Evaluation of the Effectiveness of Realistic Mathematics Education: Meta-Thematic Analysis

Assoc. Prof. Dr. Şenel Elaldı
Sivas Cumhuriyet University - Türkiye
ORCID: 0000-0003-0780-4207
selaldi@cumhuriyet.edu.tr

Abstract

This study was aimed to determine the effectiveness of the Realistic Mathematics Education (RME) used in mathematics teaching. For this aim, studies including participant views on the use of RME were examined in accordance with the PRISMA flow chart and in line with the inclusion criteria determined by the researcher. These criteria were determined as "studies involving the RME application in the field of mathematics, studies conducted between 2012-2022 (last ten years), studies containing qualitative participant views, and studies published in Turkish or English". A total of 146 studies reached were evaluated according to these criteria, and the remaining 24 studies were included in the meta-thematic analysis. The data on the examination of the use of RME were obtained by the document analysis and analyzed by the content analysis through the use of the Maxqda-11 qualitative data analysis program. The themes that emerged from the analysis were: contribution to the delivery of course, making connections with daily life, contribution to the attitude towards mathematics and contribution to thinking skills. These themes and codes were interpreted separately. In addition, direct quotations from the sources were included to support the presentation of the relevant themes and codes. Analysis results showed that RME has contributed positively to math teaching in many ways. On the other hand, the negative contribution of RME to math attitude emerged with codes such as inefficient use of time, noise, negative group synergy and intra-group conflicts. It is suggested to include more RME practices in order to adopt the principle of "mathematics for all" on Freudenthal's discourse, to develop a positive attitude towards mathematics and to associate it with real life.

Keywords: *Realistic Mathematics Education, Attitude toward math, Math and connections with daily life, Meta-thematic analysis*

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INTRODUCTION

Realistic Mathematics Education (RME) is a mathematics teaching approach and an educational theory specific to the field of mathematics, founded by the Dutch mathematics educator Hans Freudenthal and developed by the Freudenthal Institute to realize the innovation movement needed in mathematics teaching and learning (Van den Heuvel-Panhuizen, 1996). RME is a field-specific teaching theory based on the fact that mathematics is a subject area, how students can learn mathematics and how mathematics should be taught (Van den Heuvel-Panhuizen & Wijers, 2005). According to the RME approach, mathematics has to be close to children and related to situations in daily life. However, the word "realistic" here does not actually refer to the connection with the real world. This word also indicates real problem situations that students can visualize in their minds. Originally the name "realistic" comes from "zichREALISEren", the German translation of "to imagine". Therefore, the name given to the RME approach is actually emphasized on people's ability to make things real in their minds (Van den Heuvel-Panhuizen, 2001). RME has two important rules; math has to be connected with reality and math is a human is activity (Van den Heuvel-Panhuizen, 1996). As math is accepted as human activity by Freudenthal, it is invented, not discovered (Van den Heuvel-Panheuizen, 2003). In order to keep things under control, human beings count, measure, classify and rank them. In other words, social facts and needs create the need to do math. For example; the need to know which of the two things took up more space led to the invention of measuring (Van den Heuvel-Panheuizen, 2003).

Freudenthal's most convincing argument is not that in the future all students will be mathematicians, but that mathematics for the vast majority will be a tool for solving problems in everyday situations (Koleza, 2000). Therefore, the idea of providing a learnable and accessible mathematics education, which is why mathematics is not foreign to all students is at the base of the RME approach (Gravemeijer & Terwel, 2000). In a math course, taking a real-life problem and expressing it with mathematical symbols for students are mathematization for the RME approach. In other words, Freudental called the process of reaching a mathematical concept from a real model as mathematization (Freudenthal, 1968, as cited in Altun, 2008). Mathematization can be examined in two stages as horizontal and vertical mathematization. Horizontal mathematization is the process of formulating or visualizing a problem in different ways, exploring relationships, transferring a real-life problem to a mathematical problem, while vertical mathematization is reaching higher level mathematical concepts, formulas by working with symbols and establishing relationships between existing mathematical concepts (Van den Heuvel-Panhuizen, 1996).

When the literature is examined, it has been revealed that the RME approach increases the quality and success in teaching (Cansız, 2015; Sevinc & Lesh,2018; Tarım & Kükürt, 2021, Yazıcı, 2021), provides learning by discovery (Özdemir & Üzel, 2011), helps students develop a positive attitude towards mathematics (Ayvalı, 2013; Korkmaz, 2017a; Okuyucu, 2019; Özdemir, 2019; Sevim, 2019), improves their thinking skills (Cansız, 2015; Çolak, 2020; Ödemiş, 2019; Özdemir & Üzel, 2011) and provides meaningful and permanent learning by associating them with real life (Çilingir Altıner & Dinç Artut, 2017; Çolak, 2020; Ersoy, 2013; Fesakis, Karta & Kozas, 2018; Gibney, 2014; Kösece, 2020).

This study was aimed to determine the effectiveness of the RME approach, which is one of the student and activity-centered approaches, in mathematics teaching. In this direction, it is aimed to investigate the effectiveness of studies that contain the qualitative dimension on RME in the national and international literature, in line with the views of the participants.

In the literature review, one meta-thematic analysis was found on GME. This study by Uyanıker (2021) has included only the theses conducted in Turkey. However, research articles and international studies have not included. Therefore, due to the lack of sufficient studies including meta-thematic analysis on RME in the literature, it was decided to conduct the current research in order to contribute to this field. In line with this main purpose, it was aimed to determine the contribution of RME:

- to the delivery of course,
- to connections with daily life,
- to the attitude towards mathematics and,
- to thinking skills

METHOD

The studies that included participant views within the scope of the qualitative dimension were examined and a meta-thematic analysis of these studies was performed. While performing meta-thematic analysis, the important thing is not to have a large number of data, but to have a sufficient number and to reach the saturation point of the researcher. In meta-thematic analysis, new themes and codes are created from the information obtained through document analysis. In other words, meta-thematic analysis can be explained as a type of analysis that combines the qualitative findings of the studies by creating themes and codes, based on document/document review, containing a verbal/textual analysis process. More general and comprehensive results are included in the research with newly obtained themes and codes (Batdı, 2019).

Studies included in the research

The studies on RME were detected in the databases of the Higher Education Council National Thesis and Dissertation Center (YÖK), Dergipark, ProQuest Dissertations and Theses, Web of Science, Ebscohost-Eric, Dergipark, Sage Journals Online and, Google Scholar databases. While scanning, the keywords "RME Applications", "RME in mathematics education" were used in both Turkish and English. As a result of the scanning, all studies were examined in accordance with the criteria prepared by the researcher according to criterion sampling, one of the purposive sampling methods.

Research criteria:

a) studies that included the RME application in the field of mathematics
b) Studies conducted between the years 2012-2022 (last ten years)
c) Studies that include qualitative participant views
d) Studies published in Turkish or English

Data were collected in accordance with the PRISMA flow chart (See Figure 1) developed by Moher, Liberati, Tetzlaff, Altman, and Prisma Group (2009).

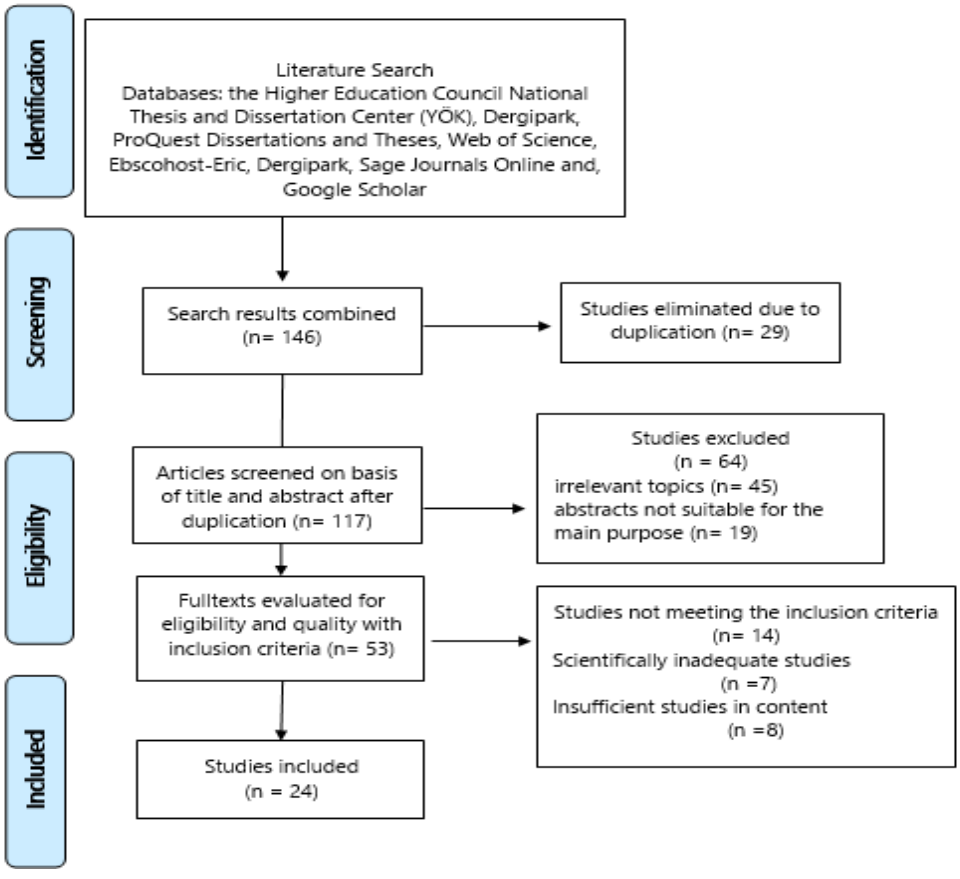

Figure1. *The Flow Diagram of the Studies in the Process of Inclusion in the Meta-Thematic Analysis*

As given in Figure 1, the flow diagram of the studies included in the meta-thematic analysis shows that 29 studies out of 146 studies reached from databases were not included in the analysis due to duplication. The reason is that these studies were downloaded several times due to being accessed from different databases. Among the remaining 117 studies, 64 were not included in the analysis due to the fact that their contents did not match the research topic of the current study, although the unrelated topic titles intersected with the keywords. On the other hand, 19 of the remaining 72 studies were not included in the analysis as they did not overlap with the main purpose of the study. Subsequently, 29 of the remaining 57 studies were not included in the analysis because they did not meet the current study criteria and were not considered sufficient in terms of scientific quality and content. As a result, it was preferred that the studies used in the research comply with the inclusion criteria, provide validity and reliability, and contain solid sources. The number of studies to be used within the scope of meta-thematic analysis in accordance with the criteria sought was 24 [M.A. Theses (n= 15), PhD Dissertations (n=3), Articles (n=6)].

Data Collection Tools

The data on the examination of the use of RME applications in mathematics teaching were obtained by document analysis. Document analysis is one of the data collection methods that can be explained as a type of analysis that allows to examine and evaluate printed or electronic (computer-based and Internet-accessible) materials and documents, and to gather information from the examined documents and make new meanings (Corbin & Strauss, 2008). The data obtained on RME based on document analysis were analyzed by content analysis method. Content analysis is a technique used to reach objective, systematic and quantitative results discussed in the text (Polit & Beck, 2010). Data were analysed through the use of the Maxqda-11 qualitative data analysis program. The themes that emerged from the analysis were: contribution to the delivery of course, making connections with daily life, contribution to the attitude towards mathematics and, contribution to thinking skills.

Validity and Reliability

In this study, the credibility, transferability, dependability and confirmability strategies suggested by Guba and Lincoln (1994) were applied in order to ensure the credibility of the results obtained through the analysis of qualitative data. The triangulation technique was used for the credibility criterion. Triangulation of data sources can be classified in two ways as method and research review. The use of data obtained through different methods such as document analysis, observation and interview for confirmation increases the validity and reliability of the results (Yıldırım & Şimşek, 2013). In order to fulfill the transferability criterion, the results of the research were transferred with sufficient details. For the dependability stage, the creation of themes and codes was provided by two researchers and comparisons were made mutually. For the stage of confirmability, "direct quotations" of participants obtained from the studies were included. Each study within the scope of the research was coded as A1, p.1-T(PhD)3, p.1- T(M.A.)1, p.1 (A: Article; 1. Inclusion number; p: page; 1. page number; T(PhD): Doctoral Thesis; T(M.A.) Master's Thesis) and these codes were used in the analysis and interpretation stages.

FINDINGS

The themes and codes obtained as a result of the analyzes were presented as models. The first theme "Contribution to the Delivery of Course" is given in the model in Figure 2.

Some of the codes created in order to explain the contribution of RME to the delivery of course can be expressed as "providing teaching with different materials, effective use of time, modelling, permanence, solidarity, productivity, learning with fun, learning by doing, activity-based, team work, quiet classroom environment, learning through play, learning with music, ensuring class participation, visual problems make it easier to understand, providing an environment for discussion, enabling to make inferences by reasoning, providing exchange of ideas, increasing academic success, ensuring concentration and, keeping interest in the lesson alive."

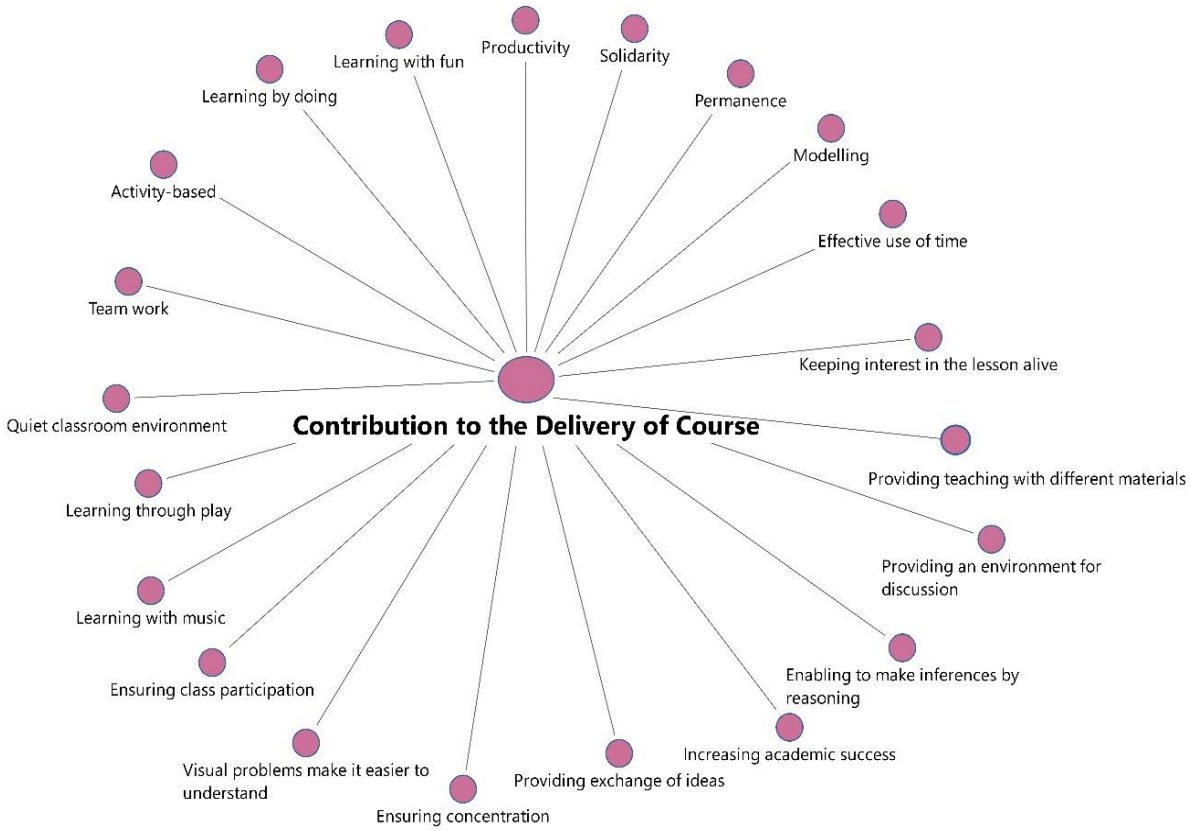

Figure 2. *Contribution of RME on the Delivery of Course*

Some direct quotations supporting the codes shown in Figure 2 are given below:

Being together with my friends affected me more. We achieved solidarity together T (M.A) 2, p.65.

Frankly, I loved these activities. And without realizing it, we have learned that subject T(M.A.)10, p.66.

... with this method, I both have a more fun lesson and learn more easily T(M.A.)15, p.80.

What is taught becomes more permanent and more understandable T (M.A) 5, p.75.

I can say that my grades in mathematics exams have increased thanks to the RME approach we have used in the lessons. I think my interest in the course and my belief that I will succeed in mathematics have increased. This allowed me to study mathematics and solve more questions and even be successful. Because I started to study by enjoying the lesson, and as I succeeded, I studied harder, which inevitably triggered success... T(PhD)1, p.151.

We exchanged ideas, helped each other and learned by discussing A4, p.35.

...good, fun, fantastic, and different A3, p.59.

When the activity is done, the topics become more understandable. Everyone participates because it's fun. For example, I was the type of person who slept all the time in math classes. But since we do activities, I willingly attend classes. For example, there were friends who could not do it in the group, I always wanted to do it instead of them T(M.A.)8, p.93.

Using supportive material in the lesson actually prevents the student from being distracted and motivates the student to the lesson. In addition, since it becomes concrete, it also facilitates the teaching of the subject T (M.A) 13, p.222.

We learned symmetry while dancing, we imagined tables T(M.A.)6, p.100.*We were able to understand the things that we could not understand with the help of our friends* A.2, p.517.

Figure 3 includes the theme of "Making Connections with Daily Life" and the codes under this theme

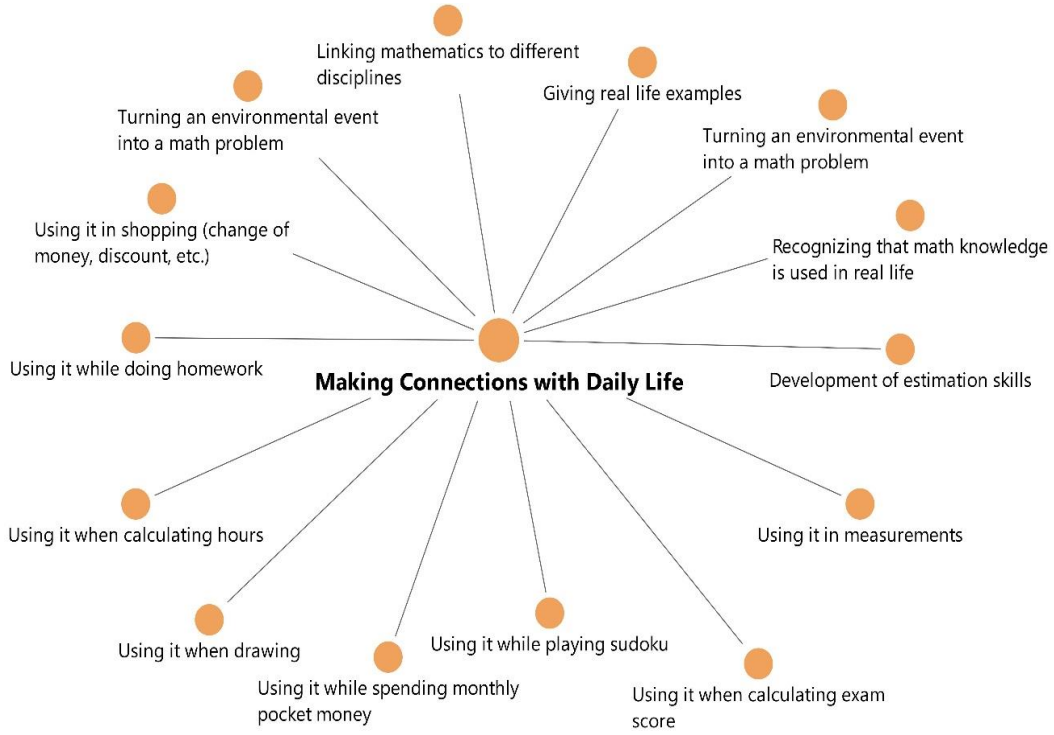

Figure 3. *RME's Making Connections with Daily Life*

Some of these codes are "recognizing that math knowledge is used in real life, turning an environmental event into a math problem, giving real life examples, linking mathematics to different disciplines, using it in shopping (change of money, discount, etc.), using it while doing homework, using it when calculating hours, using it when drawing, using it while spending monthly pocket money, using it while playing Sudoku, using it when calculating exam score, using it in measurements and, development of estimation skills." Some direct quotations regarding these codes are given below:

Even our mothers can use math while cooking without realizing it. How much salt or sugar to put T(M.A.)14, p.115.

During our course you're forced to make all the calculations concrete, by thinking up situations from the everyday world A.4, P.12.

Even estimating the air temperature requires knowledge of mathematics T(PhD)3, p.240.

RME is actually learning by doing. It is learning by discovering. .....Immediately taking students to the market, making them shop, and then asking them to learn what we are doing here now. The student will find it himself, experience and interpret the situation himself T(M.A)13,p.222.

Our mothers actually use math even in the kitchen. We were not aware of this before. But now we can see mathematics in everyday life T(PhD)3, p.217.

Children don't know how to pay rent, electricity bill, other expenses in real life. I think it would be a very enjoyable homework to examine the bills at home and take notes about the invoice and tax amounts for them T (M.A) 13, p.62.

Since our teacher gave real-life examples, I combined the concepts more easily in my mind A.6, p.159.

Math should be real life oriented. If we only study it for the exam, we cannot use or have difficulty in using it outside. Therefore, if it is real life oriented, our life outside becomes easier T (PhD)3, p.97.

We believe that we could show our students the relationship between mathematics and real-life A.5, p.311.

we learn better if we start every lesson with problems or examples in daily life. It is even more memorable because it connects the subject with real life T(M.A)15, p.83

The theme of "Contribution to the Attitude towards Mathematics" that is given in Figure 4 includes positive and negative attitudes.

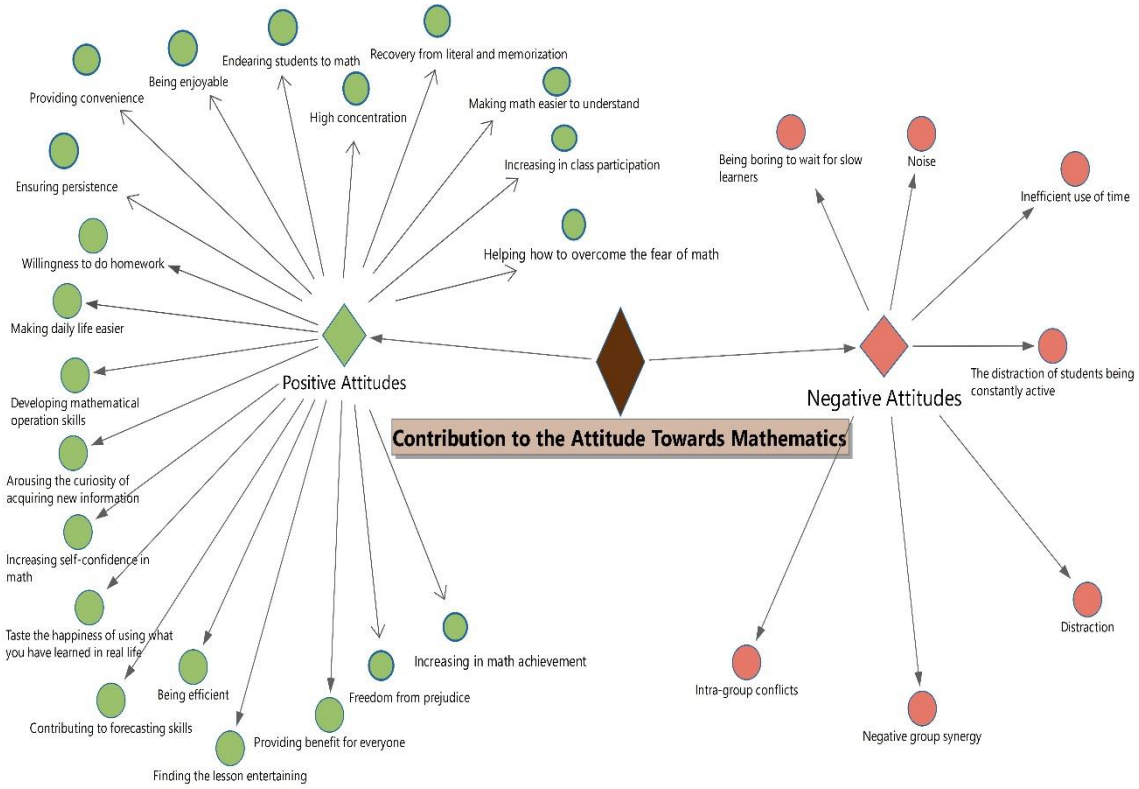

Figure 4. *Contribution of RME on the Attitude towards Mathematics*

Some codes taking part in the positive contribution to the attitude toward mathematics are: "freedom from prejudice, recovery from literal and memorization, high concentration, increasing in math achievement, making math easier to understand, increasing in class participation, helping how to overcome the fear of math, ensuring persistence, providing convenience, endearing students to math, being enjoyable, providing benefit for everyone, being efficient, finding the lesson entertaining, contributing to forecasting skills, taste the happiness of using what you have learned in real life, increasing self-confidence in math, arousing the curiosity of acquiring new information, developing mathematical operation skills, making daily life easier and, willingness to do homework." Some direct quotes are given below:

I used to be afraid of making mistakes in math classes. However, this method allowed me to overcome my fear because it gave us freedom T(M.A.)9, p.83.

I used to see the math class as just formulas. However, thanks to this method, my prejudices disappeared T (M.A) 12, p.84.

We liked math lessons more and waited for the lesson to come T(M.A.)4, p.138.

I can even learn math subjects that I think is a difficult subject. These activities destroyed my prejudices. I like mathematics T(PhD)1, p.147.

Love you so much. Mathematics seems like hide and seek to me. You are solving such a question and trying to find the answer. It's a fun lesson. Solving questions about math is also very fun T(M.A.)10, p.70.

We liked the math lesson more, we waited for the lesson to come T (M.A)2, p.65.

I didn't feel like attending math class before. But now the lesson interests me. I can understand math. I thought I wouldn't understand for the rest of my life because I couldn't understand it beforehand T(M.A.)12, p.86.

As shown in Figure 4, some negative codes such as inefficient use of time, noise, negative group synergy, the distraction of students being constantly active, being boring to wait for slow learners, distraction and, intra-group conflicts for math attitude also emerged. Some examples of direct quotations for these codes are given below:

It was boring to wait for some of our friends because they had a hard time solving problems T(M.A.)7, p.140.

It gets too loud sometimes, it's distracting T(M.A.)10, p.71.

I think I understood more in previous lessons. As I have already mentioned, there is too much noise in the class. When someone other than the teacher speaks in the classroom, I cannot concentrate on the lesson and have difficulty understanding it T(PhD)1, p.141.

I don't like in-group disagreements T(M.A.)10, p.67.

We cannot take notes in RME applications. When we can't keep a notebook, we don't know what to do in the exam. Some formulas were remembered while we were doing the activity, but I can't remember the others because we didn't take notes T(M.A.)8, p.92.

Too much emphasis on the same things makes the lesson boring. That's why I didn't like it T(PhD)2, p.78.

Figure 5 shows the theme of "Contribution to Thinking Skills" and the codes in this theme. The codes in this theme were aligned as "developing a different perspective, creative thinking, enabling discovery, gaining connection and association skills, abstract thinking, ability to express freely, providing a blend of ideas, gaining a different point of view, gaining problem solving skills, organizing problems of daily life situations, turning something into a mathematical problem, exchanging ideas, supporting concrete thinking, making it easier to imagine 3d objects, contribution to reasoning skills, contribution to inference and, gaining the ability to think independently."

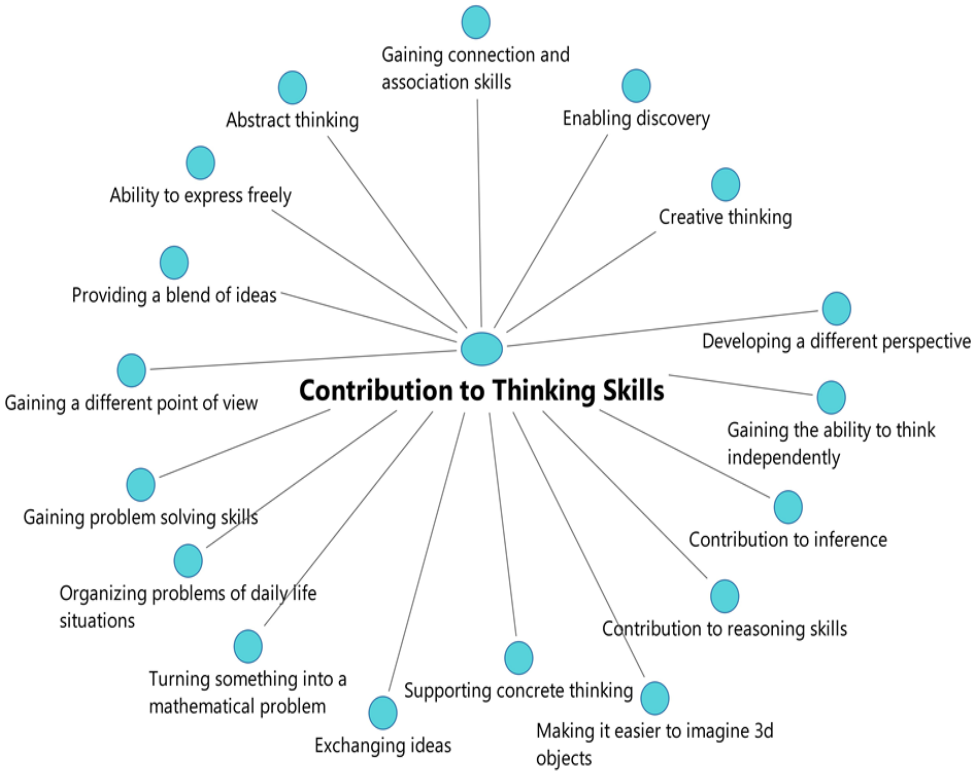

Figure 5. *Contribution of RME on Thinking Skills*

Some direct quotations related to these codes given in Figure 5 are below:

I think the contribution of creative thinking to the use of mathematics is great. In fact, we can say that mathematics and creative thinking are intertwined and inseparable T(PhD)1, p.158.

It is very useful and develops us both in terms of creative thinking and mathematics T(M.A.)15, p.82.

How the problem is solved gains importance in new activities. Our communication increased while we were solving real problems T (M.A) 11, p.67.

Even my friends, who had never wanted to speak in classes before, realized that their opinions were valued and they did not hesitate to express themselves. In this way, I can say that we are more social in the classroom and in mathematics lessons and even outside the classroom T(PhD)1, p.146.

I think it's thinking centered. In our education system, the teacher shows something. We try to memorize it blindly. However, I think that the courses that include the GMA approach make us think T(M.A.)7, p.76.

CONCLUSION AND SUGGESTIONS

When the documents of 24 studies reached within the scope of meta-thematic analysis were examined, many codes were found for the positive contributions of RME to the delivery of the course, facilitating learning by connecting with daily life, individual development, attitude towards mathematics and thinking skills. In this context, it is possible to say that RME contributes positively to students and teachers. In the literature, there are studies stating that the RME approach has a positive effect on students' success compared to traditional methods (i.e., Altaylar & Kazak, 2021; Aydın Ünal, 2008; Fhyn, 2008; Tarım & Kükürt, 2021; Uskun Aytekin, Çil & Kuzu, 2021; Webb, Van Der Kooji & Geist, 2011). Within the scope of the current study, it is clear that the use of the relevant approach in different subjects of math and at education levels affects success positively and ensures that the learning environment is productive. In this context, it has been revealed that in the learning environment, RME has developed the ability to work with the group and, in accordance with this, has increased the in-class cohesion and developed the feelings of cooperation and solidarity within the group. Similiar findings in some studies in the literature (i.e., Uskun Aytekin et al.,2021; Zulkardi, 2002) supports the results of the current research.

Within the scope of this study, it was revealed positive contributions of RME to the delivery of course. During this process, the activities implemented in the context of the relevant approach provided the students with the opportunity to participate actively in accordance with the principle of learning by doing and provided the learned subject to be more understandable and more permanent. In addition, it has been revealed that the use of supportive materials in the lesson prevents the distraction of the students and motivates them to the lesson. It is also among the observed findings that students learn by enjoying the lesson both in group work with their friends and individually in the lesson environment where they are active. These results show consistency with the results of the studies conducted by Aydın Ünal, 2008; Özdemir and Üzel, 2018; Wubbels, Korthagen and Broekman, 1997.

When the contributions of RME to connecting with daily life were examined, it was observed that the students generally enjoyed this approach. It is clear from the findings that the more real life oriented math is, the easier it is for students to adapt math to their outside lives. In this regard, real life problems given in the activities attracted more attention of the students and made them feel as if they were their own problems. In addition, it is obvious that RME contributes to the development of students' problem solving skills and to develop their own different solutions (Altaylı, 2012; Kurt & Doğan, 2019; Kösece, 2020; Pınar, 2019). On the other hand, it has been revealed that the students' awareness of solving the problems they may encounter in real life such as shopping payments, rent, electricity bills and other expenses or the amount of ingredients used in cooking has increased.

When the contributions of the RME approach to the math attitude were examined, it was revealed that students generally enjoyed the practices of this approach. The results of the research included in the analysis showed that the students developed a positive attitude towards math and thus they participated in the lesson more actively due to the fact that they have destroyed their prejudices against

math. While they saw mathematics as a boring lesson that they had to memorize formulas, could not put into practice because they could not concretize what they learned, and were afraid of making mistakes, it has now been revealed that their attitudes have changed in a positive way. In addition, it is also clear from the findings that RME arouses students' curiosity and makes the subject more interesting. On the other hand, it can be inferred from the studies that the limitations of RME can be eliminated by supporting the content with appropriate materials and activities in order to ensure learning by doing, planning the use of time well, preventing the distraction of the students who are constantly active (Bıldırcın, 2012; Cansız, 2015; Çelik, 2016; Demir, 2017; İnce, 2019; Korkmaz, 2017b).

It has been revealed that RME contributes positively to many thinking activities such as creative thinking, expressing oneself freely, supporting concrete thinking, gaining independent thinking skills, and exchanging ideas. Especially creative thinking and RME have been discussed together. In this vein, Ismunandar, Gunadi, Taufan, Mulyana and Runisah (2020) concluded that learning using the RME approach was effective enough to develop students' creative thinking. On the other hand, the results revealed that valuing students' ideas in math lessons increased their self-confidence and participation in the lesson, and they did not hesitate to express themselves and try to produce ideas in the lesson.

In conclusion, it is suggested that teachers use this approach in math education within the framework of appropriate subjects, since it is one of the approaches that are both suitable for the program and student-centered. It is also suggested that this approach, which allows students to have fun in the lessons, to associate what they have learned with daily life, and to participate effectively, should be applied more widely.

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Gerçekçi Matematik Eğitiminin Etkililiğinin Değerlendirilmesi: Meta-Tematik Analiz

Doç.Dr. Şenel Elaldı
Sivas Cumhuriyet Universitesi - Türkiye
ORCID: 0000-0003-0780-4207
selaldi@cumhuriyet.edu.tr

Özet

Bu çalışma, matematik öğretiminde kullanılan Gerçekçi Matematik Eğitiminin (GME) etkililiğini belirlemek amacıyla yapılmıştır. Bu amaçla GME kullanımına ilişkin katılımcı görüşlerinin yer aldığı çalışmalar, PRISMA akış şemasına uygun olarak ve araştırmacı tarafından belirlenen dahil edilme kriterleri doğrultusunda incelenmiştir. Bu kriterler "matematik alanında RME uygulamasını içeren çalışmalar, 2012-2022 yılları arasında yapılan çalışmalar (son on yıl), nitel katılımcı görüşlerini içeren araştırmalar ve Türkçe veya İngilizce yayınlanmış çalışmalar" şeklinde belirlenmiştir. Ulaşılan toplam 146 çalışma bu kriterlere göre değerlendirilmiş ve kalan 24 çalışma meta-tematik analize dahil edilmiştir. GME kullanımının incelenmesine ilişkin veriler doküman analizi ile elde edilmiş ve Maxqda-11 nitel veri analiz programı kullanılarak içerik analizi ile analiz edilmiştir. Analiz sonucunda dersin işlenmesine katkı, günlük yaşamla bağlantı kurma, matematiğe yönelik tutuma katkı ve düşünme becerilerine katkı temaları ortaya çıkmıştır. Bu temalar ve kodlar ayrı ayrı yorumlanmıştır. Ayrıca ilgili tema ve kodların sunumunu desteklemek için kaynaklardan doğrudan alıntılara yer verilmiştir. Analiz sonuçları, GME'nin matematik öğretimine birçok yönden olumlu katkı sağladığını ve öğrenme ortamında verimliliği artırdığını ortaya çıkarmıştır. Derste destekleyici materyallerin kullanımının öğrencilerin dikkatlerinin dağılmasını önlediği ve derse motive ettiği ortaya çıkmıştır. Öğrencilerin gerek arkadaşlarıyla grup çalışmalarında gerekse bireysel olarak aktif oldukları ders ortamında dersten keyif alarak öğrendikleri, öğrencilerin fikirlerine değer vermenin özgüvenlerini ve derse katılımlarını artırdığını, derste kendilerini ifade etmekten ve fikir üretmekten çekinmediklerini ortaya koymuştur. GME'nin matematik tutumuna olumsuz katkısı ise zamanın verimsiz kullanımı, gürültü, negatif grup sinerjisi ve grup içi çatışmalar gibi kodlarla ortaya çıkmıştır. Freudenthal'in söylemindeki "herkes için matematik" ilkesinin benimsenmesi, matematiğe karşı olumlu tutum geliştirilmesi ve gerçek hayatla ilişkilendirilebilmesi için GME uygulamalarına daha fazla yer verilmesi önerilmektedir.

Anahtar Kelimeler: *Gerçekçi Matematik Eğitimi, Matematiğe yönelik tutum, Matematik ve günlük yaşamla bağlantılar, Meta-tematik analiz*

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Genişletilmiş Özet

Problem: Gerçekçi Matematik Eğitimi (RME), Hollandalı matematik eğitimcisi Hans Freudenthal tarafından kurulan ve matematik öğretimi ve öğreniminde ihtiyaç duyulan yenilik hareketini gerçekleştirmek için Freudenthal Enstitüsü tarafından geliştirilen bir matematik öğretim yaklaşımı ve aynı zamanda matematik alanına özgü bir eğitim teorisidir (Van den Heuvel-Panhuizen, 1996). GME, matematiğin bir konu alanı olduğu, öğrencilerin matematiği nasıl öğrenebilecekleri ve matematiğin nasıl öğretilmesi gerektiği üzerine kurulu alana özgü bir öğretim kuramıdır (Van den Heuvel-Panhuizen & Wijers, 2005).

Freudenthal'ın matematikle ilgili savı gelecekte tüm öğrencilerin matematikçi olacağı üzerine değil, matematiğin büyük çoğunluk için günlük hayatlarındaki problemleri çözmek için bir araç olacağı üzerinedir (Koleza, 2000). Bu nedenle GME yaklaşımının temelinde öğrenilebilir ve erişilebilir bir matematik eğitimi sağlama fikri yatmaktadır (Gravemeijer & Terwel, 2000). Matematik dersinde gerçek hayattan bir problemin alınması ve bunun öğrenciler için matematiksel sembollerle ifade edilmesi, GME yaklaşımı için matematikleştirmedir. Diğer bir deyişle Freudental, gerçek bir modelden matematiksel bir kavrama ulaşma sürecini matematikleştirme olarak adlandırmıştır (Freudenthal, 1968, aktaran Altun, 2008).

Alanyazın incelendiğinde GME yaklaşımının öğretimde kaliteyi ve başarıyı artırdığı (Cansız, 2015; Sevinc & Lesh,2018; Tarım & Kükürt, 2021), keşfederek öğrenme sağladığı (Özdemir & Üzel,2011), öğrencilerin matematiğe karşı olumlu tutum geliştirmelerine yardımcı olduğu (Korkmaz, 2017a; Okuyucu, 2019; Özdemir, 2019; Sevim, 2019), düşünme becerilerini geliştirdiği (Cansız, 2015; Çilingir, 2015; Çolak, 2020; Ödemiş, 2019; Özdemir & Üzel, 2011) ve gerçek hayatla ilişkilendirerek anlamlı ve kalıcı öğrenme sağladığı (Çilingir Altıner & Dinç Artut, 2017; Çolak, 2020; Gibney, 2014; Kösece, 2020) ortaya çıkarılmıştır.

Bu çalışma, öğrenci ve etkinlik merkezli yaklaşımlardan biri olan GME yaklaşımının matematik öğretimindeki etkililiğini belirlemek amacıyla yapılmıştır. Bu doğrultuda ulusal ve uluslararası alanyazında GME'ye ilişkin nitel boyutu içeren çalışmaların etkinliğinin katılımcı görüşleri doğrultusunda araştırılması amaçlanmıştır.

Alanyazın taramasında, GME ile ilgili yapılan bir meta-tematik analiz çalışmasına rastlanmıştır. Ancak Uyanıker (2021) tarafından yapılan bu çalışmada sadece Türkiye'de yapılmış tezlerin analizi ele alınmış; makaleler ve uluslararası çalışmalar dahil edilmemiştir. Alanyazında GME ile ilgili meta-tematik analiz içeren yeterli çalışma bulunmaması nedeniyle makaleler ve uluslararası çalışmaları da kapsayan daha detaylı bir analizle alana katkı sağlamak amaçlanmış ve mevcut araştırmanın yürütülmesine karar verilmiştir. Bu doğrultuda, GME'nin:

- dersin işlenişine,
- günlük yaşamla bağlantısına,
- matematiğe yönelik tutuma ve,
- düşünme becerilerine katkısının ortaya çıkarılması amaçlanmıştır.

Yöntem: Nitel boyut kapsamında katılımcı görüşlerine yer verilen araştırmalar incelenmiş ve bu çalışmaların meta-tematik analizi yapılmıştır. Meta-tematik analizde doküman analizi yoluyla elde edilen bilgilerden yeni temalar ve kodlar oluşturulur (Batdı, 2019).

Ulusal Tez Merkezi (YÖK), Dergipark, ProQuest Dissertations and Theses, Web of Science, Ebscohost-Eric, Dergipark, Sage Journals Online ve Google Scholar veritabanlarından GME ile ilgili çalışmalar taranmıştır. Tarama yapılırken hem Türkçe hem de İngilizce olarak "GME Uygulamaları", "matematik eğitiminde GME" anahtar kelimeleri kullanılmıştır. Tarama sonucunda amaçlı örnekleme yöntemlerinden ölçüt örneklemeye göre araştırmacı tarafından hazırlanan ölçütlere göre tüm çalışmalar incelenmiştir.

Araştırma Ölçütleri:

a) Matematik alanında RME uygulamasını içeren çalışmalar
b) 2012-2022 yılları arasında yapılan çalışmalar (son on yıl)
c) Nitel katılımcı görüşlerini içeren çalışmalar
d) Türkçe veya İngilizce yayınlanmış çalışmalar

Bu ölçütler kapsamında ulaşılan toplam 146 çalışma incelenmiş ve Prisma Akış Şeması'nda (Bkz. Şekil 1) gösterildiği gibi eleme kriterleri sonucu 24 çalışma analize dahil edilmiştir. Veriler döküman analiziyle elde edilmiş ve içerik analizi yöntemiyle Maxqda-11 nitel veri analiz programı kullanılarak analiz edilmiştir. Çalışmanın geçerlik ve güvenirliğinde Guba ve Lincoln'ün (1994) inandırıcılık, aktarılabilirlik, güvenirlik ve onaylanabilirlik stratejileri uygulanmıştır.

Sonuçlar: Analiz sonucunda GME'nin; Dersin İşlenmesine Katkısı, Günlük Yaşamla Bağlantı Kurmaya Katkısı, Matematiğe Yönelik Tutuma Katkısı ve Düşünme Becerilerine Katkısı temaları ortaya çıkmıştır.

"**Dersin İşlenmesine Katkısı**" teması altında: "farklı materyalle ders işlemeyi sağlaması, etkili zaman kullanımı, modelleme, kalıcılık, dayanışma, yardımlaşma, verimlilik, eğlenerek öğrenme, grup çalışması, sessiz sınıf ortamı, oyunla öğrenme, müzik eşliğinde öğrenme, derse katılımı sağlama, görsel problemlerin anlamayı kolaylaştırması, tartışma ortamı sunması, akıl yürüterek çıkarımda bulunmayı sağlaması,fikir alışverişini sağlaması, akademik başarıyı artırması, konsantrasyonu sağlaması ve derse olan ilgiyi canlı tutması" kodları yer almıştır.

"Günlük Yaşamla Bağlantı Kurmaya Katkısı" teması altında yer alan kodlar şunlardır: "matematik bilgisinin gerçek hayatta kullanıldığını fark etme, çevresel bir olayı matematik problemine dönüştürme, gerçek hayattan örnekler verme, matematiği farklı disiplinlerle ilişkilendirme, alışverişte kullanma (para bozdurma, indirim vb.), ödev yaparken kullanma, saat hesabı yaparken kullanma, çizim yaparken kullanma, aylık harçlık harcarken kullanma, sudoku oynarken kullanma, sınav puanı hesaplamak için kullanma."

"Matematiğe Yönelik Tutuma Katkısı" temasında olumlu ve olumsuz katkıları olmak üzere iki kategori oluşturulmuştur. Olumlu katkıları altında "önyargılardan arınma, ezberden kurtulma, yüksek konsantrasyon, matematik başarısını artırma, matematiği daha kolay anlaşılır kılma, derse katılımı artırma, matematik korkusunu yenmeye yardımcı olma, kolaylık sağlama, öğrencilere matematiği sevdirme , eğlenceli olma, herkese fayda sağlama, verimli olma, dersi eğlenceli bulma, tahmin etme becerisine katkı sağlama, öğrendiklerini gerçek hayatta kullanmanın mutluluğunu tatma, matematiğe özgüveni artırma, yeni bilgiler edinme merakı uyandırma, matematiksel işlem becerilerini geliştirme, günlük hayatı kolaylaştırma ve ödev yapmaya istekli olma"kodları yer almıştır. Olumsuz katkıları altında ise "zamanı etkisiz kullanma, gürültü, negatif grup sinerjisi öğrencilerin sürekli aktif olmasının dikkat dağıtması, yavaş öğrenenleri beklemenin sıkıcı olması, dikkat dağılması ve grup içi anlaşmazlıklar" kodları yer almıştır.

"Düşünme Becerilerine Katkısı" teması **"**farklı bakış açısı geliştirme, yaratıcı düşünme, keşfetmeyi sağlama, bağlantı kurma ve ilişkilendirme becerisi kazanma, soyut düşünme, özgürce ifade etme, fikirleri harmanlama, farklı bakış açısı kazanma, problem çözme becerisi kazanma, günlük yaşam durumlarına ait problemleri organize etme, bir şeyi matematik problemine dönüştürme, fikir alışverişinde bulunma, somut düşünmeyi destekleme, 3 boyutlu nesneleri hayal etmeyi kolaylaştırma, muhakeme becerilerine katkı, çıkarım yapma ve bağımsız düşünme becerisi kazanma" kodlarından oluşmuştur.

Öneriler: Meta-tematik analiz kapsamında ulaşılan 24 çalışmanın dokümanları incelendiğinde GME'nin dersin işlenmesine olumlu katkıları, günlük hayatla bağ kurarak öğrenmeyi kolaylaştırması, bireysel gelişime katkısı, matematiğe yönelik tutuma katkısı ve düşünme becerilerine katkısı ortaya çıkmıştır. Bu bağlamda GME'nin öğrenci ve öğretmenlere olumlu yönde katkı sağladığını söylemek mümkündür. Alanyazında GME yaklaşımının geleneksel yöntemlere göre öğrenci başarısı üzerinde olumlu etkisi olduğunu belirten çalışmalar bulunmaktadır (örn., Altaylar & Kazak, 2021; Aydın Ünal, 2008; Fhyn, 2008; Tarım & Kükürt, 2021; Uskun Aytekin, Çil & Kuzu, 2021; Webb, Van Der Kooji & Geist, 2011). Mevcut çalışma kapsamında ilgili yaklaşımın matematiğin farklı konularında ve eğitim kademelerinde kullanılmasının başarıyı olumlu yönde etkilediği ve öğrenme ortamında verimliliği sağladığı açıktır. Bu bağlamda GME'nin öğrenme ortamında grupla çalışma becerisini geliştirdiği ve buna uygun olarak sınıf içi kaynaşmayı arttırdığı, grup içi işbirliği ve dayanışma duygularını geliştirdiği ortaya çıkmıştır. Alanyazındaki bazı araştırmalarda (Uskun Aytekin vd.,2021; Zulkardi, 2002) benzer bulgular mevcut araştırma sonuçlarını desteklemektedir.

Bu çalışma kapsamında GME'nin dersin işlenmesine olumlu katkıları ortaya konulmuştur. Derste destekleyici materyallerin kullanımının öğrencilerin dikkatlerinin dağılmasını önlediği ve derse motive

ettiği ortaya çıkmıştır. Matematik ne kadar gerçek hayata yönelik olursa, öğrencilerin matematiği dış yaşamlarına uyarlamaları o kadar kolay olmaktadır. Bu bağlamda etkinliklerde verilen gerçek yaşam problemleri öğrencilerin daha çok ilgisini çekmiş ve kendi problemleriymiş gibi hissetmelerini sağlamıştır. Öğrencilerin formülleri ezberlemek zorunda kaldıkları, öğrendiklerini somutlaştıramadıkları için matematiği sıkıcı bir ders olarak görürken, artık tutumlarının olumlu yönde değiştiği ortaya çıkmıştır. Ayrıca GME'nin öğrencilerde merak uyandırdığı ve konuyu daha ilgi çekici hale getirdiği de bulgulardan anlaşılmaktadır. GME'nin yaratıcı düşünme, kendini özgürce ifade etme, somut düşünmeyi destekleme, bağımsız düşünme becerisi kazanma, fikir alışverişinde bulunma gibi birçok düşünme etkinliğine olumlu katkı sağladığı ortaya çıkmıştır. Özellikle yaratıcı düşünme ve RME birlikte ele alınmaktadır. Öte yandan, sonuçlar matematik derslerinde öğrencilerin fikirlerine değer vermenin özgüvenlerini ve derse katılımlarını artırdığını, derste kendilerini ifade etmekten ve fikir üretmekten çekinmediklerini ortaya koymuştur.

Sonuç olarak, bu yaklaşımın hem programa uygun hem de öğrenci merkezli yaklaşımlardan biri olması nedeniyle öğretmenlerin matematik eğitiminde uygun konular çerçevesinde kullanmaları önerilmektedir. Öğrencilerin derslerde eğlenmelerini, öğrendiklerini günlük hayatla ilişkilendirmelerini ve etkin katılımlarını sağlayan bu yaklaşımın daha yaygın olarak uygulanması önerilmektedir.