favour of the post-tests, the significance level between the average pre-test and post-test scores in the experiment group, to which RME was applied, was higher to that of the control group. These results are in compliance with the findings of many studies examining the effects of RME-supported teaching over student success. According to the research findings of Kurt (2015), Kaylak (2014), Nama Aydın (2014), Çakır (2013), Ersoy (2013), Uygur (2012) and Arseven (2010); the learning activities structured with the RME approach are more effective on students' academic success compared to the activities in the Ministry of National Education primary school mathematics teaching curriculum. It may be said that, it effects academic success in general and mathematics success in particular. There are several key variables that affect the definition of teaching procedures' nature, such as teaching methods and strategies; along with individual difference variables such as epistemological beliefs, self-confidence and motivation (Gravemeijer & Terwel, 2000). Among these variables, the probable effects of teaching methods used in mathematics courses have been a subject for many studies since they have a high potential of effecting both quality and quantity of teaching/learning procedures (Nama Aydın, 2014). Especially when the currently applied structuring approach and the RME approach are compared; both appear to be effective in increasing teaching quality, facilitating teaching and creating teaching integrity. Meanwhile, the RME, being natural and problem solving-driven, facilitates acquiring mathematical knowledge and encourages students to be creative. On the other hand, the teaching activities of the structuring approach are deemed not to be suitable for individual work. It is considered that the activity driven teaching curriculum in our country could be more effective when it is used as a group activity (De Corte, 2004; Gravemeijer & Terwel, 2000; Tunalı, 2010).

According to the results taken from the research findings, it has been detected that teaching the fifth grade "Natural Numbers and Operations in Natural Numbers" subject by activities prepared in line with Realistic Mathematics Education principles is more effective on student attitude towards mathematics, compared to the current curriculum. In order to measure the effectiveness of RME-based teaching on student attitude towards mathematics, pre-tests and post-tests were applied to the experiment and control groups. The post-tests of the two groups with no significant difference according to the pre-test results display a significant difference in favour of the experiment group. While the post-tests applied to both groups indicating a significant difference in favour of the experiment group shows that the RME-based education is more effective, also the relationship between the pre-test and post-test results of each group within itself was examined. It was detected that in groups' own comparisons, there were significant differences in favour of the post-tests in the experiment group, while there was no difference in the control group. These results are in compliance with the findings of many studies examining the effects of RME-supported teaching over student attitude towards lessons. According to the research findings of Nama Aydın (2014),

Ersoy (2013), Arseven (2010), Fauzan (2002), Zulkardi (2002), Gravemeijer and Terwel (2000), the learning activities structured with the RME approach are more effective on students' attitudes towards mathematics, compared to the activities in the Ministry of National Education primary school mathematics teaching curriculum. Meanwhile, there are also some studies claiming that the RME does not have an effect on attitude (Kaylak, 2014; Bıldırcın, 2012). As it was presented above, in the academic literature, it has been detected that the RME not only significantly effects success in mathematics or learning some subjects of mathematics, but it is also effective on some emotional features, such as developing positive attitudes towards mathematics. These significant and positive effects may be considered to be associated with the approach that suggests the mathematics learning processes should be in relation with real life situations (Nama Aydın, 2014). Accordingly, the key principle of the RME developed by Hans Freudenthal in the 1970's is that; for mathematics to have a practical value and become a significant and effective part of the human life, it should be in relation with the real life, close to children and the society (Bıldırcın, 2012; Üzel, 2007).

5. Suggestions

The findings of the research suggest that the activities prepared in line with the Realistic Mathematics Education for the fifth grade mathematics lessons affect students' success and attitudes towards mathematics positively. Therefore, to increase the levels of these variables, while teaching abstract subjects in mathematics, the RME-supported activities may be prepared and the class environment may be arranged accordingly. For these activities to be implemented properly and effectively, in in-service training programs for teachers, the features, principles of the RME may be presented, along with tangible RME-driven examples. In the Realistic Mathematics Education, the teacher's role in class is more crucial, compared to the traditional class. In this regard, the RME is actually really close to the new Ministry of National Education mathematics curriculum based on structuring approach. Teachers need to work more outside the class, meanwhile, inside the class they should be more careful to help students reflect and follow their improvement. For this reason, in teacher training programmes, the RME approach and its applications should be included. Therefore, prospective teachers getting to know the RME approach in pre-service trainings may implement this approach in-service more easily. It is striking that the RME-based activities do not only increase the success level of students on the Natural Numbers and Operations subject, but equally emotional learning products developed in time, such as the attitude positively. It should be taken into account that students' attitudes towards mathematics start to become negative once abstract and challenging matters are included in the content, since they cannot establish bonds between these subjects and the real life. It can be expressed that teaching abstract subjects in mathematics with RME-based activities is important as it has the potential to change this negative attitude into positive. Even though the National Ministry of Education has made changes in education programs in our country; studies conducted the outcomes of exams such as PISA, TIMSS, and the Mathematics Olympiad revealed that the deeply-rooted problems in mathematics education still persist. To resolve this, the results of this research show that the Ministry may benefit from the Realistic Mathematics Education in its curriculum development studies. In the "teaching-learning processes" dimension, considered to be the most important dimension of curriculum development, the Realistic Mathematics Education principles may be used in preparing learning activities. For the RME approach to be implemented effectively, teachers should be supported regarding teaching materials and resource diversity. Students' access to raw data and rich material that would enable them to rediscover mathematics as if they were scientists should be provided. In classes where RME is applied, teachers should use alternative evaluation methods for

measuring students' comprehension, such as performance evaluation that enables process assessment, problem solving, keeping diaries, observation and interview; apart from multiple choice tests. Establishing bonds between mathematics and real life situations helps reducing prejudices against mathematics, and shows that mathematics is actually at the centre of life. Students reach enduring knowledge by discovering it themselves, rather than taking it granted. That is how they learn to produce knowledge. Therefore, teachers need to associate mathematics with real life situations as possible, to increase students' motivation and make them like mathematics. Similarly, teachers need to consider the "from close to far" principle and give examples from students' immediate environment, to create better results in effective learning.

In the research, the RME-based activities were used in the teaching of the secondary school fifth-grade Natural Numbers and Operations subject. While this subject is an important subject that students have trouble in learning, they have other challenging subjects in mathematics, in that particular grade and also in superior levels (Problem Solving, Probability, and Complex Numbers). Therefore, in future research, investigating RME-based activities in these and similar abstract subjects in a comparative approach may create a more elaborate examination of the findings of this research. In the study, the effectiveness of teaching the Natural Numbers and Operations subjects with RME-based activities was examined by a pre-test post-test control group design. This particular design is highly valid since it enables causality and also allows intervention in the experiment group. However, its generalizability is limited, like in any other experiment design. Hence, surveying with higher samples (n > 1000) and in different levels (primary school, secondary school, high school) may help contribute to overcoming these limits. By providing teachers with in-service training, the changes of RME in teachers' and prospective teachers' learning-teaching philosophy and teaching methods, their capability of developing RME-based activities and course plans may be researched. Within the scope of this research, teacher and student feedbacks on RME-based teaching procedures were not included. In future research, teacher and student feedbacks may be included. Conducted studies generally cover a few subjects and are short-term. Therefore, the Ministry of National Education may conduct long-term and in-depth research on this method by designating pilot schools and examine the effects of this method on student success through nationwide exams.

References

Altaylı, D. (2012). *Gerçekçi matematik eğitiminin oran orantı konusunun öğretimi ve orantısal akıl yürütme becerilerinin geliştirilmesine etkisi.* Master's Thesis, Atatürk University, Institute of Education Sciences, Erzurum.

Altun, M. (2006). Matematik öğretiminde gelişmeler. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi, 19*(2), 223-238.

Arseven, A. (2010). *Gerçekçi matematik öğretiminin bilişsel ve duyuşsal öğrenme ürünlerine etkisi.* Doctoral dissertation, Hacettepe University, Institute of Social Sciences, Ankara.

Baykul, Y. (1990*). İlkokul beşinci sınıftan lise ve dengi okulların son sınıflarına kadar matematik ve fen derslerine karşı tutumda görülen değişmeler ve öğrenci seçme sınavındaki başarı ile ilişkili olduğu düşünülen bazı faktörler.* Ankara: ÖSYM Yayınları.

Bıldırcın, V. (2012). *Gerçekçi matematik eğitimi (GME) yaklaşımının ilköğretim beşinci sınıflarda uzunluk alan ve hacim kavramlarının öğretimine etkisi.* Master's Thesis, Ahi Evran University, Institute of Social Sciences, Kırşehir.

Büyüköztürk, Ş. (2010). *Sosyal bilimler için veri analizi el kitabı.* Ankara: Pegem.

Cohen, J. (1988). *Statistical power analysis for he behavioral sciences.* Hillsdale, NJ: Earlbaum Associates.

Çakır, P. (2013). *Gerçekçi matematik eğitimi yaklaşımının ilköğretim 4. sınıf öğrencilerinin erişilerine ve motivasyonlarına etkisi.* Master's Thesis, Dokuz Eylül University, Institute of Education Sciences, İzmir.

De Corte, E. (2004). Mainstreams and perspectives in research on learning (mathematics) from instructions. *Applied Psychology, 53*(2), 279-310.

Ersoy, E. (2013). *Gerçekçi matematik eğitimi destekli öğretim yönteminin 7. sınıf olasılık ve istatistik kazanımlarının öğretiminde öğrenci başarısına etkisi.* Master's Thesis, Sakarya University, Institute of Education Sciences, Sakarya.

Fauzan, A. (2002). *Applying realistic mathematics education (RME) in teaching geometry in Endonesian primary schools.* Doctoral dissertation, University of Twente, Enschede.

Gravemeijer, K., & Terwel, J. (2000). Hans freudenthal: A mathematician on didactics and curriculum theory. *J. Curriculum Studies, 32*(6), 777- 796.

Kaylak, S. (2014). *Gerçekçi matematik eğitimine dayalı ders etkinliklerinin öğrenci başarısına etkisi.* Master's Thesis, Necmettin Erbakan University, Institute of Education Sciences, Konya.

Kurt, E. S. (2015). *Gerçekçi matematik eğitiminin uzunluk ölçme konusunda başarı ve kalıcılığa etkisi.* Master's Thesis, Ondokuz Mayıs University, Institute of Education Sciences, Samsun.

Nama Aydın, G. (2014). *Gerçekçi matematik eğitiminin ilkokul 3. sınıf öğrencilerine kesirlerin öğretiminde başarıya kalıcılığa ve tutuma etkisi.* Master's Thesis, Abant İzzet Baysal University, Institute of Education Sciences, Bolu.

Tekin, H. (1993). *Eğitimde ölçme ve değerlendirme.* Ankara: Yargı.

Tunalı, Ö.K. (2010). *Açı kavramının gerçekçi matematik öğretimi ve yapılandırmacı kurama göre öğretiminin karşılaştırılması.* Master's Thesis, Uludağ University Institute of Social Sciences, Bursa.

Turgut, F. (1984). *Eğitimde ölçme ve değerlendirme metotları.* Ankara: Saydam.

Uygur, S. (2012). *6. sınıf kesirlerle çarpma ve bölme işlemlerinin öğretiminde gerçekçi matematik eğitiminin öğrenci başarısına etkisi.* Master's Thesis, Atatürk University, Institute of Education Sciences, Erzurum.

Üzel, D. (2007). *Gerçekçi matematik eğitimi (RME) destekli eğitimin ilköğretim 7. sınıf matematik öğretiminde öğrenci başarısına etkisi.* Doctoral dissertation, Balıkesir University, Institute of Natural Sciences, Balıkesir.

Yazıcı, E. (2004). *Öğrenme stilleri ile ilköğretimde beşinci sınıf matematik dersindeki başarı arasındaki ilişki. Master's Thesis*, Selçuk University, Institute of Natural Sciences, Konya.

Zulkardi, Z. (2002). *Developing a learning environment on realistic mathematics education for Indonesian student teachers.* Doctoral Dissertation, University of Twente, Enschede.