Analysis of Realistic Mathematics Education Studies Carried Out in Turkey: A Document Analysis Research*

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Abstract: The goal of this research is to analyze the Realistic Mathematics Education (RME) studies conducted in Turkey through document analysis and to reveal what a trend is. In the research, 89 studies, including 18 articles, 71 theses, selected with a purposeful sampling method, published between 2002 and 2020, were analyzed. In the selection of the studies, Google Academic search engine, TÜBİTAK ULAKBİM DergiPark, YÖK National Thesis Center databases were used. All of the studies were examined through type, year, purpose, method, sample, data collection tools, subject areas, results via content analysis. The data are presented in tables using frequency and codes. Most of the studies consist of master theses, examining the effect on success, using experimental method is preferred. When the results are examined it is seen that applications for RME generally increase the success and permanence of the information and have a positive effect on skills such as attitude, motivation, prediction. The teacher candidates were suggested to have activities based on RME, teachers are to be given in-service training.

Keywords: Document Analysis, RME, Studies Carried Out In Turkey

1. Introduction

Developments and changes in the world affect the education system as in every field and make it necessary to use new approaches in the education and training process. One of the contemporary learning approaches developed for mathematics education is Realistic Mathematics Education (RME), which was introduced by Dutch mathematics educator Hans Freudenthal, and the basis of this approach is the idea that the human mind grasps objects through intuition (Özdemir & Üzel, 2011; Van den Heuvel- Panhuizen, 1996; Streefland, 1990). The RME approach, based on the views that "Mathematics is a human activity and mathematics must be linked to reality (Freudenthal, 1971; Freudenthal, 1991)" has emerged as a challenge to traditional teaching using real-world contexts (Zulkardi, 1999; Gravemeijer, Hauvel & Streefland, 1990).

Freudenthal emphasizes that mathematics should be associated with reality, adapt to society in terms of human values and be close to children (Van den Heuvel-Panhuizen, 1996). The word reality mentioned in the RME not only addresses the connection with the real world, but also the real problem situations in the minds of the students. In fact, in RME, emphasis is placed on being able to make things real with reality. For example, even a problem with non-real fairy tales can create a suitable content for RME (Van den Heuvel-Panhuizen, 2000). As long as the student can make sense of this situation in his/her mind.

Like the constructivist approach, RME focuses on the process rather than the result (Altun, 2006). According to Freudenthal, learning mathematics is a process of interpretation, and in order for a child, in order to be able to learn real mathematics, it is necessary to take the meaning at every stage as a priority (Nelissen & Tomic, 1998). To give an example of the process of interpretation, the question "Do the medians of a triangle intersect at a single point" is not a realistic problem. Although it is a concrete situation, daily life experiences and a context familiar to the students are not included in this question (Wubbels, Korthagen & Broekman, 1997). In order to make sense, it is necessary to reveal a mathematization process that progresses from the real model to the mathematical concept. Mathematization, which is one of the main goals of mathematics education, allows mathematics to be rediscovered by students (Freudenthal, 1968; Freudenthal, 1971).

Mathematization has two stages as horizontal and vertical mathematization. “Horizontal mathematization, transition from a vital (environmental) event to symbols; Vertical mathematization is reaching higher level mathematical concepts and formulas by working with symbols and establishing relationships between existing mathematical concepts (cited in Altun, 2018: 33)”. The concepts called horizontal and vertical mathematization in RME are emerged from the arrangement of the question "What should students do to reinvent mathematics?" question according to students' perspectives (Özdemir & Üzel, 2013). In addition to these, it is essential to start the process with a real life problem first in order to perform both horizontal and vertical mathematization according to RME. According to the RME approach, real life problems do not need to have only one solution,

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they can offer more than one solution, and these problems should be a starting point for students to determine how to use mathematics in real life (Moschkovich, 2002). Although real life has an important place in the learning processes of individuals, it also has a role in the formation of various differences in learning processes (Şenol, Dündar, Kaya, Gündüz & Temel, 2015).

Today, mathematics is perceived as knowledge and skills that are based on the modeling of reality, and are formed by the process of problem solving and interpretation (De Corte, 2004). However, the fact that the mathematics taught in schools is not taught in harmony with real life, students have problems in adapting the knowledge and skills they learn in school to real life (Vershaffel, De Corte, Lasure, Vaerenbergh, Bogaerts, & Ratinckx, 1999) and considering that RME is an approach developed to find solutions to these problems, a large number of studies fulfilled in the field of RME, it is better understood.

When the literature is examined, it has been seen that there are studies in the type of content analysis that examine the studies made for RME. One of these studies was conducted by Kaplan, Duran, Doruk and Öztürk (2015), and 12 theses were analyzed with meta-analysis method in order to reveal the effect of RME-based teaching on mathematics achievement more clearly. As a result of the study, a medium-level effect finding was reached, and based on this finding, the importance of encouraging the use of teaching for realistic mathematics education and providing guidance that would give students the responsibility of solving problems was mentioned. Another study was carried out by Tabak (2019). As a result of the research, which examined 33 theses and 5 articles published until 2018, it was determined that the studies were mostly conducted in 2015, and the effect of a course designed with RME on student achievement and students' attitudes towards mathematics was found to be in majority. In addition, it was emphasized that there are a limited number of studies in which students' knowledge creation and interpretation processes are examined in a subject area designed with RME. As can be seen, although there are similar and interesting studies on the research subject in the literature, these studies focused on a small number of studies and no information was given about current studies. For this reason, it is thought that this article, which summarizes the data of 89 RME studies conducted between 2002 and 2020, will make significant contributions to the literature that constantly updates itself. In this context, in this research, where 71 theses and 18 articles were examined, the following problems were discussed:

1. What types of works have been made (article, master's thesis, doctoral dissertation)?
2. What were the publication year of the studies?
3. What kind of things have been aimed to?
4. Which methods have been used to?
5. What type of samples have been preffered to study?
6. Which data collection tools have been used?
7. Which subject areas have been covered in these studies?
8. What kind of results has been achieved?

1.1. The Importance of Research

In this research, RME related studies which carried out in Turkey are evaluated in terms of what purpose it serves, by which methods are made with, what results have been achieved from, and in connection with these what is needed in new studies will be considered extensively; therefore it will guide researchers who will conduct research on RME.

1.2. Limitation of the Study

This research is limited to totally 89 studies including 71 thesis' and 18 articles which are made by Turkish researchers in Turkey. The articles that are stated to be produced from theses in the footnotes of the examined articles and the document analysis studies for RME are not included in this research. Studies with RME in the title, abstract or keywords of the study were examined within the purpose of the research. The papers were not reviewed within the scope of this research.

2. Method

2.1. Research Model

Document analysis method was used in this research. Document analysis; it is the coding and examination of the existing records and documents related to the intended work to be carried out, according to a determined norm or system. During the document analysis; The person conducting the research first accesses the necessary resources, reads the resources he accessed one by one, notes the information he needs, and makes various

evaluations based on these notes. In the syntheses made by document analysis, works made specific to any field can be classified according to various features (Çepni, 2018).

2.2. Data Collection and Analysis

In the field of Realistic Mathematics Education, its abbreviation is RME. However, in the surveys, it was seen that it was also used as Realistic Mathematics Teaching (RMT). Based on this, the keywords "Realistic Mathematics Education", "Realistic Mathematics Teaching", "RME", "RMT" were used in the searching process. The studies to be used for the research have been obtained from the Google Academic search engine, TÜBİTAK ULAKBİM DergiPark and YÖK National Thesis Center database. Studies with RME expression in titles, abstracts and keywords were analyzed within the scope of the research and studies directly related to RME were included in the study. In this research, studies made by Turkish reseachers in Turkey is considered. It is taken into consideration that the examined theses and articles are accessible. In addition, articles and papers produced from theses were not included in the research. After all these screening processes, 71 theses and 18 articles were examined.

First of all, all studies included in the research were examined one by one and at the end of this examination, the required data were transferred to the tables in computer environment. Later, the data that were deemed not necessary were removed from these tables and the remaining data were obtained in the form of a summary. Studies were examined according to research problems and coded according to appropriate themes. Only the frequencies are included in the tables statistically. After making a general explanation under the tables, the similarities and differences seen in the studies were analyzed in detail using the content analysis method according to the importance of the theme. In order not to create confusion due to the large number of studies examined, the studies were coded as A1, A2, A3,…, A89 and used in this way throughout the article.

2.3. Validity and Reliability of the Study

In order to avoid any mistakes while coding, the studies were first examined in detail. Afterwards, the simplified information obtained from the studies in the direction of each research problem was tabulated and put into writing. The coding made for the reliability of the coding were coded by two researchers and it was observed that there was 81% agreement between the coding. After reaching a consensus among researchers about the codes that could not be adapted, the coding was finalized. At the same time, the validity and reliability of the encodings were checked by two mathematics educators who are experts in the field.

3. Findings

In this section, the findings obtained as a result of the analysis of the data are included in line with the research problems.

Table 1. Data regarding the study types examined

Study Type	Study Codes	Frequency
Article	A6, A7, A8, A11, A13, A15, A17, A28, A30, A33, A35, A44, A46, A49, A59, A69, A85, A87	18
Master	A2, A3, A4, A5, A9, A12, A14, A16, A18, A19, A21, A22, A23, A24, A26, A27, A29, A31, A32, A34, A36, A37, A38, A39, A40, A41, A42, A43, A50, A51, A52, A53, A54, A55, A56, A57, A58, A60, A61, A62, A63, A64, A65, A66, A67, A68, A70, A72, A73, A74, A75, A76, A78, A81, A82, A86, A88	57
PhD	A1, A10, A20, A25, A45, A47, A48, A71, A77, A79, A80, A83, A84, A89	14
Total		89

As can be seen from Table 1, 18 of the studies for RME are articles, 57 of them are master's theses and 14 of them are doctoral dissertations.

Table 2. Data regarding the publication years of the reviewed studies

Publication Year	Study Codes	Frequency
2002	A7	1
2006	A8	1
2007	A32, A83, A84	3
2008	A12, A41, A67	3
2010	A1, A4, A10, A33, A60, A85	6
2011	A24, A77	2
2012	A5, A16, A19, A81	4
2013	A14, A23, A40, A76	4
2014	A15, A25, A34, A57, A58, A62, A80, A86	8
2015	A20, A29, A30, A42, A61, A66, A68	7
2016	A26, A35, A71, A79	4

Table 2 continued

2017	A11, A18, A22, A28, A31, A59, A69	7
2018	A6, A9, A13, A27, A37, A39, A44, A46, A55, A56, A78, A82, A88, A89	14
2019	A2, A3, A17, A21, A36, A38, A43, A45, A47, A48, A50, A51, A52, A53, A54, A63, A64, A65, A70, A72, A73, A74, A75	23
2020	A49, A87	2
Total		89

As can be seen from Table 2, the first study for RME was conducted in 2002. In the study conducted by Altun (2002), an appropriate approach to RME was proposed regarding the teaching of the number line and an experimental study was conducted on the proposed model. Table 2 also examined when the RME study in Turkey, particularly increased after 2010, the most noteworthy work was made in 2019.

Table 3. Data regarding the aim of the reviewed studies

Aims	Study Codes	Frequency
RME's impact on success	A2, A3, A4, A5, A6, A9, A10, A12, A16, A18, A19, A20, A22, A23, A24, A29, A31, A32, A33, A36, A37, A39, A40, A42, A48, A49, A51, A52, A53, A54, A57, A59, A61, A62, A64, A65, A66, A67, A68, A70, A71, A72, A74, A78, A81, A83, A88	47
Examining opinions, suggestions and perspectives towards RME	A10, A13, A17, A30, A31, A35, A40, A48, A49, A56, A59, A61, A64, A65, A66, A69	16
RME's effect on attitude	A2, A10, A12, A24, A42, A48, A51, A53, A57, A59, A62, A66, A71, A72, A74, A78	16
The effect of RME on the permanence of information	A2, A6, A9, A19, A31, A39, A42, A52, A53, A61, A62, A70, A72	13
Learning environment for RME activity design/implementation/examining its effectiveness	A1, A7, A17, A21, A26, A30, A38, A41, A44, A46, A50, A55, A73, A75, A76, A84, A85, A86	18
The effect of RME on motivation	A22, A23, A27, A53, A72, A88	6
Examination of mathematization processes	A34, A58, A63, A79, A87	5
The effect of RME on problem solving skills	A10, A28, A29	3
The effect of RME supported teaching on mathematical literacy	A28, A29, A53	3
Examining the nature of creating information (Abstraction) in the learning process of concepts	A25, A60, A77	3
Examination of the effect of RME on interpretation and concept processes	A80, A86	2
Comparison of RME with different learning theories	A8, A11	2
The effect of RME on creative thinking/reasoning skills	A20, A47	2
The effect of RME on self-efficacy perception	A29, A31	2
The effect of RME on misconception	A6	1
The effect of RME on forecasting and strategy use	A14	1
Explaining the importance of the history of mathematics in RME	A15	1
The effect of RME on anxiety	A31	1
The effect of RME on statistical thinking skills	A36	1

Table 3 continued

The effect of RME on reflective thinking skills	A39	1
Examination of high school entrance exam questions in the context of RME	A43	1
The effect of short films in relating mathematics to real life	A45	1
The effect of RME on self-reporting	A71	1
Examination of non-verbal proofs within the framework of RME activities	A82	1
Elimination of errors made in four processes with RME	A89	1

Table 3 presents data regarding the aims of the studies examined. When Table 3 is examined, it is noteworthy that a significant part of the studies were carried out to determine the effect of RME on success. In addition, the number of studies examining the opinions, suggestions and perspectives of RME and the effect of RME on the attitude and information permanence is quite high. There are a limited number of studies examining the effect of RME on misconceptions, variables such as statistical thinking, reflective thinking, anxiety, and self-report.

Table 4. Data regarding the methods of the reviewed studies

Methods	Study Codes	Frequency
Experimental Method	A2, A3, A4, A7, A9, A12, A16, A19, A22, A23, A24, A27, A29, A31, A32, A33, A36, A37, A39, A40, A41, A42, A48, A49, A51, A52, A57, A61, A62, A66, A70, A71, A72, A74, A76, A78, A81, A83, A84, A85, A86, A88	42
Case Study Method	A1, A17, A25, A26, A30, A35, A38, A43, A44, A45, A46, A50, A56, A58, A60, A63, A73, A77, A79, A87	20
Mixed Method	A5, A6, A10, A14, A18, A20, A21, A28, A54, A59, A64, A65, A67, A68	14
Teaching Experiment Method	A34, A47, A80, A82	4
Action Research Method	A53, A55, A75, A89	4
Document Analysis Method	A8, A11, A15, A69	4
Phenomenology Research Method	A13	1
Total		89

When Table 4 is examined, it is noteworthy that the experimental method is preferred in a significant part of the studies on RME. In studies where experimental method was used, it was generally tried to determine the effect of RME on success. As can be seen, few studies have been conducted on teaching experiment, action research, document analysis, and phenomenological research methods. However, it is gratifying to find studies examining the long-term effect by designing learning environments suitable for RME with the case study method (A1, A17, A25, …).

Table 5. Data collection tools of completed studies that have been examined

Data Collection Tool Types	Data Collection Tools	Study Codes	Frequency
Test	Achievement Test	A3, A4, A5, A6, A9, A10, A12, A16, A18, A19, A20, A21, A22, A24, A25, A28, A29, A31, A32, A33, A37, A39, A40, A41, A42, A48, A49, A51, A52, A54, A57, A59, A61, A62, A64, A65, A66, A67, A68, A70, A71, A72, A74, A76, A78, A81, A83, A84, A85, A88	50
	Equivalence Test	A3, A4, A12, A14, A48, A49, A57, A65, A67, A83, A88	11
	Permanence/Tracing Test	A2, A52, A53, A62	4
	Readiness Test	A19, A38, A63	3
	Understanding Test	A84, A85	2
	Knowledge Test	A1, A55	2
	Prediction Test	A14	1

Table 5 continued

	Reach Test	A23	1
	Creative Thinking Test	A20	1
	Mathematical Literacy Test	A53	1
	Problem Solving Skill Test	A10	1
Test Total			77
Scale	Attitude Scale	A2, A10, A12, A16, A21, A24, A25, A28, A29, A37, A41, A42, A48, A51, A57, A59, A62, A66, A71, A72, A74, A76, A78, A83	24
	Motivation Scale	A22, A23, A27, A53, A72, A88	6
	Perception Scale	A28, A29, A31	3
	Anxiety Scale	A31	1
	Statistical Thinking Scale	A36	1
	Success Motive Scale	A36	1
	Reflective Thinking Scale	A39	1
Scale Total			37
Interview	Interview/Opinion Form	A1, A5, A10, A13, A14, A16, A18, A20, A21, A25, A26, A28, A29, A30, A31, A34, A35, A38, A40, A41, A45, A46, A50, A54, A59, A61, A64, A65, A66, A67, A68, A69, A73, A74, A77, A80, A89	37
Interview Total			37
Observation	Observation/Observation Form	A1, A18, A20, A24, A26, A45, A46, A63, A73, A77, A79, A82	12
Observation Total			12
Survey	Survey	A48, A49, A55, A56, A83	5
	Evaluation Survey	A67	1
Survey Total			6
Documents	Activity Paper/Worksheet	A7, A20, A25, A34, A38, A44, A45, A47, A50, A58, A63, A66, A75, A76, A77, A78, A80, A86, A89	19
	Video/Speech Record	A17, A46, A47, A58, A69, A74, A79, A80, A82, A89	10
	Diary/Note/Report/Journal	A10, A34, A45, A47, A55, A58, A74, A80, A82, A89	10
	Document	A8, A11, A15, A43, A79, A87	7
Documents Total			46
Other	Personal Information Form	A9, A18, A29, A89	4
	Open-Ended Questions	A34, A47, A60	3
	Self-Report Inventory	A71	1
Other Total			8

When Table 5 is examined, it is seen that many different data collection tools are used in the RME studies. It is a gratifying development that so many different data collection tools are used together in RME studies. All data collection tools are given in detail in the table so that researchers who will conduct similar studies can reach the data collection tool they want to reach in a shorter time. It is noteworthy that the data collection tools used are predominantly in the type of "Test" data collection tool, and the most test is the Achievement Test.

Table 6. Data on the samples of the completed studies that have been examined

Samples	Study Codes	Frequency
1st Grade	A7	1
2nd Grade	---	0
3rd Grade	A9, A19, A60, A62	4
4th Grade	A6, A23, A25, A28, A29, A51, A61, A72, A80, A84, A85, A89	12
5th Grade	A10, A16, A54, A71, A76, A84, A85	7

Table 6 continued

6th Grade	A3, A14, A21, A24, A27, A32, A33, A36, A38, A39, A47, A50, A52, A70, A74, A76, A77, A78, A81, A86	20
7th Grade	A1, A5, A12, A37, A40, A42, A45, A53, A57, A66, A75, A76, A79, A82, A83, A88	16
8th Grade	A17, A22, A34, A45, A59, A63, A67, A76, A87	9
9th Grade	A2, A41, A46, A55, A65, A68	6
10th Grade	A31, A64	2
11th Grade	A26, A48, A49	3
12th Grade	A4, A20	2
Teacher Candidates	A30, A44, A58, A69	4
Teachers	A13, A18, A35, A56, A73	5
Others	A8, A11, A15, A43	4
Total		95

When Table 6 is analyzed, it is seen that the studies were carried out with students from 1st grade to 12th grade (excluding 2nd grade), teacher candidates and teachers. However, it is noteworthy that studies are generally carried out with secondary school students and predominantly with 6th grade students. As emphasized in the introduction section, RME is an important field of study for mathematics and teachers who need to emphasize RME in lessons should have more information on this subject. For this reason, more studies are needed to provide teachers and teacher candidates with RME experiences. At the same time, it is thought-provoking that no study has been done on the 2nd grade. It may be useful to conduct RME studies at this level and to compare the results with other grade levels in the primary school.

Table 7. Data on the learning areas and subjects of the reviewed studies

Learning Areas	Study Subject	Study Codes	Frequency
Numbers and Operations	Natural Numbers/Operations with Natural Numbers	A7, A10, A39, A59, A71, A89	6
	Fractions/Operations with Fractions	A6, A14, A25, A32, A33, A51, A62, A81, A84, A85, A86	11
	Decimal Notation	A54, A80	2
	Percentages	A53, A66	2
	Multipliers and Multiples	A74	1
	Sets	A50, A68	2
	Integers/Operations with Integers	A3, A12, A27	3
	Rate and Ratio	A5, A42, A47, A53, A73	5
	Square Root Expressions	A63	1
Numbers and Operation Total			33
Algebra	Algebraic Expressions	A24, A37, A39, A45, A53, A70	6
	Equation and Systems of Inequality	A24, A34, A65, A83	4
	Functions	A55	1
	Logic	A41	1
	Sequences	A48, A49	1
	Derivative	A2	1
	Integral	A4	1
Algebra Total			16
Geometry	Geometric Solids and Figures	A21, A28, A29, A38	4
	Triangles and Quadrangles	A2, A45, A46, A57, A88	5
	Angles	A60, A75	2
	Equality and Similarity	A17	1
	Trigonometry	A2	1
	Analytical Geometry	A26, A77	2
Geometry Total			15

Table 7 continued

Measuring	Measuring Length	A16, A19, A23, A61, A67, A72	6
	Measuring Area	A16, A18, A24, A31, A52, A57, A72	7
	Measuring Time	A23, A72	2
	Weighing	A23	1
	Measuring Liquid	A19, A23, A78	3
Measuring Total			19
Data Processing	Data Collection and Evaluation	A9, A36, A53, A64	4
	Data Analysis	A36, A76	2
Data Processing Total			6
Probability	Probability of Simple Events	A1, A22, A40, A64, A87	5
Probability Total			5
Other	Learning Theories/Approaches	A8, A11, A13, A30, A44	5
	RME Theoretical Framework	A13, A30, A35, A44	4
	Mathematical Modeling	A58, A79	2
	Mathematics History	A15	1
	Real Life Problems	A56, A69, A82	3
	High School Entrance Exam Question	A43	1
Other Total			16

The subjects and learning areas they belong to were determined according to the primary, secondary and high school curricula (MEB, 2018a; MEB, 2018b).

When Table 7 is analyzed, it is seen that RME studies are carried out for each learning area in the mathematics curriculum. It is noteworthy that the studies are mainly carried out in the field of "Number and Operations" and the most studies are on fractions and operations with fractions. Adapting different teaching experiences for fractions and operations learning area to other subjects can contribute significantly to the literature. Only one study has been done on subjects such as derivative, integral, logic, trigonometry at high school level. Different RME studies are needed to address these issues.

Table 8. Data on the results of the completed studies that have been examined

Results	Study Codes	Frequency
RME has a *positive* effect on success.	A2, A3, A4, A5, A6, A9, A10, A12, A16, A18, A22, A23, A24, A29, A31, A32, A33, A36, A37, A39, A40, A42, A48, A49, A51, A52, A53, A54, A57, A61, A62, A64, A65, A66, A67, A68, A70, A71, A72, A74, A78, A81, A83, A88	44
RME has *no effect* on success.	A19, A20, A59	3
There are *positive* opinions, suggestions and perspectives for RME.	A10, A31, A35, A40, A48, A49, A59, A61, A64, A65, A66, A69	12
There are opinions, suggestions and perspectives that *it should be used more effectively* for RME.	A13, A17, A30, A56	4
RME has a *positive* effect on attitude.	A10, A24, A42, A48, A51, A53, A66, A71, A72, A74	10
RME has *no effect* on attitude.	A2, A12, A57, A59, A62, A78	6
RME has a *positive* effect on the permanence of information.	A6, A9, A19, A31, A39, A42, A52, A53, A61, A62, A70, A72	12
RME has *no effect* on the permanence of information.	A2	1
The learning environment designed for RME has a *positive* effect on activity and application examples.	A1, A7, A21, A26, A30, A41, A46, A50, A55, A75, A76, A84, A86	13

Table 8 continued

The activity and application examples of the learning environment designed for RME have *no effect.*	A17, A38, A44, A73, A85	5
RME has a *positive* effect on motivation.	A22, A23, A27, A88	4
RME has *no effect* on motivation.	A53, A72	2
RME has a *positive* effect on comprehension/concept creation/ mathematization/abstraction processes.	A25, A34, A60, A63, A77, A79, A80, A86, A87	9
Education on accordance with RME does not have a *sufficient effect* on mathematization.	A58	1
RME supported teaching *positively* affects problem solving skills.	A10, A28, A29	3
RME supported education has a *positive* effect on mathematical literacy.	A28, A29, A53	3
RME has been compared with different learning theories.	A8, A11	2
RME has a *positive* effect on creative thinking/reasoning skills.	A20, A47	2
The effect of RME self-efficacy perception is *positive.*	A29	1
RME does not have a *significant effect* on self-efficacy perception.	A31	1
RME has a *positive* effect on overcoming misconceptions.	A6	1
RME has a *positive* effect on forecasting and strategy using.	A14	1
The importance of the history of mathematics was mentioned in the RME.	A15	1
RME has a *positive* effect on reducing anxiety	A31	1
RME has a *positive* effect on statistical thinking skills.	A36	1
RME has a *positive* effect on reflective thinking skills.	A39	1
When examining the entrance exam questions for high schools in the context of RME, it was seen that they were *not suitable* for RME.	A43	1
Short films have a *positive* effect on associating mathematics with real life.	A45	1
RME has a *positive* effect on self-report.	A71	1
Examining non-verbal proofs within the framework of RME activities has a *positive* effect.	A82	1
RME has a *positive* effect on eliminating errors in four transactions.	A89	1

The results obtained from the studies examined in Table 8 are presented in line with the purposes given in Table 3. The results are given in detail in the table so that the researchers who plan to work in this field can quickly examine which results have been achieved in the studies. When the results were examined, it was found that success increased in 44 out of 47 studies in which the effect on RME on success was examined and there was no significant effect on success in 3 studies. Among these studies, in A19, 3rd grade students had RME activities for measuring fluids and their lenghts, but no significant difference was found between the experimental group trained with RME and the control group trained with a constructivist approach. It was observed that RME activities on derivatives in A20 and GCD-LCM in A59 did not have a significant effect on increasing success. However, in similar studies dealing with the same issues, it was stated that RME increased

the success (A23, A78, …). When the results are analyzed, it is seen that there are studies (A6, A10, A19, A22, A23, A31, A35, …). There are also studies stating that it does not have a significant effect (A2, A9, A53, A72, …). Contrary to these studies, in all studies (A10, A20, A28, A29, A31, A47, A53, A71) where variables such as problem solving, literacy, creative thinking, statistical thinking, reflective thinking, self-report and anxiety were discussed, RME had a positive effect. It has been revealed that it creates.

4. Discussion, Conclusion and Suggestions

In this section, the results obtained from the research are discussed in line with the research problems. When the findings were examined, it was seen that most of the studies examined consisted of theses. Since the articles produced from theses are not examined within the scope of the research, it is expected that the number of articles is less than the theses. Among theses, there are more master theses than doctoral dissertation. When the years of publication of the studies were examined, it was seen that the first study was conducted in 2002, and the most work was done in 2019. When the number of studies by years is examined, it is noteworthy that RME studies have gained more importance since 2010.

When the purposes of the studies analyzed, it was seen that the most studies were conducted to determine the effect of RME on success. The number of studies examining the opinions, suggestions, perspectives of RME and the effect of RME on attitude is quite high. When the literature is examined, it is noteworthy that almost every subject area, success, attitude and opinion taking studies are frequently included (Benli-Özdemir, 2021; Yıldız, Baltacı & Kartal, 2020; Çetin & Mirasyedioğlu, 2019; Awofala & Ojaleye, 2018; Sönmez, 2018; Şeker & Kartal, 2017; Belbase, 2015; Kaleli-Yılmaz, 2015; Lalau, 2014; Topan, 2013; Arslan, Çanlı & Sabo, 2012; Kutluca & Birgin, 2007; Güven & Karataş, 2003). In addition to these, there were quite a lot studies examining to the effect of RME on the permanence of information, motivation, problem solving skills and abstraction. Also, it was observed that RME studies were included in different subject areas such as statistical thinking, self-report, effect on misconception, high school entrance exam questions and history of mathematics. The fact that studies are not carried out continuously for the same purposes and that even non-verbal proofs are examined in the context of RME are pleasing in terms of adding different information to the literature and expanding the literature.

Another problem analyzed within the scope of the research was the methods used in the studies. When findings were examined (Table 4), it was seen that a significant part of the studies were carried out by experimental method, followed by the case study method and the mixed method. In the studies where the experimental method was preferred, the classroom environment designed for RME was compared with the classroom environment conducted in schools. It has been determined that the designed RME environments are effective in most of these studies comparing learning environments designed in different subject areas with traditional learning environments are frequently included in the literature (Ürey, Çepni & Yıldız, 2013; Koparan & Güven, 2014; Çekmez & Baki, 2018). An important point what draws attention in the method sections of the studies is that only screening studies carried out using quantitative data collection tools such as scale and questionnaire are not included. It is gratifying that different methods such as teaching experiment and phenomenology research are used in RME studies.

The data collection tools used in the studies are presented in Table 5 in detail. For the convenience of researchers who want to work in this field, data collection tools are not presented under general titles such as test and scale, but with individual names such as achievement test, retention test, readiness test, attitude scale, anxiety scale. When the data collection tools were examined, it was seen that different data collection tools such as test, scale, interview, observation, questionnaire, document were used in RME studies, and among them, tests were the most preferred. When the test were examined specifically, it was noticed that there were different test names such as achievement, knowledge, equivalence, comprehension, permanence, readiness and the most used test was the success test. In addition, while examining the test names used in the studies, the question arises whether it is necessary to give such different names to tests. Because although the names given to the tests are different, it has been determined that their contents are similar to each other. For example, while the test prepared on derivative in A20 is called success test. It will be useful to explain what kind of differences are between these tests and why names such as knowledge test, achievement test, reach test, readiness test are given instead of achievement test. Especially researchers who are new to scientific studies may have difficulty in distinguishing the differences of many data collection tools that similar to each other but with different names and choosing the ones that are suitable for them. For this reason, it will be useful to give the same name as possible to data collection tools with the same content and if a different name is given, the reasons for this will be presented.

When the samples of the completed studies were taken into consideration, it was seen that RME studies were carried out with all grade levels from 1st grade to 12th grade, except for the 2nd grade. Why the 2nd grade is not preferred is a matter of curiosity. It is noteworthy that among these classes, the most studies were carried out with 6th graders, followed by studies with 7th grade and 4th graders. There are also studies conducted with pre-

service teachers (A30, A44, A58, A69) and teachers (A13, A18, A35, A56, A73) but it is noticed that the number of studies is quite limited compared to other grade levels. However, it is extremely important that the RME approach, which is given so much importance, is firstly understood by the teachers who are in the kitchen and the teacher candidates who will be the teachers of the future, how it can be used and what activities can be done. For this reason, it is thought that long-term RME studies that will provide teachers with teaching experiences will make significant contributions to the field.

When the learning areas and subjects in which the studies are carried out which are examined, it is seen that studies are carried out for all learning areas and the most completed studies are in the field of learning numbers and operations then operations with fractions also fractions. When the literature is analyzed, it is noteworthy that there are frequent studies on fractions for different purposes (Altıparmak & Palabıyık, 2019; Özdemir & Özçakır, 2019; Eichhorn, 2018; Çakmak-Gürel & Okur, 2016; Çelik & Çiltaş, 2015; Aksu & Konyalıoğlu, 2014). Adapting different RME experiences for fractions and operations learning areas to other subjects can contribute to the literature. In addition, it has been observed that a limited number of RME studies have been conducted on subjects such as derivative, integral, logic, trigonometry at high school level. Researchers who want to work in the field of RME can turn to these issues.

When the results obtained from the RME studies are examined, it has been determined that RME has a positive effect on variables such as success, attitude, persistence of information, motivation, mathematical literacy, creative, statistical and reflective thinking, reasoning, self-efficacy perception, prediction and strategy usage. There are also studies stating that it has no positive effect but these studies are limited. In this context, it can be said that RME is an effective learning approach in general. As Altun (2008) also stated, RME can be used as an alternative method that can be used to teach mathematics due to its positive effects. However, in previous studies, it was mentioned that RME was not sufficiently introduced in mathematics education programs, it was not adequately explained in education faculties and many mathematics educators were not aware of RME (Çakır, 2011). As a result of this research, it was determined that the number of studies carried out with teachers and teacher candidates is quite limited. Therefore, it is thought that it will be beneficial to give more importance to the RME approach in undergraduate programs, to have pre-service teachers make examples of activities based on RME and to train teachers on this subject with in-service training courses. Finally, this research, in which 89 RME studies were examined in detail, is expected to make significant contributions to the literature.

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Appendix: Theses and Articles Examined Within The Scope Of The Research Conducted

A1. Akkaya, R. (2010). *Olasılık ve istatistik öğrenme alanındaki kavramların gerçekçi matematik eğitimi ve yapılandırmacılık kuramına göre bilgi oluşturma sürecinin incelenmesi [The investigation of knowledge construction process of concepts in probability and statistical learning field according to the realistic mathematic education and constructivism theory]* (Unpublished Doctoral Dissertation). Uludağ University, Turkey.

A2. Akkaya, Y. (2019). *Ortaöğretim 9. sınıf matematik öğretiminde gerçekçi matematik eğitimi yaklaşımının başarı, tutum ve kalıcılık üzerindeki etkisinin incelenmesi [Analysing the effect of realistic mathematics*

education approachon success, attitude and retentionon secondary 9th class mathematics teaching] (Unpublished Master's Thesis). Aydın Adnan Menderes University, Turkey.

A3. Aksarı, H. (2019). *Gerçekçi matematik eğitimine dayalı öğretimin 6. sınıf öğrencilerinin matematik başarısına etkisi [The effect of realistic mathematics education on the mathematics achievement of 6th grade students']* (Unpublished Master's Thesis). Akdeniz Univesity, Turkey.

A4. Akyüz, M. C. (2010). *Gerçekçi matematik eğitimi (rme) yönteminin ortaöğretim 12. sınıf matematik (integral ünitesi) öğretiminde öğrenci başarısına etkisi [Effect of realistic mathematics education (rme) method on student success in secondary education 12th grade mathematics (integral unit)] education* (Unpublished Master's Thesis). Yüzüncü Yıl University, Turkey.

A5. Altaylı, D. (2012). *Gerçekçi matematik eğitiminin oran orantı konusunun öğretimi ve orantısal akıl yürütme becerilerinin geliştirilmesine etkisi [The effect of realistic mathematics education on teaching the subject of ratio and proportion and development of proportional reasoning skills]* (Unpublished Master's Thesis). Atatürk University, Turkey.

A6. Altıparmak, K. & Çiftçi, B. (2018). Bilgisayar destekli gerçekçi matematik eğitimi yaklaşımının etkililiği üzerine deneysel bir çalışma [An experimental study on the effectiveness of computer aided realistic mathematics education]. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 12* (2), 228-253.

A7. Altun, M. (2002). Sayı doğrusunun öğretiminde yeni bir yaklaşım [A new approach to teaching the number line]. *Elementary Online, 1*(2), 33-39.

A8. Altun, M. (2006). Matematik öğretiminde gelişmeler [The development in mathematics teaching]. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi, 19* (2), 223-238.

A9. Altunay, K. (2018). *İlkokul 3. sınıf öğrencilerinde gerçekçi matematik etkinliklerinin veri öğrenme alanına etkisi [Efficiency of datum learning field of realistic mathematic activities on 3th grade of primary students]* (Unpublished Master's Thesis). Bayburt University, Turkey.

A10. Arseven, A. (2010). *Gerçekçi matematik öğretiminin bilişsel ve duyuşsal öğrenme ürünlerine etkisi [Effects of the realistic mathematics teaching on cognitive and affective learning outcomes]* (Unpublished Doctoral Dissertation). Hacettepe University, Turkey.

A11. Aşık, G. & Yılmaz, Z. (2017). Matematik eğitimi çalışmalarında tasarım tabanlı araştırma ve öğretim deneyi yöntemleri: farklar ve benzerlikler [Designed-based research and teaching experiment methods in mathematics education: Differences and similarities]. *Journal of Theory and Practice in Education, 13*(2), 343-367.

A12. Aydın-Ünal, Z. (2008). *Gerçekçi matematik eğitiminin ilköğretim 7. sınıf öğrencilerinin başarılarına ve matematiğe karşı tutumlarına etkisi [The effects of realistic mathematics education on 7th grade students' achievements and attitudes toward mathematics]* (Unpublished Master's Thesis). Atatürk University, Turkey.

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